# FORENSIC SCIENCE INDIA REPORT

*A Study of Forensic Science Laboratories (2013-2017)*

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NLU DELHI

PROJECT 39A
EQUAL JUSTICE
EQUAL OPPORTUNITY

# FORENSIC SCIENCE INDIA REPORT

## A Study of Forensic Science Laboratories (2013-2017)

by Project 39A
National Law University, Delhi

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We are also deeply grateful to Ms. Punya Srivastava, Additional Secretary, Prime Minister's Office, Mr. Anil Subramaniam, Joint Secretary, Ministry of Home Affairs, and Dr. SK Jain, Director-cum-Chief Forensic Scientist of the Directorate of Forensic Science Services (DFSS) at the Ministry of Home Affairs for their faith in our idea and abilities to conduct this survey and for their incredible support throughout the process. Thanks to Dr. S Ahmed, Senior Scientific Officer, DFSS for facilitating communication with the laboratories and his assistance.

The mentorship and guidance provided by Dr. TR Baggi has been crucial for the conceptualisation and execution of this survey. As the next generation of professionals working at the intersection of forensic science and law, we are truly inspired to witness and learn from his untiring efforts and lifelong commitment to strengthening the field of forensic science.

This survey would not have been possible without the unwavering support and enthusiasm from National Law University, Delhi (NLU Delhi), particularly Professor Ranbir Singh and Professor Srikrishna Deva Rao (former Vice Chancellors, NLU Delhi), Professor (Dr.) GS Bajpai (Vice Chancellor, NLU Delhi) and Professor Harpreet Kaur (Registrar, NLU Delhi). I am especially thankful to Dr. Anup Surendranath for his companionship, guidance and constant encouragement to build our work on forensics at Project 39A and for trusting the vision for this project.

Finally, this report is the culmination of the efforts by many talented and hardworking individuals, who partook in this unscripted journey with me. Devina Sikdar was crucial in laying the foundation for our work on forensics at Project 39A and has contributed immensely to the conceptualisation and designing of this survey, and conducting the fieldwork. The research, data analysis and the first phase of report-writing was powered by the intellect, commitment and rigour shown by Devina Malaviya and Devina Sikdar. As much of this work was conducted remotely during the stressful and uncertain conditions of the COVID-19 pandemic, I am truly grateful to them for their perseverance. Lastly, this report has been made possible only through the diligence, tenacity and terrific efforts by Maria Divya Sahayaselvan, Saloni Ambastha and Ishita Gupta in the second phase of analysis and writing. They faced the deep-end of this project with great resolve and have carried this crucial work over the finish line through their hard work. It is a matter of tremendous pride to lead this remarkable and interdisciplinary team of forensic scientists and lawyers, to reimagine the system of forensic science in India which operates in pursuit of justice and fairness for all.

The contributions of the NLU Delhi student volunteers in the initial data collection and fieldwork have greatly benefited this project. We are also thankful for the support and guidance by Karthik Ramesh in the data input and trend analysis for this report.

Finally, I would be remiss to not acknowledge my incredible colleagues, current and former, across different teams at Project 39A, who inspire and drive me by setting a great example through their own work and scholarship. I would also like to thank the administrative and finance staff at Project 39A for their constant support and for making it all possible.

**Shreya Rastogi**

*Project Head and Lead Author*

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# MESSAGE FROM THE VICE-CHANCELLOR

This report is aimed at deepening our collective understanding of the issues facing the forensic science system in India. It seeks to stimulate a system-wide assessment of the quality of evidence produced by forensic science laboratories for courts of law. In light of the increasing reliance on forensic science as an instrument for ensuring justice, this report is a timely and necessary intervention towards examining the needs of our forensic infrastructure and the quality of forensic evidence submitted in courts.

The working conditions in laboratories have a direct impact on the validity and reliability of the reports furnished by the forensic scientists. Besides its unfamiliarity with the ground reality of the forensic science system, the legal community has an insufficient understanding of the scientific foundations underlying the forensic science disciplines. Despite this, heavy reliance is placed on the opinions of forensic experts across different types of legal proceedings. Such an approach fails to account for both the limitations of forensic science and the practical challenges faced by laboratories, which can cause injustice to victims and accused persons alike.

The roadmap towards building a strong and robust forensic system must be imagined from both scientific and legal perspectives. The cross-disciplinary lens of this report sheds the constraints of viewing the role and functioning of the forensic system in silos. It comprehensively studies the functioning of government forensic science laboratories, covering aspects ranging from their funding, human resources, case processing, infrastructure to quality management. While the issues of case pendency and the lack of adequate staff have been repeatedly recognised by courts, a serious overhaul of the governance of forensic science in India is urgently needed. I am delighted to see that my colleagues at Project 39A have undertaken to examine these critical gaps at the intersection of law and science.

Rigorous empirical research on forensic science is not an easy task. Only two surveys by government bodies have been previously attempted towards assessing the forensic science system at a national level. This report is the outcome of a first-of-its-kind study to conduct field surveys of the laboratories and incorporate the on-ground narratives from forensic scientists working in them about their daily challenges. I would like to express my heartfelt gratitude to Ms. Punya Srivastava, Additional Secretary, Prime Minister's Office, Mr. Anil Subramaniam, Joint Secretary, Ministry of Home Affairs, and Dr. SK Jain, Director-cum-Chief Forensic Scientist of the Directorate of Forensic Science Services at the Ministry of Home Affairs for their support in enabling such access and for guiding this survey. Such dedication to institutional self reflection is rare and we are deeply appreciative of the faith reposed in the Forensics research team at Project 39A headed by Ms. Shreya Rastogi.

We are also indebted to Dr. TR Baggi (Former Director, Central Forensic Science Laboratory, Hyderabad) for his invaluable role as Senior Project Advisor. His knowledge and insights have been crucial in the successful completion of this project. Our gratitude is extended particularly to the scientists and the staff at the forensic science laboratories surveyed, for sharing their experiences and trusting the research team to represent them faithfully in this report.

Supporting robust empirical research is one of the core pillars of National Law University, Delhi as a legal institution, and Project 39A continues to fulfil this institutional vision. We hope that this report is a useful tool for policymakers, judges, legal professionals and forensic scientists to better understand and address the current challenges in the administration and functioning of the forensic science system. I hope that it inspires a nation-wide resolve towards ensuring that only scientifically valid and reliable evidence is used within the criminal justice system.

**Professor (Dr.) GS Bajpai**

*Vice Chancellor, National Law University, Delhi*

# NOTE FROM THE EXECUTIVE DIRECTOR

Forensic science will play an increasingly dominant role in the future of India's criminal justice system. Yet, India lacks a comprehensive regulatory framework and the legal standards necessary to govern the use of forensics in the administration of criminal justice. Given the level of objectivity attributed to the evidence of forensic experts in our criminal justice system, the absence of both a policy framework and legal standards presents an urgent problem.This report is the outcome of a growing worry that the forensic substructure upon which criminal justice rests may, in fact, not be capable of bearing the burden being placed on it.

It shows that forensic laboratories grapple with myriad challenges in every aspect of their functioning, along with the unrelenting demands of the legal system. Despite mounting pressure on the laboratories to provide definitive answers to the questions posed in a trial, they operate in highly restrictive conditions, with alarming levels of pendency in casework and vacancy in personnel. Their problems are exacerbated by the absence of a regulatory structure to monitor and provide necessary support to them. Forensic policy has to develop scientific and quality standards to ensure that the evidence submitted by laboratories is foundationally valid. Simultaneously, courts must also develop legal standards to ensure the evidentiary reliability of forensic evidence.

Without legislative or judicial standards to govern the assessment of forensic evidence, unscientific forensic disciplines are still relied on by Indian courts. For instance, while some foreign courts do not admit bitemark evidence as its foundational validity has been disproved, Indian courts continue to convict on the basis of it. Additionally, courts do not evaluate whether the forensic technique was correctly applied by the forensic scientist in a specific case. These issues are exacerbated by procedural rules that allow forensic reports to be admitted without the examination of the forensic scientist as witness before court.

The gaps in Indian forensic policy are particularly stark due to the dearth of comprehensive data and research into the state of our forensic laboratories. Previous government reports on the forensic science system and the recommendations made therein have gone largely unnoticed. Our hope is that this report will meet a different fate, given its rigorous empirical backing and independent authorship. My colleague Shreya Rastogi has displayed exceptional commitment to conceptualising and implementing this study, leading a team of dedicated professionals to execute the work through many hurdles. Their zeal in executing such an intricate and demanding survey was remarkable. This monumental effort by the team is particularly commendable given that large parts of it were conducted during the COVID-19 pandemic, which increased the difficulties with fieldwork and data analysis. Ultimately, it was only possible because of the crucial support of the laboratories that participated in the survey and displayed their commitment to imagining a stronger forensic science landscape.

The recommendations in this report are an effort to strengthen the use of forensic evidence in India's administration of the criminal justice system. The benefits of developing a governance framework and evidentiary standards for forensic science for a variety of stakeholders including investigative agencies, judicial actors, legal professionals and forensic scientists, cannot be overstated. Most importantly, this report hopes to secure the interests of both victims and accused persons, so that questions of justice and liberty are not erroneously answered due to our inattention towards the forensic science system.

**Dr. Anup Surendranath**
*Professor of Law*
*Executive Director, Project 39A*
*National Law University, Delhi*

# FOREWORD

Forensic science is a critical element of the criminal justice delivery system. It is a multidisciplinary and dynamic science. From the collection of evidence at crime scenes to the submission of expert reports in courtrooms, forensic science has improved the quality and accuracy of criminal investigations and trials. New path-breaking advancements in the branches of pure and applied sciences are regularly adopted in improving and perfecting different forensic disciplines. Courts rely on forensic evidence due to the assurance lent by this scientific background. However, not all forensic disciplines have empirically-tested foundations. While the foundational validity of laboratory-based disciplines like forensic chemistry, forensic physics, and forensic biology including DNA profiling is established, pattern-matching disciplines like footwear impressions, firearms analysis, document examination and tool marks are more subjective, with little scrutiny of their scientific foundations. Cyber forensics is an essential new discipline which is also finding its rightful place, but needs to be standardised and established. Therefore, there is a need for the forensic and legal systems to evolve and ensure that only scientifically valid, reliable and unequivocal techniques are relied upon.

It is equally important to address the challenges facing the administration and functioning of forensic science laboratories. The operational independence and financial autonomy of forensic science laboratories must be secured to ensure that the laboratories are able to set their own priorities with respect to budgetary requirements, infrastructure, human resources, training and case examination. Further, issues relating to funding and expenditure, human resources and case management vary across laboratories and divisions, and must be understood separately. There is an urgent need for the harmonization of standard operating procedures across the country. Recognising the need for evidence-based policy making to address the needs of the forensic science system, Project 39A at National Law University, undertook this landmark survey in India in collaboration with the Ministry of Home Affairs which combined quantitative and qualitative data collection with comparative analysis of best practices followed in other jurisdictions. The study's commitment to view forensic science from the lens of scientific foundations and quality management is also not fully explored in the Indian context.

Towards overhauling the forensic science system in India, central and state governments should initiate mechanisms towards implementing the recommendations made in this report. This would ensure that only well-grounded scientific reports are submitted in courts. Such periodical surveys followed by critical, technical and statistical analysis are necessary to assess the proficiencies and deficiencies within the system.

**Dr. Tulsidas R Baggi,**
PhD, FIC, FRSC
*Senior Project Advisor*
*Former Director,*
*Central Forensic Science Laboratory, Hyderabad*

# LIST OF ABBREVIATIONS

| | |
|---|---|
| **BCOI** | Bar Council of India |
| **BPR&D** | Bureau of Police Research & Development |
| **CAG** | Comptroller & Auditor General |
| **CBI** | Central Bureau of Investigation |
| **CDFD** | Centre for DNA Fingerprinting & Diagnostics, Hyderabad |
| **CFPB** | Central Fingerprint Bureau |
| **CFSL** | Central Forensic Science Laboratory |
| **CrPC** | Code of Criminal Procedure , 1973 |
| **CSO** | Crime Scene Officer |
| **DDO** | Drawing & Disbursing Officer |
| **DFSS** | Directorate of Forensic Science Services |
| **DRDO** | Defense Research & Development Organisation |
| **FBI** | Federal Bureau of Investigations |
| **FCOI** | Forensic Council of India |
| **FCS** | Flexible Complementing Scheme |
| **FSL** | Forensic Science Laboratory |
| **FSR** | Forensic Science Regulator |
| **FTCoE** | Forensic Technology Center of Excellence, US |
| **FY** | Financial Year |
| **GEQD** | Government Examiner of Questioned Document |
| **GFR** | Government Financial Rules |
| **IEA** | Indian Evidence Act, 1872 |
| **ISO** | International Organisation for Standardization |

| | |
|---|---|
| **LIMS** | Laboratory Information Management System |
| **LNJP NICFS** | Lok Nayak Jayaprakash Narayan National Institute of Criminology & Forensic Science |
| **MHA** | Ministry of Home Affairs |
| **MFSU** | Mobile Forensic Science Unit |
| **MoHFW** | Ministry of Health & Family Welfare |
| **MoPP&P** | Ministry of Personnel, Public Grievances & Pensions |
| **MPF** | Modernisation of Police Forces |
| **NABL** | National Accreditation Board for Testing & Calibration Laboratories |
| **NAS** | National Academy of Sciences |
| **NCRB** | National Crime Records Bureau |
| **NFSU** | National Forensic Science University |
| **NHRC** | National Human Rights Commission India |
| **NICFS** | National Institute of Criminology & Forensic Science |
| **NIJ** | National Institute of Justice, US |
| **NIST** | National Institute of Standards & Technology, US |
| **NMC** | National Medical Commission |
| **OCME** | Office of Chief Medical Officer, New York |
| **OSAC** | Organization of Forensic Area Committees for Forensic Science, US |
| **PCAST** | President's Council of Advisors on Science & Technology |
| **R&D** | Research & Development |
| **RFSL** | Regional Forensic Science Laboratory |
| **RR** | Recruitment Rules |
| **SFSL** | State Forensic Science Laboratory |
| **SOP** | Standard Operating Procedure |

| | |
|---|---|
| **SPAC** | Scientific Performance Audit Committee |
| **SPSC** | State Public Service Commission |
| **SSC** | Staff Selection Commission |
| **SWG** | Scientific Working Group |
| **SWGDAM** | Scientific Working Group on DNA Analysis Methods |
| **UPSC** | Union Public Service Commission |
| **WPM** | Working Procedure Manual |

# EXECUTIVE SUMMARY

## INTRODUCTION

Forensic science is a crucial part of the criminal justice administration. It refers to the application of scientific methods and techniques to assist in the collection, identification, analysis and interpretation of evidence. The results of forensic analysis and the opinions of forensic examiners are considered expert scientific evidence under Indian law. The quality of forensic examination conducted by forensic science laboratories (FSLs) impacts the interests of victims and defendants alike.

Forensic laboratories in India have been in existence since the British colonial era, and are now administered in a three-tiered structure of Central, State and Regional FSLs (CFSLs, SFSLs, RFSLs), with additional district mobile forensic units (MFSUs).[1] Currently, there are 117 functional FSLs, of which 10 are accredited by the National Accreditation Board for Testing and Calibration Laboratories (NABL).

There are eight CFSLs, including CFSL Unit in Shimla, governed by the Union Ministry of Home Affairs (MHA) through the Directorate of Forensic Science Services (DFSS). The CFSL in Delhi was under the Central Bureau of Investigation (CBI) until recently. Across the states, there are 31 SFSLs and 78 RFSLs which are currently functional and are administered by each state's home or police departments. RFSLs and MFSUs

1 See Graphic 1 on the organisation of the forensic science system in India at pg 41.

in every state are under the administrative and financial control of the respective SFSL. While the DFSS does not exercise direct control over state and regional laboratories, it provides financial and technical support to all FSLs. Distinct from this framework, forensic medicine is administered by the Ministry of Health and Family Welfare (MoHFW) through the Directorate General of Health Services (DGHS). Autopsies and examinations in medico-legal cases (MLCs) are conducted in government hospitals and medical colleges.

Despite the growing focus on forensics, there is a significant dearth of empirical research on the challenges and needs of FSLs in India. It is also essential to scientifically audit the practice within different forensic divisions within each FSL. Previous reports, including the National Human Rights Commission's 'State of the Art of Forensic Science: For Better Criminal Justice' (1999), and the Ministry of Home Affairs reports 'Perspective Plan on Indian Forensics' (2010) and 'Report on Scientific Performance Audit of DFSS HQ and its CFSLs' (2011) have identified significant concerns regarding the inadequacy of financial, personnel and infrastructural resources within laboratories. However, the recommendations made in these reports have not been implemented.

This Report aims to fill the critical gaps in our understanding of the prevailing conditions and issues within FSLs. In this survey, 61 FSLs were chosen within the sample size, in order to include all CFSLs (8), SFSLs (31) and at least one RFSL (22) from each state. 30 laboratories responded to the survey, comprising three CFSLs, 17 SFSLs and 10 RFSLs.[2] Out of these participating laboratories, we visited 17 FSLs as part of our fieldwork. The Report integrates quantitative data from the assessment period i.e. 2013-2017, with on-ground narratives of forensic scientists to identify the challenges faced by FSLs regarding budget and expenditure, recruitment, education and training, case management, infrastructure and quality management. Based on their inputs and comparative best practices, we have made recommendations towards addressing these structural problems. The Report also includes a scientific audit of the forensic DNA profiling practices followed in India, given the rising demand for DNA

**2** See Graphic 2 showing a map of functional FSLs in India at pg 51.

evidence and its position as one of the most advanced forensic disciplines. Finally, we provide an analysis of the law on expert forensic evidence.

To strengthen the current forensic science system, adherence to principles of quality control and quality assurance must be the focus of legislative, executive and judicial interventions on forensic science.

## CHAPTER I: BUDGET & EXPENDITURE

### Trends

- The central government funds the CFSLs and provides financial support to state laboratories through schemes or specific grants. SFSLs and RFSLs are primarily funded by the respective state governments. The process of budget approvals, fund disbursal and expenditure approvals is complex and varied. Overall, there is a high variance in the budget and expenditure data between FSLs.[3]

*Receipt*

- 18 out of 30 laboratories provided information on sources and amounts of funds received. The proportion of different funding sources in the total fund receipt varies across laboratories[4] and assessment years.[5] Central funding is highly inconsistent and no SFSL or RFSL received central funding in every assessment year.[6] Despite a disparity in state funding across laboratories, six FSLs showed a consistent increase in the yearly receipt of state funds.[7]
- Seven FSLs received more funds overall than their total forecasted budget, while CBI-CFSL and RFSL Nagpur received less than 50% of their total forecast, getting as little as 14% in one year and more than 100% in others.[8]

**3** See Graphic 3 on the ranking of FSLs as per total funds received at pg 63.

**4** See Graphic 4 on the breakdown of funding sources for FSLs at pg 65.

**5** See Graphic 5 and 6 on year-wise funding received from the central and state governments respectively at pg 68 and 70.

**6** See Graphic 5 on year-wise funding received from the central government at pg 68.

**7** See Graphic 6 on year-wise funding received from state governments at pg 70.

**8** See Table 2 on laboratory-wise comparison of forecast, receipt and expenditure of funds across the assessment period at pg 79.

*Expenditure*

- 20 laboratories provided information on the forecasted budget and 22 supplied information on expenditure. Collectively, laboratories spent only 69.4% of the total forecasted amount, spending only 40.2% of the amount forecasted on equipment & maintenance.[9] Although the expenditure on equipment consistently increased over time, it was less than 50% of the amount forecasted throughout the assessment period.[10]
- Three FSLs recorded a higher overall expenditure than their forecasted budget, while CBI-CFSL and RFSL Nagpur spent less than 50% of their forecasted budget.[11]
- Received funds were underutilised consistently across years by CBI-CFSL, CFSL Chandigarh, SFSL Bhubaneswar, SFSL Raipur and RFSL Nagpur. SFSL Raipur spent less than 75% of its received funds every year. On the other hand, RFSL Dharamshala, SFSL Lucknow and SFSL Shimla had an overall expenditure-to-receipt ratio of 100% or more. [12]

## Challenges

- 15 out of 27 state and regional laboratories in the survey were under the administrative and financial control of the police department. They had more cumbersome budget approval, receipt and disbursal processes. They shared concerns regarding interference with budgetary decisions, determining the priority of cases for forensic examination as well as decision-making in individual cases.
- Inconsistency and delays in central funding cause it to lapse every year, hampering capital-intensive and long-term infrastructure expansion. The cumbersome tender and procurement processes further interfere with laboratories' ability to spend allocated funds before they lapse.
- Laboratory directors have inadequate financial powers to procure

**9** See Graphic 7 on expenditure and forecast comparison across budget heads at pg 73.

**10** See Graphic 8 on year-wise analysis of forecast and expenditure at pg 74.

**11** See Table 2 on laboratory-wise comparison of forecast, receipt and expenditure of funds across the assessment period at pg 79.

**12** See Table 2 on laboratory-wise comparison of forecast, receipt and expenditure of funds across the assessment period at pg 79.

and spend on routine equipment and supplies needed for casework, especially in RFSLs, which carry out a majority of the country's forensic casework but are financially dependent on SFSLs.
- The salaries of the scientific staff at FSLs are not at par with similar positions in other government laboratories. Employee benefits such as medical insurance to cover occupational hazards and allowances are also inadequate, especially for contractual staff.
- None of the laboratories, including CFSLs which are envisioned as centres for research and development (R&D) in forensic science, allocate any funds for R&D.

**Recommendations**

- DFSS should hold consultations with state governments to separate FSLs from police departments, to ensure the impartiality and reliability of forensic results submitted to courts. This will also secure greater financial independence for FSLs, smoother budgetary processes and improved utilisation of funds.
- Central grants should be earmarked for the development of SFSLs and RFSLs and sub-allocated to ensure appropriate expenditure on different budget heads. Central and state funds should be consistently disbursed at the beginning of every year across laboratories.
- The financial powers of FSL directors, especially in RFSLs, should be revised in light of the routine costs of conducting casework. RFSL directors should be empowered as Drawing and Disbursement Officers (DDOs) under the financial rules and the coordination over financial planning between RFSLs and SFSLs must be improved.
- Financially trained personnel should be available in each FSL for improved budgetary planning and financial analysis. DFSS and its state counterparts should conduct regular needs assessment surveys to enable better financial planning for FSLs.

## CHAPTER II: RECRUITMENT, EDUCATION & TRAINING

### Trends

*Overall Vacancy*

- Across the 26 laboratories which provided recruitment-related data, 40.3% (1294 out of 3211 posts) of total sanctioned posts were vacant.[13] There is a high variance in the vacancy rates across FSLs. SFSL Lucknow observed a vacancy rate of 72.5%, while RFSL Nagpur and RFSL Pune had negative vacancy rates due to the hiring of contractual staff.[14]

*Scientific Vacancy*

- Of the total vacancies (901 posts), 69.6% were for scientific staff.[15] SFSL Lucknow, SFSL Banderdewa, RFSL Berhampur, RFSL Jagdalpur and SFSL Verna had a vacancy rate higher than 50% in the scientific posts even after the inclusion of contractual staff, while three of the four RFSLs in Maharashtra had negative vacancy rates due to contractual scientific staff.[16]

*Additional Posts Required*

- Beyond vacancies in currently sanctioned posts, 17 laboratories expressed the need for additional posts to be sanctioned. In these FSLs, 903 additional posts are required, of which 572 are for scientific staff.

### Challenges

- The approval processes for sanctioning new posts and filling sanctioned posts are cumbersome, protracted and irregular. The recruitment processes and the eligibility criteria for every post vary across states.
- There is little adherence to prescribed work norms, which are aimed

**13** See Graphic 9 showing an overview of the data on posts filled, vacant and additionally required at pg 96.

**14** See Graphic 11 on comparison of total rate of filled and vacant posts at pg 101.

**15** See Graphic 10 on scientific posts across FSLs at pg 100.

**16** See Graphic 12 on comparison of total rate of filled and vacant scientific posts at pg 103.

at the effective distribution of scientific and non-scientific work and regulating annual caseloads of different divisions to ensure the quality of forensic examination. Further, the work norms, issued by the Bureau of Police Research & Development (BPR&D) in 2002, which were adopted by DFSS, are outdated.

- Scientific staff is extremely dissatisfied due to the heavy workload along with constant pressure from investigative authorities and courts, historical pendency of cases and lack of parity in pay and employment benefits with similarly placed staff working in universities or other administrative services.
- To cope with the delays in recruitment processes, FSLs are compelled to hire contractual scientific staff. Some laboratories have raised concerns regarding the quality of work relating to contractual staff due to a lack of accountability. Contractual staff in FSLs have also shared concerns regarding lower pay and lack of employee benefits as compared to permanent staff.
- FSLs prefer hiring candidates with degrees in pure sciences rather than in forensic science, due to the lack of regulation of forensic science education and standardised curricula with an emphasis on practical learning. Further, the professional practice of forensic science is also unregulated, despite the need to ensure the competence and proficiency of forensic examiners.
- New recruits to the scientific staff in the FSLs do not undergo dedicated training before being assigned casework. Most laboratories conduct 'on-the-job' training with supervision by senior staff. The existing scientific staff is also not provided adequate opportunities for continuous learning on the latest scientific developments and new forensic techniques.

**Recommendations**

- Towards standardising forensic recruitment, DFSS should organise consultations with FSL directors, concerned officials in state police and home departments, state public service commissions and staff selection commissions to understand the bottlenecks in the recruitment process. It should accordingly devise a National Forensic Recruitment Strategy with NFSU and the proposed Forensic

Council of India (FCOI) which standardises the eligibility criteria and recruitment method for various scientific and non-scientific posts in an FSL and proposes changes to existing recruitment procedures for consideration of central and state governments.

- DFSS and the proposed Forensic Science Regulator (FSR) should prepare new work norms which reflect scientific advancements, caseload trends and the levels of personnel within the FSLs. This should be done through consultation with the proposed expert Scientific Working Groups (SWGs) for different divisions, FSL directors and the respective state police and home department officials.
- DFSS, in its needs assessment surveys, and the FSLs should regularly assess the additional requirement of FSLs for scientific and non-scientific posts based on local caseload trends.
- Towards improving their working conditions, FSLs should address occupational hazards and provide employee benefits like medical insurance, access to psychological support, better pay, research opportunities and travel allowances and maintain parity with analogous positions in other government institutions. DFSS should liaise with state governments to implement the Flexible Complementing Scheme (FCS), which allows for promotions irrespective of vacancy, in SFSLs and RFSLs.
- A Forensic Council of India (FCOI) must be established to regulate the professional practice of forensic science through the registration and licensing of forensic examiners. Such registration should be based on qualifying examinations conducted by FCOI and NFSU. Towards regulating forensic science education, FCOI, DFSS and NFSU must survey existing educational courses and institutions. Based on the survey, FCOI and NFSU must set standards for the curricula, teaching methods, infrastructure and laboratory equipment required for forensic science programmes and approve them accordingly.
- The proposed FSR, with help from NFSU, should standardise training programmes for new scientific recruits in different divisions, and incorporate both theoretical and practical components before assigning any casework. The proposed FCOI in collaboration with NFSU should curate continuous forensic education programmes for

existing forensic staff covering scientific and legal developments.

## CHAPTER III: CASE MANAGEMENT

**Trends**

- Data regarding cases received, examined and pending has been analysed for 29 FSLs that were functional during the assessment period.[17]

*Case Receipts*

- Across all FSLs, the Excise, Toxicology and Biology divisions collectively accounted for 68.7% of the total case receipts.[18] The DNA Profiling and Cyber Forensics divisions saw a consistent increase in case receipts.[19]
- As per the mean exhibit-to-case ratio, the Document division receives 16 exhibits per case, while the number is eight for Ballistics and approximately five for Cyber Forensics.[20]
- Amongst FSLs, the RFSLs in Maharashtra i.e. RFSL Nagpur, RFSL Pune and RFSL Aurangabad had the highest case receipts.[21] SFSL Banderdewa, SFSL Dehradun, SFSL Shimla, RFSL Dharamshala and RFSL Nashik saw a consistent increase in case receipts.[22]

*Examination & Pendency in Divisions[23]*

- The examination rates in Toxicology (116.7%) Excise (106%),

**17** See Graphic 13 on the different divisions in FSLs and the types of evidence they examine at pg 126.

**18** See Graphic 14 on the number of cases received by different divisions across FSLs at pg 131.

**19** See Graphic 16 on the continuous increase in cases received by the Cyber Forensics and DNA Profiling divisions, at pg 135.

**20** See Graphic 19 on the median exhibit-to-case ratio for different divisions at pg 138.

**21** See Graphic 20 on the number of cases received by different FSLs at pg 141.

**22** See Graphic 21 on FSLs with continuous increase in the number of cases received at pg 143.

**23** See Graphic 15 on examination and pendency rates in different divisions across FSLs at pg 133.

Explosives (105%), Chemistry (102.1%) and Narcotics (100.9%) were greater than 100%, showing that more cases were examined in these divisions than were received.

- Cyber Forensics (111.2%), Ballistics (100.2%) and DNA Profiling (79%) had the highest pendency rates, which compare the number of cases pending at the end of the year compared to the cases received, indicating historical pendency in these divisions.
- Despite receiving the most cases, the Excise division had one of the lowest pendency rates (8%), while Ballistics, Cyber Forensics and DNA Profiling had a higher pendency rate than the examination rate, indicating an urgent need for expansion to handle an increasing caseload.
- The DNA Profiling division's examination rate declined drastically across the assessment period while its pendency rate increased.[24] The Cyber Forensics division's examination rate was also consistently lower than its pendency rate.[25]

*Examination & Pendency in FSLs*[26]

- SFSL Bhubaneswar (122.2%), RFSL Nashik (118.3%) and SFSL Raipur (114.1%) had the highest examination rates. SFSL Bhubaneswar and RFSL Dharamshala had an examination rate higher than 100% every year.
- SFSL Imphal (400.7%), RFSL Berhampur (167.7%) and SFSL Thiruvananthapuram (119.4%) had the highest pendency rates. Five other FSLs recorded pendency rates higher than 60%.
- RFSL Nashik receives the third highest number of cases but has one of the lowest pendency rates (13%) against its examination rate (118.3%). On the other hand, SFSL Imphal and SFSL Thiruvananthapuram had a higher pendency rate than the examination rate every year, and SFSL Imphal's pendency rate was consistently higher than 300%.[27]

**24** See Graphic 17 on the year-wise examination and pendency rates of the DNA Profiling division at pg 136.

**25** See Graphic 18 on the year-wise examination and pendency rates of the Cyber Forensics division at pg 137.

**26** See Graphic 22 on examination and pendency rates in the FSLs at pg 145.

**27** See Graphics 23 and 24 at pg 147.

### Challenges

- Several laboratories shared that investigative agencies often send a large number of exhibits bearing no forensic value, which contributes to case pendency. To cope with the growing pendency and tight legislative timelines for investigation, some FSLs conduct pendency drives by working overtime to finish casework. However, this leads to serious concerns regarding the quality of forensic examination.
- Many laboratories do not have separate case-receiving sections to ensure that the case exhibits are in a sealed condition while taking custody of the samples and to remove any task-irrelevant information from case documents. Laboratories also lack document management systems to maintain a chain of custody of samples within the FSL, which is crucial with such high pendency and intensive casework.
- Given the lack of adequate scientific staff, laboratories do not conduct a technical review of the casework before submitting their reports. Such reviews are essential to minimise the risk of error and bias and ensure quality.
- Scientists are often called to assist at crime scenes or provide testimony regarding their reports to courts. In light of the high vacancies and caseload, many scientists prefer to avoid such crime scene visits or court attendances as they take several hours or even days and disrupt their casework. However, they acknowledged the importance of their presence at crime scenes to oversee the collection of evidence and their role in the proper appreciation of forensic evidence in court.

### Recommendations

- DFSS and the proposed FSR should develop standard protocols for case receipts. Case-receiving sections should be staffed with personnel trained in such protocols, context management procedures and evaluating the chain of custody.
- All cases should undergo a technical and administrative review to ensure the quality of forensic examination in every case. A technical review should include an evaluation of the data and materials underlying the examination and to ensure that the results have been reported correctly.
- A robust, uniform and digitised case management system must be

introduced in all FSLs to ensure efficient management of casework. In every FSL, there should be administrative staff trained in data input and analysis, to closely monitor and compute caseload trends in each division and allow for better internal management.

- DFSS with the proposed FSR should formulate protocols based on best practices for the collection and handling of all types of forensic evidence. NFSU must develop training programmes for police on crime scene management, and FSLs must be adequately staffed so that they can provide such training. The police must also be adequately supplied with the requisite equipment for evidence collection.
- The practice of forensic medicine should be regulated and standards should be developed for medical examination of persons and post-mortem examinations. Further, medical practitioners and staff should be adequately trained to ensure the quality of biological samples.

## CHAPTER IV: INFRASTRUCTURE

### Trends

- Out of 29 FSLs that were functional during the assessment period, 25 laboratories shared information regarding sanctioned and additional space required by them. Further, 21 laboratories specified the additional equipment required by them.

*Space*

- Of the 25 FSLs which provided data regarding space, 13 required additional space, with RFSL Nagpur, RFSL Nashik and SFSL Bhubaneswar requiring the most space for their functional divisions.[28] Seven FSLs required more than double the currently allocated space for their functional divisions, and seven required additional space in more than half of their functional divisions.
- Across FSLs, the divisions that required the most space were Biology, DNA Profiling and Ballistics.[29] Four divisions required more than

**28** See Graphic 25 on additional space required by FSLs for functional divisions at pg 169.

**29** See Graphic 27 on additional space required for functional divisions across FSLs at pg 173.

double the space currently sanctioned for them, of which Ballistics, DNA Profiling and Cyber Forensics had higher pendency rates than examination rates.

*Equipment*[30]

- Of the 21 FSLs which expressed the need for additional equipment, 13 FSLs needed it in more than half of their functional divisions. Out of these, CFSL Shimla, SFSL Banderdewa, RFSL Ranipool and RFSL Thrissur required additional equipment for all their functional divisions.
- 12 FSLs require additional equipment for their Chemistry divisions, 11 for their DNA Profiling divisions, nine for their Biology divisions. These divisions ranked amongst the highest divisions in terms of case receipts. Of the five FSLs that require equipment for non-functional divisions, four laboratories need it for their Cyber Forensics division.

## Challenges

- Laboratory design and establishment should consider the needs of scientific and technical work within different divisions, health and safety requirements and contamination minimisation measures. Such planning is lacking in many FSLs as ordinary buildings planned by police departments are often repurposed into FSLs and are not tailored to the basic needs of a laboratory.
- There is a severe shortage of space for proper storage of samples in appropriate temperature, humidity, light and ventilation conditions. Further, many FSLs do not have separate areas for scientific and non-scientific work nor mechanisms to restrict access to examination areas, which impacts the quality and integrity of forensic examinations.
- Due to lengthy procurement processes and the lack of space, FSLs are unable to purchase essential equipment or expand divisions despite increasing casework. They lack instruments to control the ambient conditions for scientific equipment, backup equipment to ensure continuity of casework, and Annual Maintenance Contracts (AMCs)

**30** See Graphic 28 on additional equipment required by FSLs for functional divisions at pg 176.

for the regular calibration and maintenance of equipment. Without the equipment functioning optimally, the quality and accuracy of casework can be compromised.
- Despite the potential exposure to hazardous materials and chemicals, FSLs do not have proper safety procedures, personal protective gear for personnel, appropriate physical infrastructure or waste disposal mechanisms. They also lack security measures to protect the integrity of stored samples and the safety of staff for laboratories in high-risk areas.

**Recommendations**

- DFSS should conduct a needs assessment survey with NFSU to understand the infrastructural needs of FSLs, conceptualised by experts in forensic science, health and safety, architecture and civil engineering and security. This should be towards developing a national plan to address these needs and DFSS should coordinate with states towards ensuring that adequate funds are earmarked for these purposes.
- DFSS and the proposed FSR should create minimum infrastructural standards for the planning and construction of an FSL, including measures for contamination minimisation, health and safety, waste disposal and workflow management.
- FSLs should be monitored by the proposed state DFSS and regularly audited by the proposed FSR to ensure adherence to the minimum infrastructural standards, especially the health and safety protocols therein, and address any challenges in their implementation.
- As the purchase of equipment is capital-intensive, a central grant earmarked for the infrastructural development of state laboratories should be consistently released. DFSS and the proposed FSR should standardise equipment across FSLs in order to explore centralised procurement, which will avoid delays related to financial approvals.

## CHAPTER V: QUALITY MANAGEMENT

### Trends

- Quality management in forensic science, comprising quality control and quality assurance processes, is critical to ensure the accuracy and reliability of forensic examinations relied on by courts. Quality management systems are necessary to detect and minimise errors, especially given the grave implications they may have within the justice system.
- Data on quality management processes, including working procedure manuals (WPMs), proficiency tests, training, error rate calculation and accreditation, was received from 27 FSLs.
- Of the 24 FSLs which provided data on WPMs, only six have formulated their own WPMs for some or all of their functional divisions. 19 laboratories follow the manuals prepared by DFSS in their divisions while 12 FSLs use manuals or reference materials such as textbooks published by external bodies.[31]
- Only five FSLs had their own quality manual, while 16 did not. Further, only five FSLs were accredited by NABL and only four laboratories besides them had participated in proficiency testing. Only three FSLs calculated error rates.

### Challenges

- FSLs lack quality management systems, and view quality management only as a requirement for accreditation and not as a part of routine casework. Additionally, developing quality management systems requires significant investment and resources. Without adequate space, equipment or trained personnel, laboratories are unable to prioritise it while grappling with a heavy caseload.
- Internal validation of every forensic technique is crucial to test and demonstrate its reliable operation within the particular setup of each division of an FSL. However, FSLs do not internally validate testing methods as the methods may have been developmentally validated or they believe that internal validation is limited to new and novel technologies developed by the laboratories.

31 See Graphic 30 on WPMs used by FSLs in their functional divisions at pg 208.

- Based on internal validation, every laboratory must create its own detailed WPM for each division to ensure standardisation in scientific testing procedures across casework. Such documents cannot be adopted from other laboratories without determining their appropriateness to the laboratory's procedures, equipment and infrastructure. Despite this, a majority of FSLs do not have their own WPMs and rely on external manuals prepared by DFSS or other sources. Further, FSLs have also reported that they refer to different materials within the same division, which raises concerns regarding standardisation and the basis for deviations in casework.
- Proficiency tests are routine discipline-specific examinations to evaluate the competence of forensic scientists and to identify areas for improvement. Most FSLs do not participate in proficiency testing, often believing it to only be a requirement for accreditation. The few laboratories that conduct internal and interlaboratory proficiency testing do not conduct blind testing, which is necessary to accurately test an examiner's competence.
- Accreditation is a certification by an independent institution, like NABL, that an FSL conforms to set quality standards. Despite being aware of the importance of accreditation, FSLs lack the technical guidance, financial support and personnel trained in quality standards and quality management procedures to dedicate to pursuing it.

**Recommendations**

- DFSS, NFSU and the proposed FSR should organise consultations with FSL directors and senior scientific staff to build a common understanding of the importance and components of quality management systems. Such consultations will help identify and provide targeted interventions for the hurdles each FSL faces in complying with quality standards.
- DFSS should design a phased Action Plan with tailored timelines for all FSLs to gradually move towards implementing quality management. Each proposed state DFSS should accordingly provide funds, resources, training and support to FSLs to enable them to complete each phase.

- FSLs must be guided by DFSS and the proposed FSR to prepare their own WPMs in a time-bound manner, supported by internal validation studies. To guide on drafting WPMs, the WPMs prepared by expert groups constituted by DFSS should be widely circulated amongst FSLs. Laboratories must regularly review and update their WPMs based on changed laboratory setups or technological advancements.
- Towards formalising quality management, FSLs must be supported by the proposed state DFSS in getting accreditation, through the provision of additional resources and consultations with accredited laboratories, the proposed FSR and NABL assessors. As many FSLs agreed, accreditation must eventually be made mandatory through flexible timelines which account for the current realities of the forensic system.

## CHAPTER VI: FORENSIC DNA PROFILING IN INDIA

### Trends

- There has been an increase in the use of forensic DNA profiling in India, following technological advancements and legislative changes towards introducing DNA evidence in sexual violence cases. In light of this, Part B of the survey sought information from the DNA profiling divisions of the FSLs towards conducting a model scientific review of DNA profiling practices in India. 15 laboratories (two CFSLs, nine SFSLs and four RFSLs) had a functional DNA profiling division.
- Different types of DNA profiling vary in their applications in forensic casework. There was a variance in the types of DNA profiling examinations that FSLs conduct as well as in the commercially available DNA kits used by them for each step of the DNA profiling process. Only RFSL Pune used software for the interpretation of mixed DNA samples.
- Only three of the 15 laboratories had developed their own WPMs for the DNA profiling division. Further, DNA kits require thresholds to be set for the DNA profiling process after internal validation, such as a minimum limit of detection of DNA for it to be reliably analysed. Such standards were absent in many FSLs, while those set by other laboratories raised concerns about whether internal

validation studies had been appropriately conducted before fixing the thresholds.

- It is necessary to conduct a statistical analysis to assign meaning and significance to a DNA 'match', based on the frequency of the observed DNA profile within a population. Statistical analysis is a core step of forensic DNA profiling, without which a DNA examination cannot be considered complete. However, only four FSLs conduct statistical analyses.
- Quality management procedures to minimise contamination, such as the separation of work areas for processing DNA samples, are particularly crucial in DNA profiling due to the sensitive nature of the evidence. Two laboratories did not have separate working areas to process DNA samples. Towards quality control, a majority of FSLs conduct technical reviews of the DNA profiling process before the final report is furnished.

**Challenges**

- Given the susceptibility of DNA samples to contamination, it is crucial to follow strict contamination minimisation protocols. However, FSLs do not have adequate contamination control protocols and the equipment to implement them. The shortage of space in the FSLs to delineate for different parts of the casework also poses a high risk of contamination. Laboratories also presently lack a staff elimination database to investigate instances of contamination.
- The standards set by the FSLs for the DNA profiling process show that its procedures were not internally validated, despite the DNA kits requiring it. Without internal validation, the necessary thresholds to be followed during DNA profiling cannot be determined, and the reliability of the DNA profiling process within a laboratory cannot be confirmed.
- A majority of the DNA samples received by FSLs are mixed DNA samples, whose interpretation is inherently more difficult and subjective. However, laboratories lack validated protocols for DNA mixture interpretation, which in turn raises doubts about the accuracy and consistency of mixture analyses. Further, FSLs do not use software for such analyses, which would provide a better basis for

interpretation.

- A majority of FSLs do not conduct statistical analyses, since laboratory protocols and courts do not clearly mandate it and the scientists lack the requisite training for it. The population genetics data necessary for such statistical evaluation is also lacking.

**Recommendations**

- DFSS, NFSU and the proposed FSR should conduct a detailed scientific audit of the functional DNA profiling divisions across FSLs, with experts in the field. This will identify and allow for targeted interventions to address areas for capacity building. The aspects of the DNA profiling practice that require validation should also be identified, and a plan devised for appropriate validation studies to be conducted.
- DFSS and the proposed FSR should develop contamination detection and prevention guidelines for DNA divisions, and FSLs must update their WPMs to reflect them. Such guidelines should be developed based on the scientific best practices followed in other jurisdictions.
- For the scientific and legal legitimacy of forensic DNA results, statistical analyses must be conducted routinely by every FSL. Towards this, scientific staff should be adequately trained by NFSU with the proposed state DFSS on different statistical models and their application to genetics data.
- An expert group on genetics must be constituted to evaluate existing population genetics studies on Indian and South Asian populations. It should prepare indices to enable statistical analysis in DNA profiling, which should be disseminated to all FSLs. Further population genetics studies should also be funded by the government and conducted by premier scientific research organisations with NFSU.

## CHAPTER VII: LAW ON EXPERT EVIDENCE

- The law relies on the accuracy and precision of scientific findings to inform its judgements. Therefore, forensic science should be practised validly and reliably, and the law needs to consider the empirical basis for each forensic discipline, its inherent limitations and its potential rate for error before forming its conclusions. Given the perpetual revisions in science and emerging research reviewing the scientific foundations of different disciplines, the law must adapt and not be bound by judicial precedent in determining the admissibility and weight of forensic evidence. This requires judges and lawyers to develop a working understanding of different forensic disciplines.
- Section 45 of the Indian Evidence Act, 1872 (IEA) allows for reliance on the opinions of experts in a diverse range of specialised areas, including forensic science. As per the case law under Section 45 IEA, including *State of Himachal Pradesh v. Jai Lal*, for a person to be an expert, they must have the special skills, qualifications and experience in that particular area of knowledge. In the context of forensic science, this means expertise in the specific forensic discipline and even the particular technique or method of examination applied in a case. Examining the expertise of forensic examiners is particularly crucial in light of the various issues with forensic science education, training and recruitment criteria and the rotation of staff between divisions.
- Further, the evidence provided by an expert to courts must be "intelligible, convincing and tested" as per *Jai Lal*. The decisions under Section 45 IEA emphasise the importance of the intelligible, reasoned and reliable nature of expert scientific opinions, towards enabling independent verification of the conclusions reached. However, they do not create a cogent framework for determining what constitutes 'science' and the manner of examining expert evidence. As a result, the admissibility of such evidence is determined by judges based on relevance, leading to unguided and subjective decision-making which may not reflect current scientific research on the forensic

discipline. Therefore, the Supreme Court should develop practice directions for trial courts on how to judge the foundational validity and reliable application of scientific techniques.

- Courts have consistently held that the 'data and materials', which form the underlying basis for an expert opinion, must be furnished for a judge to independently review the findings. However, due to the lack of clear legal standards, it is unclear which documentation must be submitted with the forensic report in each forensic discipline. This leads to variance in reporting practices across FSLs and courts, impacting the right of the defence to meaningfully challenge forensic evidence. Thus, the Supreme Court should specify the material required to be provided as part of the forensic report.
- Under Indian evidence law, the stages of determining the admissibility and weight of evidence are not well-defined. Since its admissibility is determined after both parties have led their evidence, judges as the fact-finders may be vulnerable to confirmation bias. To prevent this, the Supreme Court must specify the stage at which to determine the admissibility of expert forensic evidence.
- Section 293 of the Code of Criminal Procedure, 1973 (CrPC) provides an exemption to certain categories of government scientific experts from appearing in court for examination as a witness. Despite the practical consideration of limiting time spent away from casework, it is necessary to cross-examine every expert, irrespective of their designation, to assess their competence and evaluate the reliability of the results they have provided. The section is a major hurdle in examining the reliability of forensic evidence and its legality must be reconsidered, given its impact on the right to a fair trial guaranteed under Article 21 of the Constitution.
- The gaps within the legal framework to examine expert forensic evidence are exemplified by the court's treatment of DNA evidence. Encouragingly, courts have consistently emphasised the need to ensure proper collection, packaging, handling and transport of biological samples and maintenance of the chain of custody. However, they have also emphasised adherence to quality control and quality assurance standards, but have not identified any specific quality standards or the consequences of non-compliance.

As a result, there is variance in how different courts evaluate DNA evidence, which is further exacerbated by the lack of clarity on which 'data and materials' underlying the DNA analysis must be furnished by FSLs to the court. Further, Indian courts, unlike their foreign counterparts, do not enforce statistical analysis as a requirement for the admissibility of DNA reports. This is the primary reason for laboratories not conducting such analysis or providing its outcome as part of their reports, despite it being a core step of the DNA profiling process. Courts must enforce scientific standards through judicial scrutiny for the scientific practice within DNA divisions to improve.

## CHAPTER VIII: OVERALL RECOMMENDATIONS[32]

- This chapter proposes an overarching regulatory framework to strengthen the foundations of various facets of the forensic science system and tackle the roots of the different challenges faced by FSLs. The recommendations are based on the observed trends across FSLs, narratives of forensic scientists and best practices in other jurisdictions. We propose an expansion of the roles of existing central and state administrators and educational institutions and the creation of two new statutory bodies, whose roles should be fulfilled by existing bodies until such creation.

### Existing Bodies in Forensic Administration

- **DFSS**: DFSS has a wide mandate to oversee the forensic science system in India, especially through promoting R&D, formulating plans for capacity-building and promoting quality management through the development of scientific standards and uniform protocols for forensic practice, which should be disseminated widely. DFSS should be expanded and appropriately staffed to have an Administration wing to assist FSLs with their budget, infrastructure and quality management, and a Human Resources wing to cover recruitment, training and employee welfare. DFSS must create a framework to regularly conduct needs assessment surveys of FSLs in India towards enabling guided interventions and effective policymaking on

32 See Tables 3-9 at pg 274.

forensics. Further, it should make laboratory-wise annual statistics on case intake, examination and pendency across divisions publicly available.[33]

- **State DFSS**: To ensure impartiality and transparency in forensic work and ensure smoother administration, SFSLs and RFSLs must be administered independent of the police department by a state DFSS modelled on the central DFSS, headed by a high-ranking scientific officer. This would reduce bureaucratic delays, provide better financial and technical support and improve centre-state coordination. The state DFSS would monitor compliance with the policies, standards and protocols developed by the central DFSS or the proposed FSR.
- **NFSU**: The recently established NFSU has a wide mandate under its parent Act, including developing capabilities for research, education and training in forensic science, assisting governments in policymaking, establishing forensic databases and creating standards for forensic work. It should assume greater responsibilities, including in surveying the needs of FSLs, recruitment and the development of various protocols.

### Proposed Legislation on Forensic Science Regulation

- Despite DFSS having a wide mandate, it does not have direct control over SFSLs or RFSLs, which carry out the bulk of forensic examinations in India. It also cannot enforce compliance with scientific or quality standards in the absence of legislative authority. Therefore, a Forensic Science Regulation Act (FSR Act), with the aim to establish a regulatory system for forensic science practitioners, forensic laboratories and forensic education, must be drafted and tabled before the Parliament. Under this Act, a Forensic Science Regulator (FSR) modelled on the UK FSR must be established, to develop a code of conduct for FSLs and monitor compliance with it. A Forensic Council of India (FCOI) must also be set up to monitor education in and the professional practice of forensic science, to ensure that qualified personnel conduct forensic examinations.
- **FSR**: The FSR should be established at the central and state level,

33 See Table 3 on overall recommendations at pg 274.

comprising experienced scientists, forensic examiners and representatives of different stakeholder groups. It shall develop a code of conduct for government and private FSLs and forensic examiners, monitor adherence to the code, investigate non-compliance and restrict further casework in the FSL until resolution of the non-conformity. It shall also provide technical guidance to FSLs and establish discipline-specific Scientific Working Groups (SWGs) to develop best practices and scientific guidelines to aid FSLs in developing their own protocols and WPMs. The FSR shall ensure compliance with its standards through regular scientific audits of FSLs, towards providing the requisite technical guidance and enabling targeted resource interventions.[34]

- **FCOI**:[35] The FCOI should be established at the central and state level similar to the Bar Council of India (BCOI) and the National Medical Commission (NMC), comprising forensic experts, heads of NFSU, DFSS, state DFSS and the proposed FSR, retired judges and eminent lawyers. It shall set standards for forensic education in India in consultation with NFSU, and evaluate and accredit forensic courses and institutions based on such standards. Thus, new courses and institutions would have to seek approval from FCOI and fulfil the standards for curricula and infrastructural capabilities to support experiential learning.

  FCOI shall also collaborate with NFSU to conduct examinations to licence and certify forensic examiners in different disciplines, based on which they would be recruited to FSLs. A registry of licensed forensic examiners shall be maintained by FCOI at the central and state levels. Further, FCOI shall establish standards for professional conduct and ethics to be followed by forensic examiners, monitor and investigate non-compliance and accordingly revoke licences following due process requirements.

**34** See Table 3 on overall recommendations at pg 274.

**35** See Table 5 on recommendations related to Recruitment, Education & Training at pg 276.

# FORENSIC SCIENCE LANDSCAPE IN INDIA

This section seeks to provide an overview of the existing landscape of forensic science in India. It introduces the history of forensic science and forensic medicine institutions and their current structure of governance. It also discusses the legal provisions and developments concerning the practice of forensic science. The context herein is intended to provide a better understanding of the research objectives of the survey and the discussion throughout the other chapters of this Report.

Forensic science has been defined as the application of scientific or technical practices to the identification, collection, analysis and interpretation of evidence for criminal and civil law.[36] Forensic science is distinct from forensic medicine, as it is a broader field comprising various forensic disciplines. These range from laboratory-based analytical methods such as forensic toxicology, DNA profiling and drug analysis, to experiential pattern-matching disciplines such as fingerprinting, ballistics and shoeprint analysis. In India, the practice of forensic science is largely limited to the public sector, with private laboratories practising few disciplines of forensic science.

**36** United States President's Council of Advisors on Science and Technology, *Report to the President: Forensic Science in Criminal Courts: Ensuring Scientific Validity of Feature-Comparison Methods* (2016), pg 1 [PCAST Report]. https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/PCAST/pcast_forensic_science_report_final.pdf.

On the other hand, in forensic medicine, medical knowledge and techniques are applied in a legal context, primarily to medically examine persons for the purposes of the law. This may include medical examination of suspects, accused persons and victims. Forensic pathology is a subset of forensic medicine, which deals with the medical examination of deceased persons. In India, forensic medicine falls within the public and private healthcare system, with the practice of forensic pathology largely limited to public hospitals.

Under Indian law, various disciplines within forensic science and forensic medicine are considered expert scientific evidence.

## HISTORY OF FORENSIC SCIENCE IN INDIA

The earliest forensic laboratories established in India were the Chemical Examiner's Laboratories set up in Madras (now Chennai) in 1849, followed by Calcutta (now Kolkata) in 1853, Agra in 1864 and Bombay (now Mumbai) in 1870.[37] The establishment of these laboratories was spurred by the rise in cases of suspected poisoning, which were proving difficult for the police forces to investigate using traditional methods.[38] While these laboratories were initially under the supervision of the Civil Surgeon or the Department of Health, with the rise in the number of forensic cases, they were independently established with three divisions: (1) the medico-legal section involving toxicology and serology, (2) the general chemistry section involving analysis of food and drugs, and (3) the prohibition and excise section involving examination of different forms of alcohol.[39]

With the expansion of forensic science practice, new government posts were established to address these needs. The office of the Chief Inspector of Explosives was established to investigate cases of explosions in 1898

**37** BB Nanda & RK Tewari, *Forensic Science in India: A Vision for the 21st Century*, Select Publishers (2001), pg 30 [Nanda & Tewari].

**38** Nanda & Tewari, pg 30.

**39** Bureau of Police Research & Development (BPR&D), *Forensic Science in India: 25 Years* (1977), pg 2 [BPR&D Report].

in Nagpur, with regional laboratories in Calcutta, Bombay, Agra, and Madras.[40] Another significant government scientific post established was the Serologist to the Government of India in Calcutta in 1910, to analyse biological fluids found during criminal investigations.

The development of pattern-matching disciplines took a slightly different turn. Unlike laboratory-based disciplines which are centred around forensic applications of established scientific methods, pattern-matching disciplines are based on skills of observation and measurement, mostly honed through experience. These techniques have historically developed with the recognised aim of assisting police investigations through a process of individualisation. Many pattern-matching disciplines lack the foundational scientific research to prove the validity of their examination methods or their claims of ascertaining unique patterns.

Pattern-matching disciplines such as handwriting analysis, footprint examination, ballistics, and note forgery analysis were established under the supervision of different police departments.[41] These included the Government Examiner of Questioned Documents (GEQD), established in 1904 in Bengal and later shifted to Shimla in 1906, to identify handwriting and detect forgery. GEQD was the first forensic institution placed under the direct supervision of a police establishment i.e. the Criminal Investigation Department (CID). This was a significant departure from the institutions practising laboratory-based disciplines, which worked along with investigative agencies but were independent in their administration. Similarly, the Footprint (1915), Note Forgery (1917) and Ballistics (1930) sections were established in the CID, Government of Bengal. These sections were consolidated as scientific sections in the CID and were soon replicated in other states.

During this period, the British Empire also promoted the use of anthropometry, which refers to the measurement of the human body, and fingerprinting to verify the identity of colonial subjects, including

**40** BPR&D Report, pg 2.

**41** BPR&D Report, pg 3-4.

the identification of repeat offenders.[42] The Anthropometric Bureau for the measurement of bodily features of convicts, such as height, weight and bodily circumferences, was established in 1892 in Calcutta. Given the errors in actual casework based on incorrect assumptions about the uniqueness of bodily proportions, anthropometry was soon replaced by the study of fingerprints. Despite no conclusive scientific study even to date to prove the uniqueness of fingerprints,[43] they were found to be more distinctive than other bodily features previously measured under anthropometry. The first Fingerprint Bureau was established in India in 1897 in Calcutta.

Post-Independence, the idea of a consolidated forensic science laboratory (FSL) with various forensic divisions was conceived to reduce the administrative burden on the police in coordinating with different units for investigation. The first State Forensic Science Laboratory (SFSL) was established in Calcutta in 1952, with similar SFSLs being established in other states between the 1950s to 1970s.[44] Simultaneously, a network of Central Forensic Science Laboratories (CFSLs) in different corners of the country was conceptualised. Their role was to assist the investigative agencies in their regions and advise states towards the creation of SFSLs. CFSLs were envisioned as the premier forensic science institutions in India, invested not only in casework but also research and innovation in forensic science. The first CFSL was established in Calcutta in 1957,

**42** Simon A Cole, *Suspect Identities: A History of Fingerprinting and Criminal Investigation*, Harvard University Press (2001), pg 87-88.

**43** American Association for the Advancement of Science (AAAS), *Forensic Science Assessments: A Quality and Gap Analysis - Latent Fingerprint Examination* (2017), pg 23 [AAAS Report on Latent Fingerprint Examination]. Based on an analysis of the existing scientific literature on fingerprint analysis, this report concludes that “the scientific literature does not provide an adequate basis for assessing the rarity of any particular feature, or set of features, that might be found in a fingerprint. Examiners may well be able to exclude the preponderance of the human population as possible sources of a latent print, but there is no scientific basis for estimating the number of people who could not be excluded and there are no scientific criteria for determining when the pool of possible sources is limited to a single person.”

**44** TR Baggi, *Report on Forensic Science Laboratories - Their Utility, Problems and Remedial Measures Thereof*, Journal of Police Research & Development (1996), pg 6.

followed by CFSL Hyderabad in 1965 and CFSL Chandigarh in 1978.

## CURRENT FORENSIC SCIENCE SYSTEM IN INDIA

In India, the Union Ministry of Home Affairs (MHA) governs matters of internal security, law and order and administration of domestic territories. From 1970 till 2002, the forensic science system was under the supervision of the Bureau of Police Research & Development (BPR&D) established under the MHA.[45] However, the Directorate of Forensic Science (DFS) was separated from BPR&D in 2002[46] and later revamped as the Directorate of Forensic Science Services (DFSS) under the MHA in 2010.[47] DFSS has a wide mandate to provide technical and financial support to central and state forensic institutions, promote quality management by providing support for the development of Standard Operating Procedures (SOPs), formulate plans for capacity building in forensic science and encourage research and development (R&D) in forensic science.

Forensic science laboratories in India are organised into three tiers: Central, State and Regional forensic science laboratories (RFSLs). Currently, there are 117 functional laboratories in the country,[48] of which 10 are accredited by the National Accreditation Board for Testing and Calibration Laboratories (NABL).

**45** Nanda & Tewari, pg 43; Gopal Ji Misra & C Damodaran, *Perspective Plan for Indian Forensics*, MHA (2010), pg 7 [Perspective Plan]. http://dfs.nic.in/pdfs/IFS(2010)-FinalRpt_0.pdf.

**46** *Resolution No. 25011/41/2001-GPA.II/PM.II dated 31.12.2002*, Gazette of India, Part I, Section I, dated 01.02.2003, pg 92. http://dfs.nic.in/pdfs/First%20resolution%20of%20DFSS.pdf.

**47** *MHA, Resolution No. 25020/50/2010-PM. II dated 29.11.2010*, Gazette of India, Part I, Section I, dated 18.12.2010, pg 1871 [DFSS Charter]. http://dfs.nic.in/pdfs/MHA%20resolution%20for%20DFSS.pdf.

**48** See Graphic 2 showing a map of functional FSLs in India in Methodology at pg 51.

### Central Forensic Science Laboratories

There are eight CFSLs - one each at Bhopal, Chandigarh, Delhi, Guwahati, Hyderabad, Kolkata, Pune and the CFSL Unit in Shimla, which is under the administration of CFSL Chandigarh. DFSS has administrative control over the CFSLs, although CFSL Delhi was under the supervision of the Central Bureau of Investigation (CBI) under the central Ministry of Personnel, Public Grievances and Pensions (MoPP&P) until November 2022.

In 1998, the three CFSLs in Hyderabad, Chandigarh and Kolkata, then under the control of BPR&D, each became a 'Centre of Excellence' in Forensic Chemical Sciences, Forensic Physical Sciences and Forensic Biological Sciences, respectively.[49] This meant that the predominant responsibility of these laboratories was research and states were urged not to send their "routine" cases to CFSLs but to have them examined by their SFSLs.[50] Following the sanctioning of three new CFSLs at Bhopal, Pune and Guwahati,[51] the above research mandate was abandoned and all CFSLs under DFSS, including at Shimla, were directed to focus on R&D work.[52] The sanctioning of new CFSLs also led to the redistribution of human resources between these seven CFSLs.

### State Forensic Science Laboratories

States, either directly under their MHA or through the Department of Police, administer a three-tiered system of SFSLs, RFSLs and district Mobile Forensic Science Units (DMFUs/MFSUs). These are administratively nested within each other; RFSLs in any state are under the financial and administrative control of the SFSL of that state. MFSUs are under SFSLs directly or RFSLs. As per DFSS data, there are 32 SFSLs,

49 MHA, *Report on Scientific Performance Audit of DFSS HQ and its CFSLs* (2011), pg 3 [SPAC Report]. http://dfs.nic.in/pdfs/SPAC%20REPORT%20(FINAL).pdf.

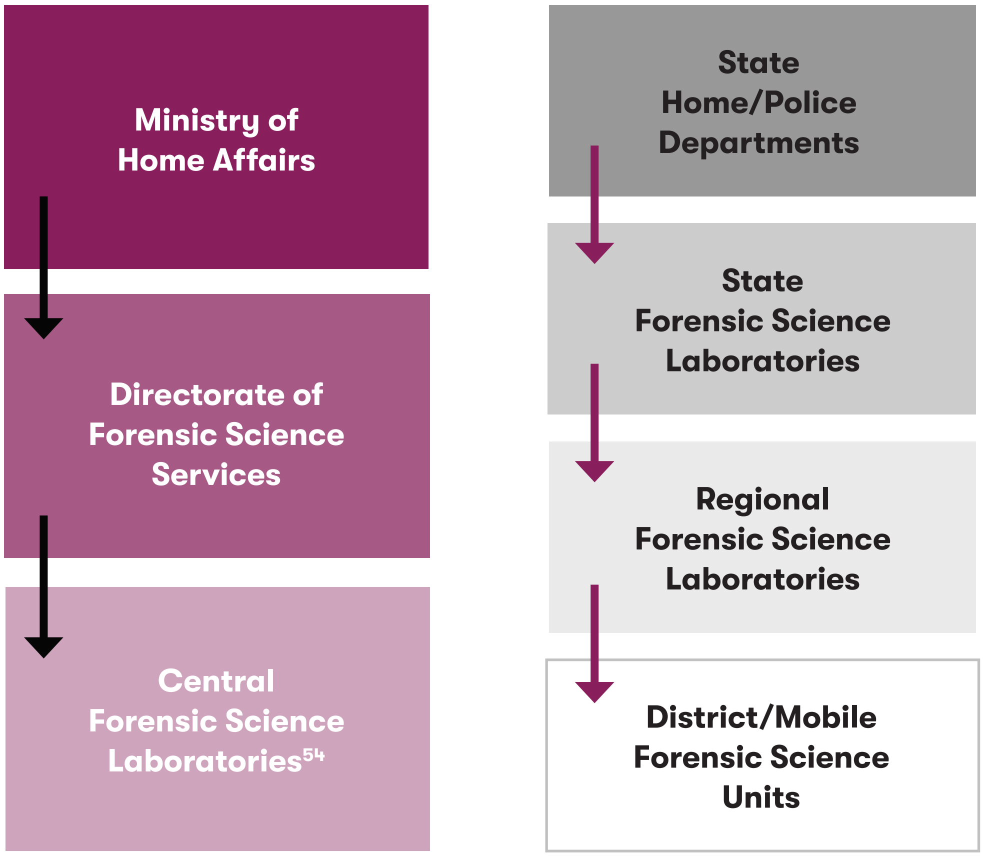
50 Perspective Plan, pg 110.

51 *MHA, Resolution No. 25020/61/13/FW/MHA dated 26.07.2013*, Gazette of India, Part I, Section I, dated 10.08.2013, pg 481.

52 *MHA Office Memorandum No. DFSS/15(16)2011/MHA/PM-II dated 02.06.2011*, as provided in the SPAC Report, pg 117.

80 RFSLs and 529 MFSUs across different states and union territories in India.[53]

**Graphic 1. Organisation of the forensic science system in India**




53 DFSS, *List of State, Regional and District/Mobile Forensic Science Units.* http://dfs.nic.in/pdfs/list%20of%20sfsl,rfsl%20and%20dmfu.docx.

54 The CFSL in Delhi was under the administrative control of the CBI, which falls under the MoPP&P, until November 2022. It is referred to as CBI-CFSL in this Report.

### Other Laboratories

There are some long-established laboratories, a few founded pre-Independence, that specialize in forensic disciplines such as chemical examination, serology or DNA profiling and augment the three-tiered FSL framework. These include laboratories such as the Institute of Serology in Kolkata under the Ministry of Health & Family Welfare (MoHFW), or the Laboratory of DNA Fingerprinting Services in the Centre for DNA Fingerprinting and Diagnostics (CDFD) in Hyderabad, under the Department of Biotechnology of the Ministry of Science and Technology. Additionally, the Central Fingerprint Bureau (CFPB) and State Fingerprint Bureau (SFPBs) are under the supervision of the National Crime Records Bureau (NCRB) and the respective State Crime Records Bureau (SCRBs). Separately, the Centre for Cellular and Molecular Biology (CCMB) and the Laboratory for the Conservation of Endangered Species (LaCONES) are autonomous laboratories under the Council of Scientific and Industrial Research (CSIR), which perform DNA analysis on ancient samples and provide expertise in wildlife forensics respectively.

### Forensic Medicine

Distinct from the forensic science structure, forensic medicine is part of the broader structure of private and government-run hospitals and autonomous institutions such as the All India Institute of Medical Services (AIIMS). The MoHFW administers the forensic medicine and pathology departments of central hospitals and autonomous bodies, through its Department of Health & Family Welfare and the Directorate General of Health Services (DGHS). States administer the forensic medicine and pathology departments of state hospitals through their respective MoHFW. Apart from government hospitals, medico-legal cases (MLCs) and post-mortem examinations may also be conducted in medical colleges in their forensic medicine or pathology departments.[55]

55 DGHS, Central Medico-Legal Advisory Committee, *Survey Committee Report on Medico-Legal Practices in India* (1964), pg 7.

## FORENSIC SCIENCE EDUCATION

Given these distinctions, the design and delivery of education in forensic science and forensic medicine are also separate. Forensic medicine is taught as a branch of medicine with a post-graduate specialization, while forensic science is taught as a branch of science. In practice, however, many forensic practitioners in India are graduates in pure science subjects who thereafter pursued forensic science.

Currently, 48 private and public educational institutions in India are publicly known to offer courses in forensic science as undergraduate, postgraduate and doctoral degrees and as diploma and other courses. The National Institute of Criminology and Forensic Science (NICFS) was established in Delhi in 1972, under the BPR&D and eventually under the MHA directly, for research, education and training in forensic science and criminology. It was renamed in 2003 as the Lok Nayak Jayaprakash Narayan National Institute of Criminology and Forensic Science (LNJN NICFS). In 2008, the Gujarat Forensic Science University (GFSU) was established in Gandhinagar. Through the National Forensic Sciences University Act, 2020, the Parliament rechristened GFSU and LNJN NICFS as the National Forensic Science University (NFSU) and deemed it as an Institute of National Importance.[56] Currently, there are six other campuses of the NFSU under operation, with plans for further expansion.

## LEGAL FRAMEWORK

The existing legal framework in India vests investigative authorities with the power to collect and examine different kinds of forensic evidence.

All arrested persons are subjected to a medical examination by a government medical officer soon after the arrest, under Section 54 of the Code of Criminal Procedure, 1973 (CrPC). Such an examination is important to record all injuries and marks of violence on the person arrested and is a check on any form of torture or coercion that such a

56 National Forensic Sciences University Act, 2020. https://beta.nfsu.ac.in/Uploads/NFSU%20Act%202020.pdf

person may have suffered in police custody. For the purposes of investigation, accused persons may be medically examined by a registered medical practitioner under Section 53 CrPC in order to collect a wide range of biological samples. In cases concerning rape, a medical examination of an accused is conducted under Section 53A CrPC, which specifies the nature of the examination to be conducted in such cases. Similarly, Section 164A CrPC specifically provides for procedures and scope of medical examination of victims of rape by a registered medical practitioner. In cases of suspected accidents, suicides or homicidal deaths, deceased bodies discovered are subjected to inquest proceedings under Section 174 CrPC. The section also allows the police to forward the body to the nearest Civil Surgeon or qualified medical practitioner for post-mortem examination.

All such medical examinations of living and deceased persons fall within the ambit of forensic medicine, wherein biological evidence is collected. The recognition and collection of biological and other evidence also take place from material objects at the crime scene, undertaken by the police themselves in conjunction with mobile FSL units. Section 311A CrPC additionally permits the collection of specimen signatures and handwriting samples from persons, including the accused. All collected biological and other samples, through medical examination, post-mortem examination and crime scene examination, are forwarded by the police to FSLs or other specialized laboratories, where they are analysed and interpreted.

The results of both the medical and post-mortem examinations, as well as the scientific analysis of the samples, are filed by the police as part of their investigative reports or separately submitted as evidence before courts. These results and the opinions of the doctor or scientist carrying out the examination or analysis are deemed relevant evidence in a criminal trial by Section 45 of the Indian Evidence Act, 1872 (IEA).

However, Section 291 CrPC allows for any deposition by a doctor before a magistrate to be submitted as evidence without their being called as a witness before the court. Similarly, Section 293 CrPC exempts government scientists occupying specific positions of seniority within laboratories from testifying as witnesses before the court, deeming their reports to suffice as evidence. This includes the Director, Deputy Director or Assistant Director of any CFSL or SFSL, as well as any other government scientist specified by the government. In practice, this provision severely restricts the scrutiny of forensic evidence by courts through the examination of the expert, unless the expert is summoned.

## RECENT DEVELOPMENTS

A distinct and important aspect of the regulatory landscape within which forensic science operates is the recent legislative changes in the form of the DNA Technology (Use and Application) Regulation Bill, 2019 and the Criminal Procedure (Identification) Act, 2022 (CPIA).

The DNA Bill facilitates the identification of certain categories of persons, including offenders, suspects, undertrials, missing persons and unknown deceased persons, using DNA analysis and through the creation of DNA databanks. It seeks to create a mechanism for the accreditation of laboratories undertaking DNA analysis and requires laboratories to share DNA data gathered through casework with the databanks. The Bill was referred to the Parliamentary Standing Committee on Science and Technology by the Rajya Sabha in October 2019, whose report, bearing several changes, was tabled before the Parliament in February 2021. The crucial changes suggested by the Committee include reconsidering the need for a crime-scene index[57] and a suspects or undertrials index,[58] limiting the scope of DNA testing and laboratories covered within its ambit by revising the definition of DNA profile,[59] ensuring the independence of the DNA regulatory board through the selection of a

**57** 340th Report of the Parliamentary Standing Committee on Science and Technology, Rajya Sabha, on the DNA Technology (Use And Application) Regulation Bill, 2019 (2021), pg 11 [PSCST Report]. https://prsindia.org/files/bills_acts/bills_parliament/2019/DNA%20Report.pdf

**58** PSCST Report, pg 14.

**59** PSCST Report, pg 12.

chairperson,[60] reconsidering the need for a regional DNA data bank,[61] and a hearing by a magistrate and the provision of a reasoned order before ordering the collection of DNA.[62]

The CPIA seeks to collect forensic 'measurements' or samples from certain classes of persons such as arrestees, detainees and convicts and allows for the processing, storage, preservation, dissemination and destruction of these samples, with the stated aim of identification and investigation in criminal matters and of prevention of crimes. The Act bestows on a wide range of police or prison officers the power to collect such samples, allows states to designate an agency to collect, preserve, store and share them and tasks the NCRB with creating and maintaining a database of the forensic records arising thereof. The rules to be promulgated under the Act may clarify the extent of the role envisioned for FSLs in this process. Several concerns regarding the overbroad nature of measurements covered within the CPIA, the grant of excessive discretion, privacy concerns from collecting and databasing such measurements, and the issues with the scientific and regulatory aspects were raised during the enactment of this law.[63]

**60** PSCST Report, pg 15.

**61** PSCST Report, pg 11.

**62** PSCST Report, pg 22-23.

**63** Project 39A, National Law University Delhi, *Research Brief on Criminal Procedure Identification Act*, 2022. https://www.project39a.com/identification-act.

# METHODOLOGY

## BACKGROUND

The state of forensic science in India has an indisputably close relationship with the strength of its criminal justice system. However, government FSLs have faced several roadblocks in realising their primary aim to deliver quality and effective assistance to law enforcement agencies and courts in crime investigation and justice delivery. Research on Indian forensic policy points towards the lack of adequate human resources, infrastructural inadequacies, organisational mismanagement and absence of quality review as the primary causes behind the sub-par functioning of FSLs. This has direct and severe implications on the quality of evidence that is produced before courts and the effectiveness of the justice they dispense.

An influx of financial resources cannot ameliorate laboratory conditions if it is not proportional to technological advancements and the increasing caseload in laboratories. Further, it will not be channelled properly unless certain fundamental concerns with the functioning of the laboratories are addressed. These include the lack of a legislative or regulatory framework to monitor the administration and functioning of FSLs, the absence of standards on the collection, storage and retention of evidence in criminal cases and the non-enforcement of robust quality management standards to ensure scientific reliability. The problems visible in the forensic science landscape cannot be bridged by judicial intervention alone,[64] as sustainable and long-lasting change requires policy changes and review mechanisms which must be driven by legislative and executive initiatives.

Empirical research on the needs and challenges of FSLs is scant in India. The recommendations of previous reports on forensic science in India have received little attention.[65] The last comprehensive report on FSLs was prepared over a decade ago by forensic scientists for the MHA.[66] It gathered information through questionnaires from various stakeholders in the practice of forensic science, including CFSLs and SFSLs, renowned forensic scientists, judicial academies, bar councils, directorates of prosecution, universities and academics. The report keenly articulated the aforementioned deep-seated concerns with the forensic science system and the need for more research and made comprehensive recommendations for the overhaul of the forensic science system in India, including the establishment of a national regulatory body by 2020. Despite this report being released in 2010, there has been very little discussion on its findings and recommendations.

It is essential to conduct periodic surveys on the prevailing condition of FSLs, as this provides policymakers with an understanding of the challenges faced by them. It is only with a clear understanding of these challenges that sustainable measures to improve the forensic science landscape in India can be imagined. As part of these surveys, it is essential to scientifically audit the techniques, methods and practices across various divisions in the FSLs to ensure the validity and reliability of the forensic testing.

In this background, this project was undertaken by Project 39A at National Law University, Delhi in collaboration with the MHA to survey

**64** See inset on role of courts in forensic science administration in Chapter VII: Law on Expert Evidence at pg 249.

**65** Perspective Plan; SPAC Report; *State of the Art of Forensic Science: For Better Criminal Justice*, National Human Rights Commission (1999) [NHRC Report]. https://drive.google.com/file/d/1kELEPcKNIJTGtnksDrncpRUozXZEb7Bi/view.

**66** Perspective Plan.

government FSLs across India on various aspects of their administration and functioning. Its objective was to understand and examine the challenges facing the forensic science system in India and propose sustainable solutions to address them. Based on our analysis of the data collected during the survey, and the comparative standards and practices followed in other jurisdictions, we have proposed recommendations to tackle the issues prevalent within the forensic science system.

We have also attempted a scientific review of the forensic DNA profiling practices and protocols followed in India, with the aim of providing a model for similar audits of other forensic disciplines. The DNA profiling division was chosen for the scientific review portion of this survey because of the significant increase in the use of forensic DNA profiling in India and its status as one of the most advanced forensic disciplines.

## SURVEY METHODOLOGY

A quantitative survey form was sent to 61 FSLs out of the 117 functional laboratories at the commencement of the project in August 2018. These selected FSLs were sampled to include all CFSLs (8), SFSLs (31) and at least one RFSL (22) from each state.[67] Quantitative data was sought for a five-year assessment period i.e. 2013-2017, with Part A seeking data regarding budget, expenditure, recruitment, casework, laboratory infrastructure, quality control and quality assurance mechanisms. FSLs with functional DNA divisions were also requested to complete Part B of the survey which sought information regarding the scientific standards and practices followed therein.

During the fieldwork, complete responses to the survey were received from 30 laboratories i.e. three CFSLs, 17 SFSLs and 10 RFSLs. Due to long delays in receipt of responses from the laboratories and after the onset of the COVID-19 pandemic in 2020, the fieldwork was suspended. Three

67 Some states did not have any functional RFSLs.

laboratories i.e. SFSL Delhi,[68] RFSL Chanakyapuri[69] and SFSL Mohali[70] provided incomplete responses and hence their data has not been included in this Report.

During the course of the fieldwork, we also visited the laboratories and interacted with scientific staff to gather qualitative information. In order to ensure free participation, the views and narratives gathered from the staff have been anonymised. We visited 17 out of the 30 FSLs which responded to the quantitative survey. We also visited SFSL Delhi and RFSL Chanakyapuri, but because we did not receive a complete response to our quantitative survey from these laboratories, they do not form part of the Report.

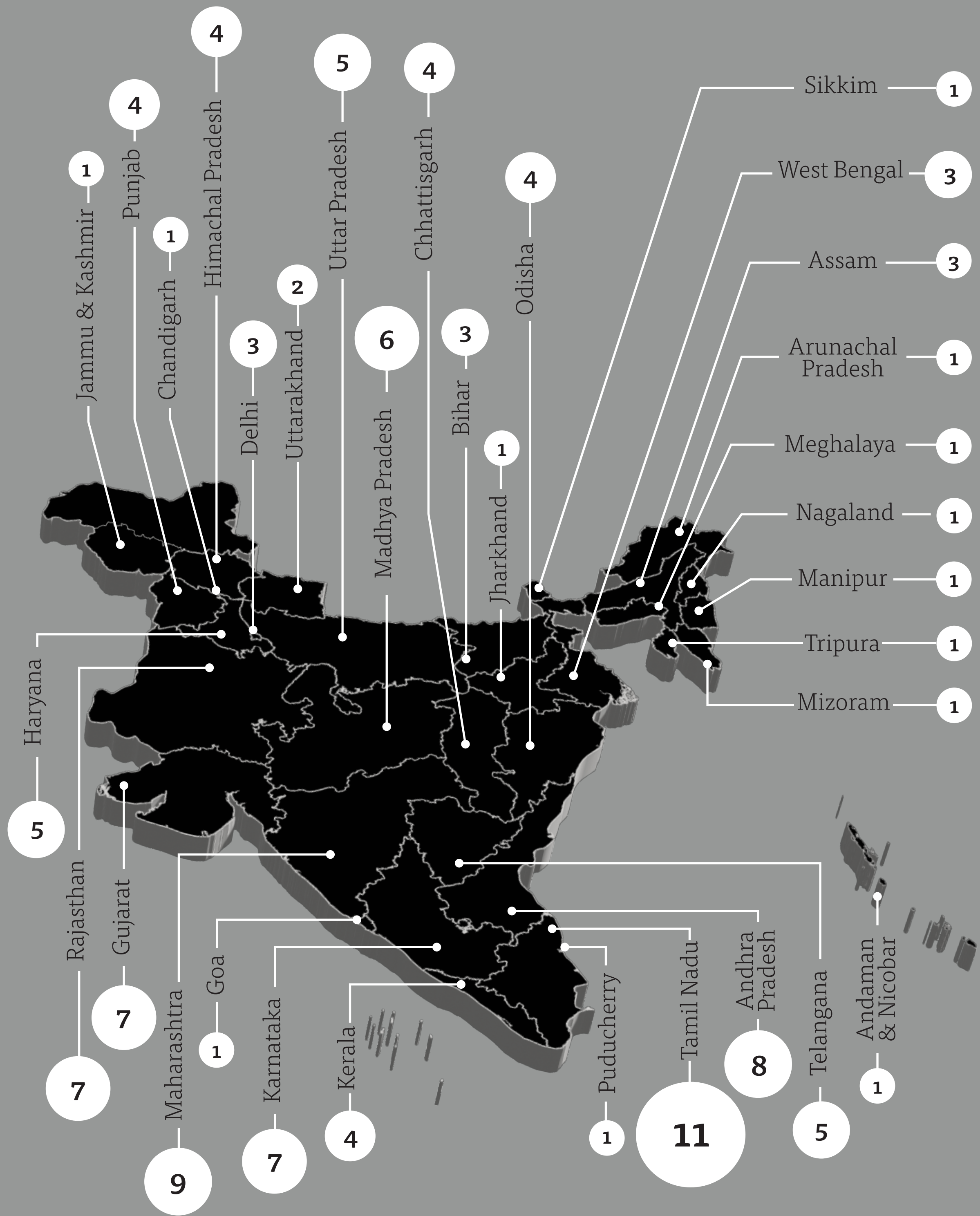
We also asked the laboratories for their working procedure manuals (WPMs), recruitment rules (RRs), quality manuals and training manuals to analyse the differences and similarities in these manuals across various laboratories. Only SFSL Aizawl, SFSL Port Blair and RFSL Dharamshala provided WPMs. SFSL Aizawl, SFSL Bhubaneswar, SFSL Raipur, SFSL Verna and RFSL Ranipool provided RRs. SFSL Shimla provided its quality manual. No laboratory has provided its training manuals.

**68** SFSL Delhi did not share budget receipt and expenditure information for 2013-2016, budget forecast information for 2013-2017 or case management data for 2013-2016. We received information about the functionality of divisions, composition of the current staff and additional equipment required, but not about infrastructure or the functional DNA Profiling division.

**69** As RFSL Chanakyapuri became functional in 2015, we received case management data for 2016-2018. We did not receive information about the budget, composition or qualifications of staff, infrastructure or the functional DNA Profiling division.

**70** From SFSL Mohali, we received case management data for all assessment years but without a division-wise break-up; information about the functionality of divisions and about the composition of current staff. We did not receive information about the budget, infrastructure or the functional DNA Profiling division.

**Graphic 2. Forensic Science Laboratories across India**



117 Functional laboratories
61 Laboratories requested to participate
30 Laboratories participated in the survey

### ANDAMAN & NICOBAR

SFSL Port Blair

### ANDHRA PRADESH

SFSL Mangalagiri
RFSL Visakhapatnam
RFSL Anantapur
RFSL Guntur
RFSL Kurnool
RFSL Rajamahendravaram
RFSL Tirupati
RFSL Vijayawada

### ARUNACHAL PRADESH

SFSL Banderdewa

### ASSAM

CFSL Guwahati
SFSL Guwahati
RFSL Jorhat

### BIHAR

SFSL Patna
RFSL Muzaffarpur
RFSL Bhagalpur

### CHANDIGARH

CFSL Chandigarh

### CHHATTISGARH

SFSL Raipur
RFSL Jagdalpur
RFSL Bilaspur
RFSL Sarguja

### DELHI

CBI-CFSL
SFSL Delhi
RFSL Chanakyapuri

### GOA

SFSL Verna

### GUJARAT

SFSL Gandhinagar
RFSL Ahmedabad
RFSL Junagadh
RFSL Rajkot
RFSL Surat
RFSL Vadodara
RFSL Valsad

### HARYANA

SFSL Karnal
RFSL Rohtak
RFSL Bhondsi
RFSL Hisar
RFSL Panchkula

### HIMACHAL PRADESH

CFSL Shimla
SFSL Shimla
RFSL Dharamshala
RFSL Mandi

### JAMMU & KASHMIR

SFSL Jammu/ Srinagar

### MADHYA PRADESH

CFSL Bhopal
SFSL Sagar
RFSL Bhopal
RFSL Gwalior
RFSL Indore
RFSL Jabalpur

### JHARKHAND

SFSL Ranchi

### KARNATAKA

SFSL Bengaluru
RFSL Mangaluru
RFSL Belagavi
RFSL Davangere
RFSL Hubballi
RFSL Kalaburgi
RFSL Mysuru

Information is based on the survey responses, responses to RTI applications, official websites of the FSLs or the state home or police departments, and news articles.

**KERALA**

SFSL Thiruvananthapuram
RFSL Thrissur
RFSL Kannur
RFSL Kochi

**MAHARASHTRA**

CFSL Pune
SFSL Mumbai
RFSL Aurangabad
RFSL Nagpur
RFSL Nashik
RFSL Pune
RFSL Amravati
RFSL Kolhapur
RFSL Nanded

**MANIPUR**

SFSL Imphal

**MEGHALAYA**

SFSL Shillong

**MIZORAM**

SFSL Aizawl

**NAGALAND**

SFSL Dimapur

**ODISHA**

SFSL Bhubaneswar
RFSL Berhampur
RFSL Balasore
RFSL Sambalpur

**PUDUCHERRY**

SFSL Puducherry

**PUNJAB**

SFSL Mohali
RFSL Amritsar
RFSL Bathinda
RFSL Ludhiana

**RAJASTHAN**

SFSL Jaipur
RFSL Udaipur
RFSL Ajmer
RFSL Bharatpur
RFSL Bikaner
RFSL Jodhpur
RFSL Kota

**SIKKIM**

RFSL Ranipool

**TAMIL NADU**

SFSL Chennai
RFSL Coimbatore
RFSL Madurai
RFSL Dharmapuri
RFSL Ramanathapuram
RFSL Salem
RFSL Thanjavur
RFSL Tirunelveli
RFSL Trichy
RFSL Vellore
RFSL Villupuram

**TELANGANA**

CFSL Hyderabad
SFSL Hyderabad
RFSL Kamareddy
RFSL Karimnagar
RFSL Warangal

**TRIPURA**

SFSL Agartala

**UTTARAKHAND**

SFSL Dehradun
RFSL Rudrapur

**UTTAR PRADESH**

SFSL Lucknow
RFSL Agra
RFSL Ghaziabad
RFSL Moradabad
RFSL Varanasi

**WEST BENGAL**

CFSL Kolkata
SFSL Kolkata
RFSL Jalpaiguri

As per the DFSS website, there are 119 functional laboratories (7 CFSLs, 32 SFSLs & 80 RFSLs) across India, while our data shows 117 laboratories (8 CFSLs, 31 SFSLs & 78 RFSLs). CFSL Unit in Shimla which is under the administration of CFSL Chandigarh, has been counted as a CFSL as it separately processes casework. DFSS data shows 5 RFSLs in Assam and Telangana each, whereas our data shows 1 RFSL in Assam and 3 in Telangana. DFSS data shows 5 RFSLs in Karnataka and Andhra Pradesh each, while our data shows 6 and 7 RFSLs respectively. RFSL Ranipool, Sikkim was considered an SFSL by DFSS. *List of State, Regional and District/Mobile Forensic Science Units*. http://dfs.nic.in/pdfs/list%20of%20sfsl,rfsl%20and%20dmfu.docx.

## SCOPE OF THE REPORT

As part of the Report, we have analysed information with respect to budget and expenditure, recruitment, education and training, casework management, infrastructure and quality management. The Report also includes an analysis of forensic DNA profiling and the law on expert evidence in India. Each chapter is divided into four parts i.e. (i) the introduction, which outlines the scope of the chapter and the methodology, (ii) the trends seen in the quantitative data, (iii) the challenges which have been identified from the narratives of the laboratories and existing research, and (iv) the recommendations which have been drafted based on inputs by laboratories, prior research in India and best practices in other jurisdictions.

In light of the issues highlighted throughout the Report, a comprehensive regulatory framework is proposed in Chapter VIII. It sets up statutory bodies and defines their roles and that of existing bodies, to ensure that the needs of the forensic science and criminal justice systems are adequately met. This framework is referenced throughout the chapters of the Report.

## LIMITATIONS

Despite consistent follow-up and reminders to the FSLs, there was a delay in responding to requests, both for filling the quantitative survey and for permission to visit the laboratory. The lack of responsiveness of laboratories severely hampered our ability to analyse state-wise trends.

Due to the lack of standardisation across FSLs, the data received from the laboratories was maintained by them in different formats. For example, the nomenclature and scope of examination by certain divisions varied across laboratories, resulting in variation in case reporting. To offset the effects of such variance, considerable efforts were made before the data analysis to standardise the data, to allow for uniform analysis across laboratories.

Despite consistent follow-up, we did not receive WPMs, RRs, quality manuals and training manuals from most of the laboratories. This limited our ability to analyse and compare recruitment, training and quality management systems between the laboratories.

# 1 BUDGET & EXPENDITURE

## INTRODUCTION

CFSLs are funded by the central government while SFSLs, RFSLs and MFSUs are funded by respective state governments and specific grants-in-aid from the central government. Laboratories also accrue funds as fees for forensic examinations conducted by them.[71] Besides regular budgetary grants, central and state government funding is also disbursed through specific schemes, such as the Nirbhaya Fund Scheme under the Ministry of Women and Child Development,[72] and the Modernisation of Police Forces (MPF) Scheme[73] and the Creation of RFSLs and DMFUs Scheme[74] under the MHA.

**71** CFSLs are barred from charging examination fees except in cases of questioned document examination. *MHA, Resolution No. 25020/61/13/FW/MHA dated 26.07.2013*, Gazette of India, Part I, Section I, dated 10.08.2013, pg 481. SFSLs and RFSLs may also charge examination fees, depending on the applicable regulations in each state.

**72** Under the Nirbhaya fund, procurement of forensic kits for sexual assault cases and measures for strengthening DNA analysis, cyber forensic and related facilities in SFSLs were being undertaken (2021). https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1784146.

**73** As per the Modernisation of Police Force Scheme Book (2010), the enhancement of forensic capabilities is an essential part of police modernisation. https://www.mha.gov.in/sites/default/files/Scheme-MPF-11Nov_1.pdf. The 237th Report on Police-Training, Modernisation & Reforms by the Parliamentary Standing Committee on Home Affairs, Rajya Sabha (2022) at pg 86 recommends that the MHA must work with the states to build at least one regional/divisional level FSL in every state. https://sansad.in/getFile/rsnew/Committee_site/Committee_File/ReportFile/15/161/237_2022_2_17.pdf?source=rajyasabha

**74** Press release regarding creation of RFSLs and DMFUs under the 11th Five Year Plan (2010). https://pib.gov.in/newsite/erelcontent.aspx?relid=64064.

At the central and state level, the process of sanctions and approvals for the budget and expenditure of any government body, including FSLs, is complex. The process of budget approvals and disbursement of funds is separate from the approvals required before any expenditure. The process for expenditure approvals may vary based on the amount of expenditure and the states where the laboratories are located. These are governed by financial rules and regulations such as the Union Government Financial Rules, 2017 (GFR).[75]

At the centre, the Integrated Finance Division within the MHA is the receiving authority for budget and expenditure proposals, which, in turn, coordinates with the Ministry of Finance and undertakes budgeting, accounts and internal audits for the MHA. The MHA has direct administrative and financial control over CFSLs and releases grants-in-aid to states for FSLs within their jurisdiction. However, these central government grants are not guaranteed annually and may vary from year to year and state to state.

State home departments or ministries administer the SFSLs, RFSLs and MFSUs within that state, either directly or through their police departments. RFSLs are under the administrative and financial control of the SFSLs, and the SFSLs have administrative and financial control over MFSUs either directly or through RFSLs. Thus, funds received by SFSLs are shared with the laboratories under them.

**75** The GFR, 2017 is a compilation of rules and orders of the central government that shall be followed while dealing with matters involving public finances. These rules and orders are treated as executive instructions to be observed by all government departments and organisations. https://doe.gov.in/sites/default/files/GFR2017_0.pdf.

The FSLs were asked to provide information for each financial year (FY) across the assessment period of 2013-2017 on receipt of funds from different sources, the projected budget forecast and their actual expenditure. Of the 30 laboratories covered in the survey, 18 provided information on sources and amounts of funds received,[76] 20 provided information on the budget forecasted and 22 supplied information on expenditure.[77] While SFSL Puducherry did not provide information regarding budget and funding in the quantitative survey, and during the field visit it shared that it had not received any funding apart from the initial funds of Rs. 365 lakhs[78] from the central government in 2011 for its establishment.

**76** SFSL Banderdewa, SFSL Dimapur, SFSL Mumbai, SFSL Port Blair, SFSL Shillong, RFSL Agra, RFSL Aurangabad, RFSL Berhampur, RFSL Jagdalpur, RFSL Pune and RFSL Thrissur have not provided any information on the source or amount of funds for the assessment period.

**77** CFSL Shimla, SFSL Dimapur, SFSL Mumbai, RFSL Agra, RFSL Berhampur, RFSL Jagdalpur and RFSL Thrissur have not provided any information on the budget forecast nor on expenditure. SFSL Banderdewa and SFSL Mangalagiri have provided information on expenditure but not their budget forecast.

**78** This amount is used for salary and equipment.

## TRENDS

### Funding Received

During the assessment period, SFSL Mangalagiri,[79] SFSL Lucknow and CBI-CFSL received the most funds in that order, while RFSL Nashik, RFSL Dharamshala and SFSL Verna sequentially received the lowest funds.

Graphic 3 shows the ranking of the FSLs based on the amount of funds received. It also shows if the FSL has other laboratories within its administrative and financial control amongst which the funding received is divided. Graphic 4 shows the breakdown of the funding sources for these laboratories.

**79** SFSL Mangalagiri was established in 2018, therefore the large amounts of funds received can be explained by the initial cost of establishment.

## Graphic 3. Ranking of FSLs by total funds received (in lakhs INR)

RFSLs & MFSUs under the laboratory

**1 SFSL Mangalagiri**
RFSLs
MFSUs
Total funds received
**9135**

**2 SFSL Lucknow**
RFSLs
MFSUs
Total funds received
**8171**

**3 CBI-CFSL**
RFSLs
MFSUs
Total funds received
**6367**

**4 CFSL Chandigarh**
RFSLs
MFSUs
Total funds received
**5922.9**

**5 SFSL Raipur**
RFSLs
MFSUs
Total funds received
**4083.2**

**6 SFSL Thiruvananthapuram**
RFSLs
MFSUs
Total funds received
**3998**

**7 SFSL Shimla**
RFSLs
MFSUs
Total funds received
**3961.7**[80]

**8 SFSL Bhubaneswar**
RFSLs
MFSUs
Total funds received
**3671.5**

**9 RFSL Nagpur**
RFSLs
MFSUs
Total funds received
**2905**

80 This includes Rs. 165 lakhs received from the central government under the CCPW scheme to establish cyber forensics-cum-training labs. However, the year in which these funds were received has not been specified, therefore it has not been considered in the year-wise analysis.

### 10 SFSL Aizawl

RFSLs
MFSUs ●

Total funds received
**1809.5**

### 11 SFSL Dehradun

RFSLs ●
MFSUs ● ●

Total funds received
**1434.1**

### 12 SFSL Agartala

RFSLs
MFSUs ● ● ●

Total funds received
**820.9**

### 13 SFSL Imphal

RFSLs
MFSUs ● ●



Total funds received
**710.2**

### 14 RFSL Ranipool

RFSLs
MFSUs ●



Total funds received
**606**[81]

### 15 SFSL Verna

RFSLs
MFSUs ● ●



Total funds received
**529**

### 16 RFSL Dharamshala

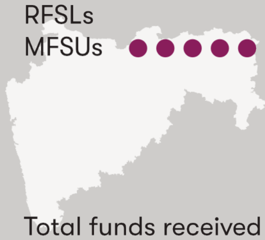
RFSLs
MFSUs



Total funds received
**521.8**

### 17 RFSL Nashik

RFSLs
MFSUs ● ● ● ● ● ●



Total funds received
**92**

### 18 CFSL Shimla[82]

RFSLs
MFSUs

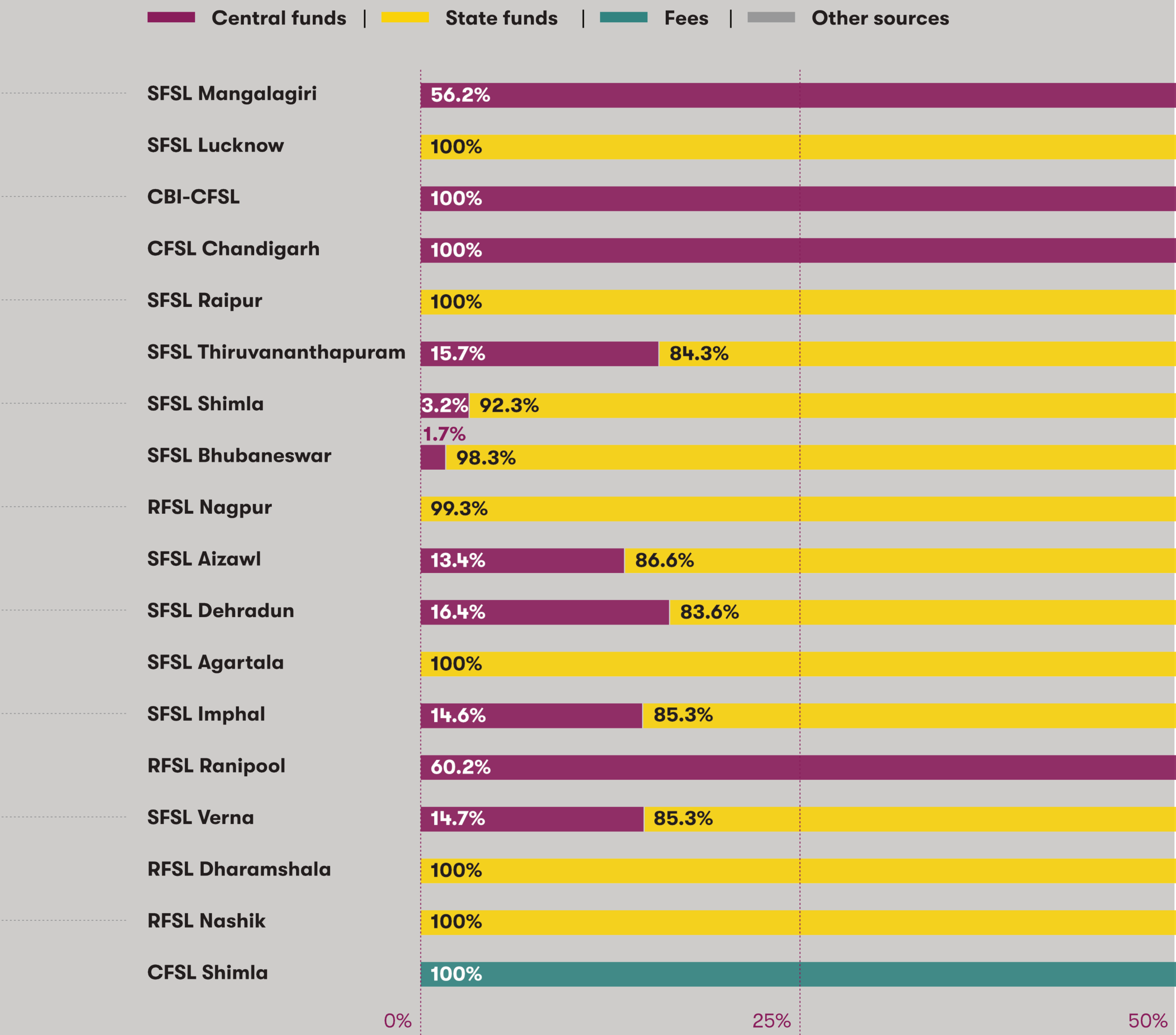


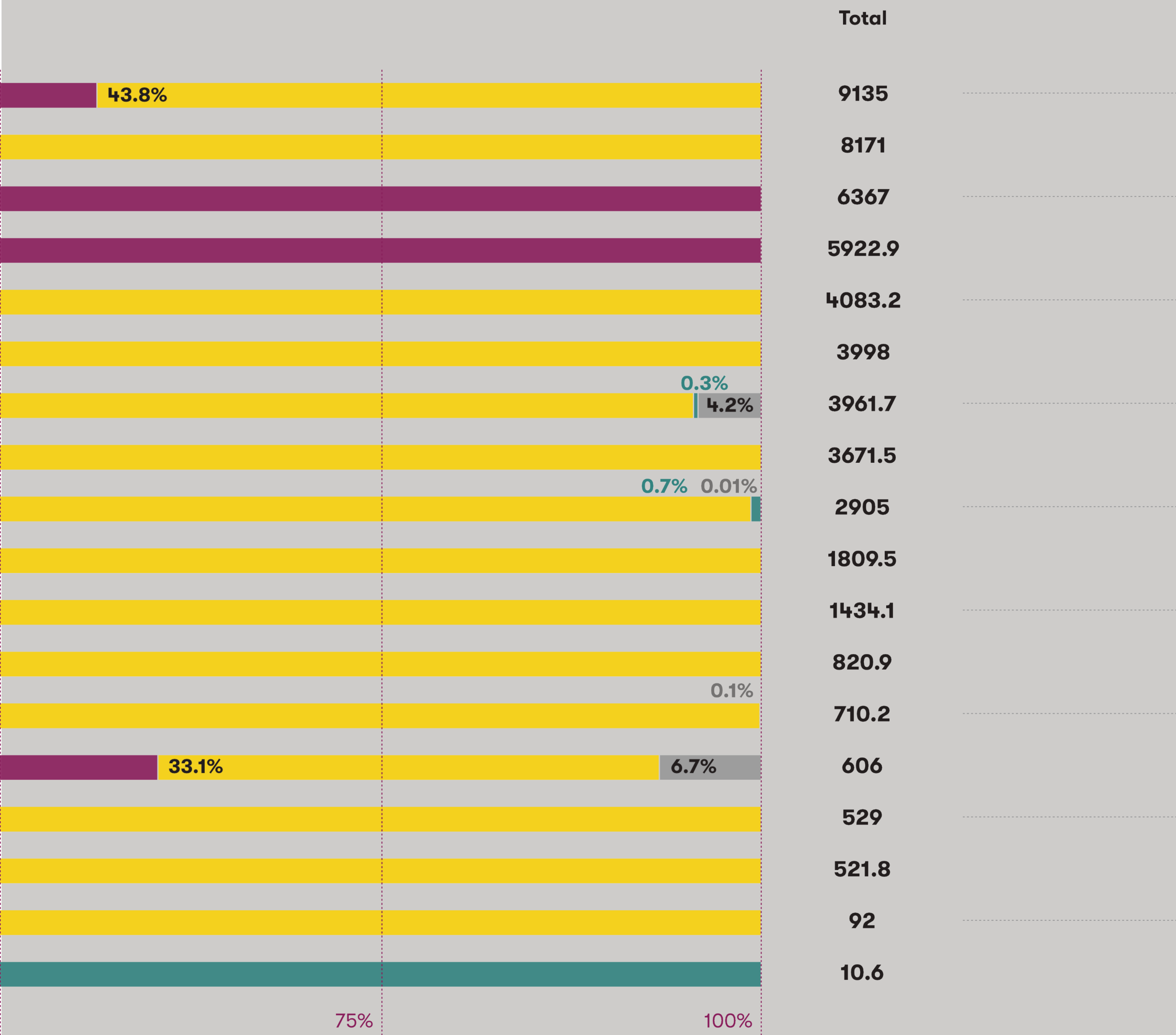
Total funds received
**10.6**

**81** This includes Rs. 40.7 lakhs received from the Narcotics Control Bureau. As the year in which these funds were received has not been specified, this amount has been added to the total funds and not to the year-wise analysis.

**82** CFSL Shimla reported that its only funding source is fees charged for forensic examination.

**Graphic 4. Breakdown of funding sources for FSLs (in lakhs INR)**




Total
43.8%
9135
8171
6367
5922.9
4083.2
3998
0.3%
4.2%
3961.7
3671.5
0.7%
0.01%
2905
1809.5
1434.1
820.9
0.1%
710.2
33.1%
6.7%
606
529
521.8
92
10.6
75%
100%

## Year-wise analysis of funding received

*Central funding*

Out of the 18 laboratories that provided funding information, 11 received funds from the central government. This includes nine SFSLs and RFSLs, which received support from both central and state governments.

As shown in Graphic 5, no SFSL or RFSL received funding from the central government across all years in the assessment period.[83] A wide variance in the consistency of financial support from the central government is evident. For instance, SFSL Aizawl and SFSL Dehradun received central funding for all assessment years except FY 2015-16, while SFSL Imphal, SFSL Verna and RFSL Ranipool received central funding in only FY 2013-14.

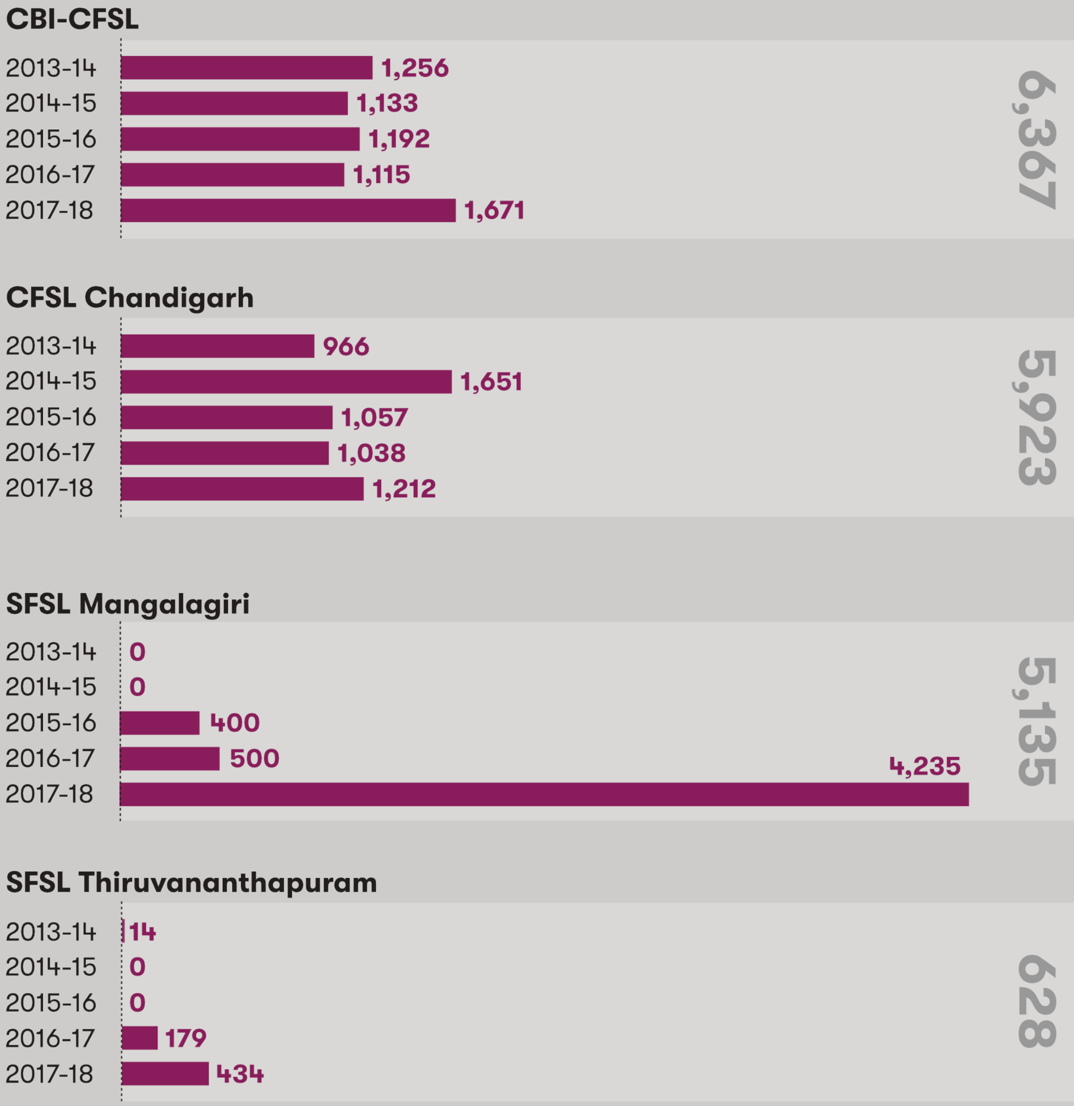
*State funding*

On a comparison of state funding, SFSL Lucknow, SFSL Raipur and SFSL Mangalagiri have received the most funds from their respective states while SFSL Verna, RFSL Ranipool and RFSL Nashik[84] have received the least, in that order (Graphic 6). Further, SFSL Aizawl, SFSL Dehradun, SFSL Dharamshala, SFSL Imphal, SFSL Shimla and SFSL Verna showed a consistent increase in the yearly financial support received from their respective states.

**83** SFSL Mangalagiri received central funding from 2015 onwards towards the cost of initial establishment.

**84** RFSL Nashik ranks the third highest based on the median number of cases received. The low levels of funding received compared to other laboratories should be considered in light of its caseload. See Graphic 20 in Chapter III: Case Management at pg 141.

**Graphic 5. Year-wise funding received from Central government (in lakhs INR)**



## Graphic 5. Year-wise funding received from Central government (in lakhs INR)

**RFSL Ranipool**

| | |
|---|---|
| 2013-14 | 365 |
| 2014-15 | 0 |
| 2015-16 | 0 |
| 2016-17 | 0 |
| 2017-18 | 0 |
| Total | 365 |

**SFSL Imphal**

| | |
|---|---|
| 2013-14 | 104 |
| 2014-15 | 0 |
| 2015-16 | 0 |
| 2016-17 | 0 |
| 2017-18 | 0 |
| Total | 104 |

**SFSL Aizawl**

| | |
|---|---|
| 2013-14 | 57 |
| 2014-15 | 81 |
| 2015-16 | 0 |
| 2016-17 | 50 |
| 2017-18 | 55 |
| Total | 243 |

**SFSL Verna**

| | |
|---|---|
| 2013-14 | 78 |
| 2014-15 | 0 |
| 2015-16 | 0 |
| 2016-17 | 0 |
| 2017-18 | 0 |
| Total | 78 |

**SFSL Dehradun**

| | |
|---|---|
| 2013-14 | 76 |
| 2014-15 | 16 |
| 2015-16 | 0 |
| 2016-17 | 80 |
| 2017-18 | 64 |
| Total | 235 |

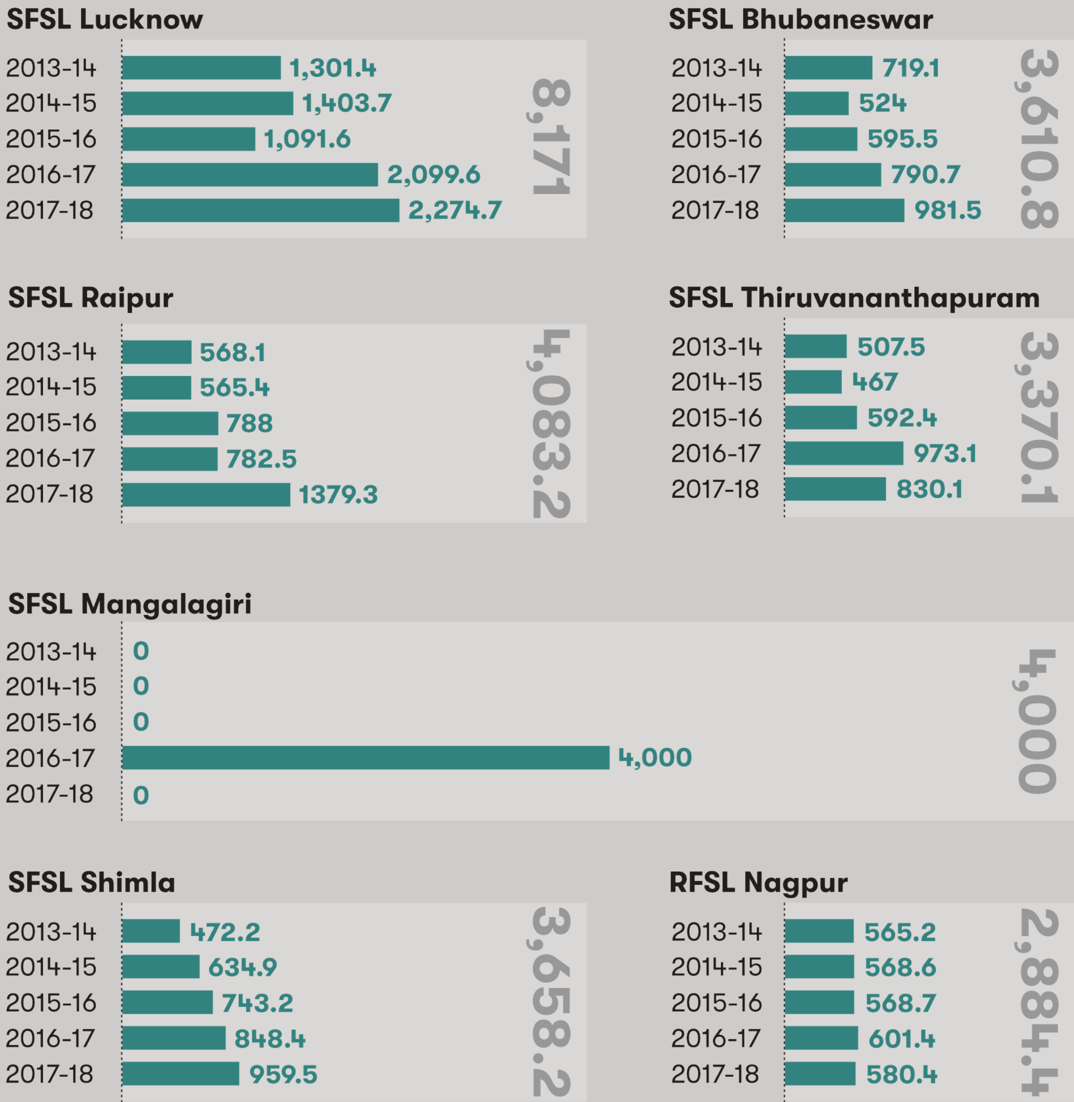
**SFSL Bhubaneswar**

| | |
|---|---|
| 2013-14 | 8 |
| 2014-15 | 21 |
| 2015-16 | 32 |
| 2016-17 | 0 |
| 2017-18 | 0 |
| Total | 61 |

**SFSL Shimla**

| Year | Funding |
|---|---|
| 2013-14 | 0 |
| 2014-15 | 0 |
| 2015-16 | 0 |
| 2016-17 | 70 |
| 2017-18 | 57 |
| Total | 127 |

**Graphic 6. Year-wise funding received from State governments (in lakhs INR)**



**Graphic 6.** **Year-wise funding received from State governments (in lakhs INR)**

## Forecast & Expenditure

Budget forecasts and expenditure were examined across six broad heads i.e. (i) Salary & wages,[85] (ii) Equipment & material,[86] (iii) Office-related expenses,[87] (iv) Allowances & professional services,[88] (v) Travel & transfer expenses and (vi) Training.

The overall expenditure for all laboratories was 69.4% of the total forecasted amount (Graphic 7). The lowest expenditure-to-forecast ratio was in the equipment & maintenance category (40.2%) while the highest was in travel & transfer expenses (81.9%). None of the laboratories, including the CFSLs, had budgeted for or spent any funds on R&D during the entire assessment period.

*Year-wise analysis of forecast & expenditure*

While there was a consistent increase in the annual expenditure on equipment & materials, its expenditure-to-forecast proportion was the lowest across the assessment period, consistently being lower than 50% (Graphic 8). The low rates of expenditure are not merely due to the receipt of lesser funds than necessary but can also be attributed to the cumbersome procedure for procurement, which has been elaborated upon in the challenges.

There was also a wide variance in the rate of expenditure-to-forecast relating to salary & wages. This raises concerns about the consistency of human resources in the laboratories and the impact of the deficit on the amount and quality of casework processed.

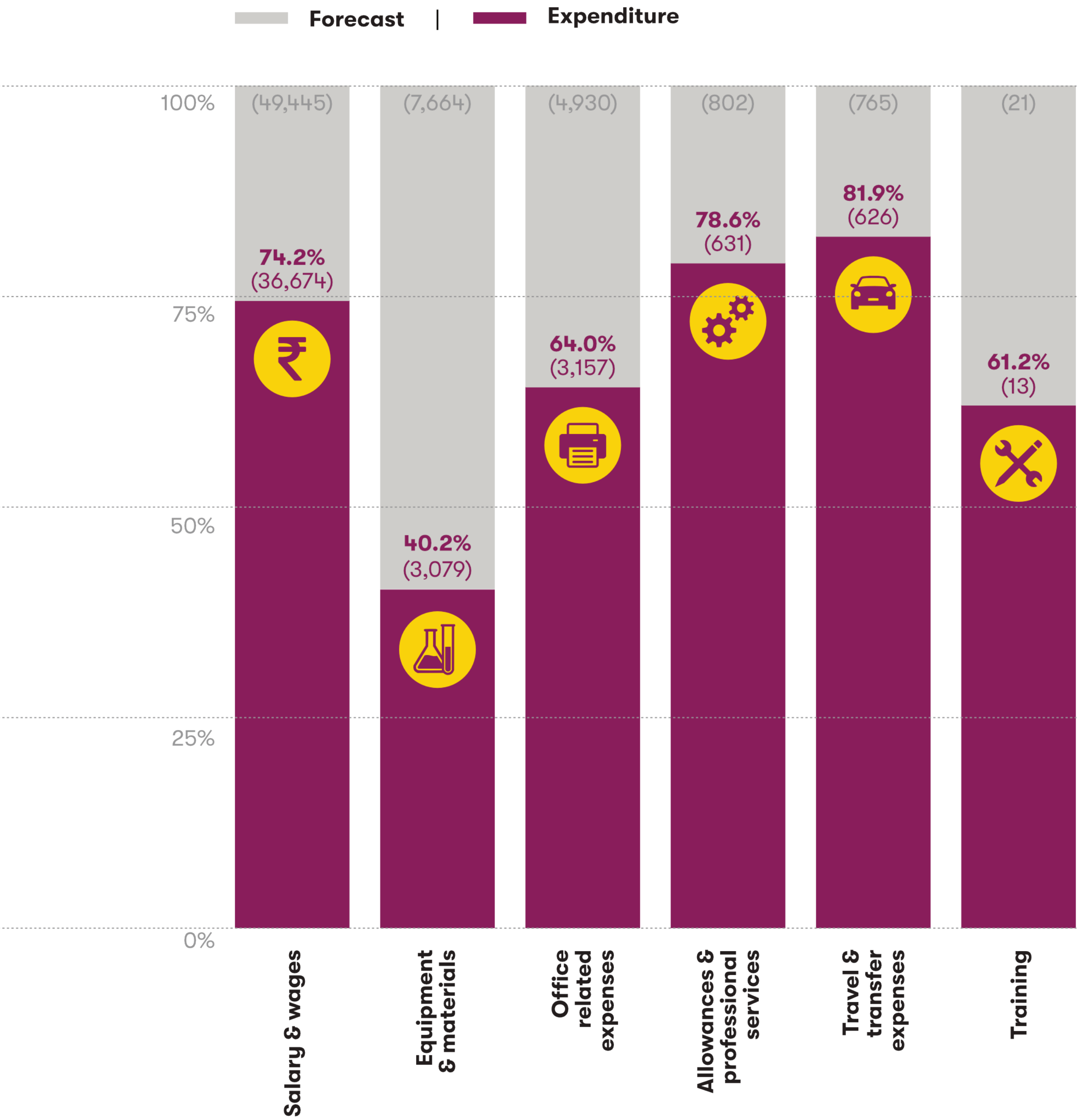
**85** This includes medical expenses and employee benefits.

**86** This includes expenditure on maintenance and motor vehicles.

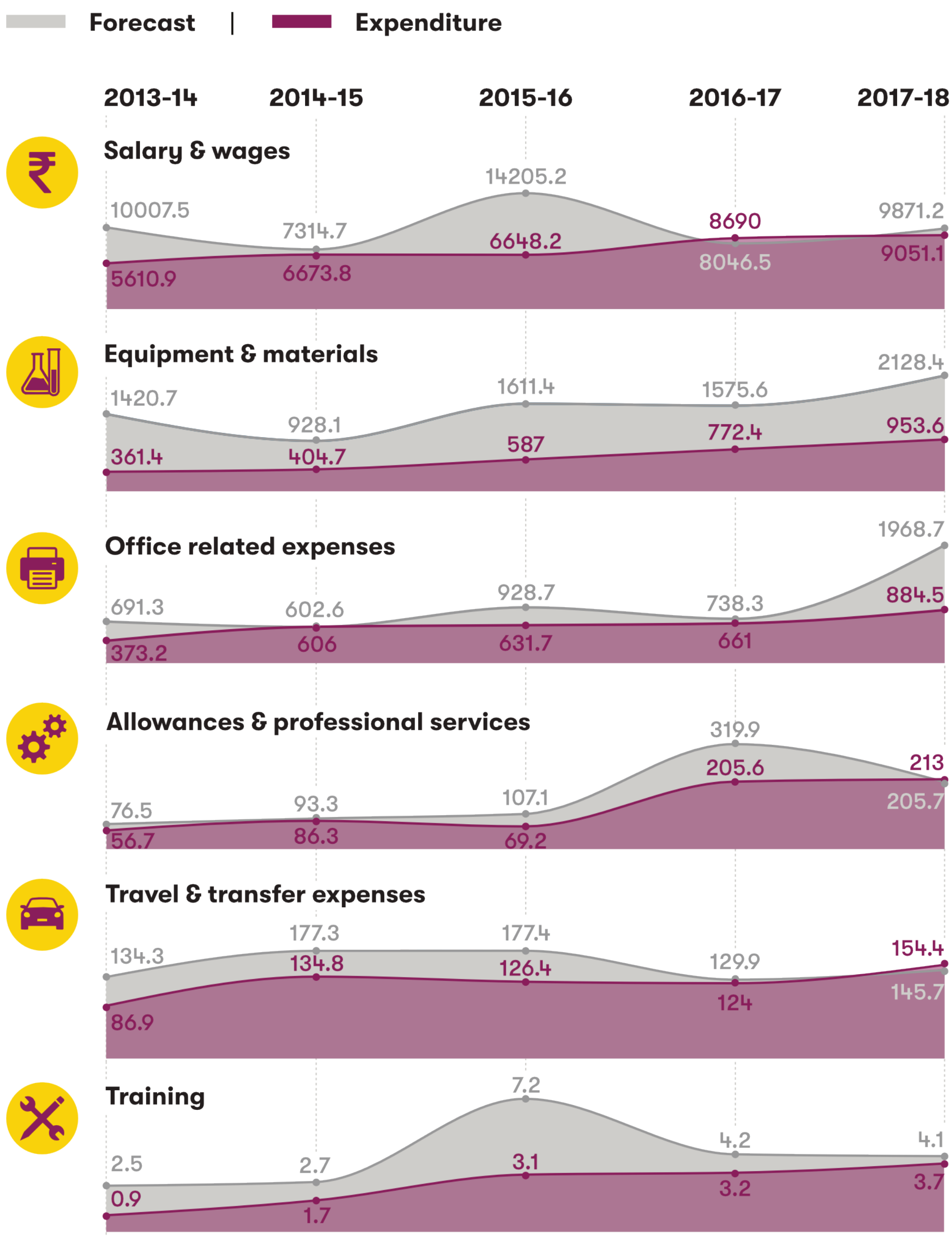
**87** This includes office expenditure, office building & infrastructure, rent and library expenditure.

**88** This includes special services and other expenses.

**Graphic 7. Expenditure & forecast comparison across budget heads (in lakhs INR)**



## Graphic 8. Year-wise analysis of forecast & expenditure across budget heads (in lakhs INR)



## Laboratory-wise Analysis

As shown in Table 1, the expenditure-to-forecast ratio under each head varies widely across laboratories as well as between different heads within the same laboratory. Barring training, several laboratories had either exceeded their forecasted expenditure or had matched it under the other heads. Many laboratories, on the other hand, had less than 50% expenditure when compared to their forecasted needs. The lowest ratio of expenditure-to-forecast was recorded in equipment & materials, as well as office-related expenses. It is important to note that only four of 22 laboratories i.e. SFSL Lucknow, SFSL Raipur, SFSL Shimla and RFSL Dharamshala separately forecasted and recorded expenses relating to training.

*Comparison of forecast & receipt*

Out of the 16 laboratories for which received versus forecast analysis could be done, seven laboratories received more funds overall than they had forecasted (Table 2). Out of these, SFSL Bhubaneswar, SFSL Imphal and SFSL Raipur received more funds than the forecasted amount in all assessment years.

On the other hand, RFSL Nagpur and CBI-CFSL received less than 50% of the funds forecasted and had the lowest receipt-to-forecast ratio of funds over the assessment period.[89] These laboratories also showed a wide variance in their annual receipt-to-forecast ratio, dropping as low as 14% in FY 2013-14 for RFSL Nagpur and 13.8% in FY 2015-16 for CBI-CFSL,[90] followed by more than 100% receipt in other years. Such inconsistency in the annual funding raises concerns regarding laboratory management.

89 RFSL Nashik has been excluded, since data relating to funds received for four out of five years was unavailable.

90 In response to the quantitative survey, CBI-CFSL had forecasted Rs. 8000 lakhs under the head of salary & wages for FY 2015-16, which is higher than the amount forecasted in other years under this head (ranging from Rs. 780-950 lakhs). This led to an increase in the total forecasted amount for FY 2015-16.

*Comparison of expenditure & receipt*

Significant variance was noticed between the expenditure and the funds received by laboratories, strongly pointing towards the underutilisation of funds as an issue. Five laboratories i.e. CBI-CFSL, CFSL Chandigarh, SFSL Bhubaneswar, SFSL Raipur and RFSL Nagpur, have consistently underutilised their funds across all years (Table 2). Amongst these laboratories, the level of expenditure for SFSL Raipur did not exceed 75% of the funds it received in any assessment year.

SFSL Lucknow, SFSL Shimla and RFSL Dharamshala had an overall expenditure-to-receipt ratio of 100% or more.[91] On the other hand, SFSL Verna and CFSL Chandigarh had the lowest rate of expenditure versus funds received for the overall assessment period.[92] Both laboratories showed inconsistent patterns of expenditure, with a significant dip in the rate of expenditure in SFSL Verna in FY 2016-17 (28.9%) and CFSL Chandigarh in FY 2014-15 (37.4%).

*Comparison of expenditure & forecast*

SFSL Imphal, SFSL Lucknow and RFSL Aurangabad recorded an overall expenditure higher than their forecast amount (Table 2). On the other hand, CBI-CFSL and RFSL Nagpur had the lowest expenditure-to-forecast ratio, both with expenditures less than 50% of the forecast amount.[93] SFSL Shillong recorded an expenditure-to-forecast rate lower than 75% across all years of the assessment period.

**91** RFSL Nashik has been excluded since data relating to funds received for four out of five years was unavailable.

**92** SFSL Mangalagiri has been excluded since it was under establishment in the assessment period. RFSL Ranipool has been excluded since data relating to expenditure is unavailable for FY 2013-14.

**93** SFSL Port Blair has been excluded since it has not provided year-wise expenditure for certain heads, including salary & wages, from 2012 to 2017.

**Table 1. Laboratory-wise data on forecast & expenditure across budget heads (in lakhs INR)**

| Laboratory | Salary & wages | | | Equipment & materials | | | Office related expenses | | |
|---|---|---|---|---|---|---|---|---|---|
| | Forecast | Expenditure | Expenditure/ Forecast | Forecast | Expenditure | Expenditure/ Forecast | Forecast | Expenditure | Expenditure/ Forecast |
| **CBI-CFSL** | 11490 | 4160.9 | 36.2% | 2065.8 | 139 | 6.7% | 242 | 231.3 | 95.6% |
| **CFSL Chandigarh** | 2833 | 2699.3 | 95.3% | 1082.5 | 84.7 | 7.8% | 680 | 532.4 | 78.3% |
| **RFSL Aurangabad** | 2107.9 | 2271 | 107.7% | 29.6 | 30.9 | 104.4% | 156.4 | 159.6 | 102.0% |
| **RFSL Dharamshala** | 478.8 | 456.8 | 95.4% | 24.3 | 26.5 | 109.1% | 27.1 | 27.1 | 100.0% |
| **RFSL Nagpur** | 6355 | 2502 | 39.4% | 82 | 80.6 | 98.3% | 275.8 | 274.6 | 99.6% |
| **RFSL Nashik** | 1841.3 | 1684.4 | 91.5% | 76.2 | 48.9 | 64.2% | 180.5 | 162.8 | 90.2% |
| **RFSL Pune** | 2910 | 2310.5 | 79.4% | 72.3 | 53.6 | 74.1% | 101.4 | 87.6 | 86.4% |
| **RFSL Ranipool** | 172.3 | 141.7 | 82.2% | 19.6 | 16.7 | 85.2% | 14 | 12.4 | 88.6% |
| **SFSL Agartala** | 643.8 | 498.7 | 77.5% | 171.1 | 46.3 | 27.1% | 121.2 | 116.2 | 95.9% |
| **SFSL Aizawl** | 1242.4 | 1146.9 | 92.3% | 433.5 | 433.5 | 100.0% | 111.6 | 62.4 | 55.9% |
| **SFSL Banderdewa** | | | | | 7.4 | | | 10.1 | |
| **SFSL Bhubaneswar** | 2228.6 | 2662.9 | 119.5% | 824.2 | 215.1 | 26.1% | 127.2 | 117.8 | 92.6% |
| **SFSL Dehradun** | 695.3 | 606.7 | 87.3% | 389.7 | 366.4 | 94.0% | 121.8 | 111.1 | 91.2% |
| **SFSL Imphal** | | 473 | | 82 | 19.4 | 23.7% | 37.3 | 42 | 112.6% |
| **SFSL Mangalagiri** | | 0.4 | | | 96.1 | | | 24.8 | |
| **SFSL Lucknow** | 7363.4 | 7724.7 | 104.9% | 69.4 | 52.4 | 75.5% | 239.9 | 220.7 | 92.0% |
| **SFSL Port Blair** | 36.8 | | | 266.5 | 6.1 | 2.3% | 74.5 | 0.3 | 0.4% |
| **SFSL Raipur** | 2820.9 | 1710.1 | 60.6% | 652 | 504.6 | 77.4% | 175.3 | 139.9 | 79.8% |
| **SFSL Shimla** | 2425.4 | 2439.1 | 100.6% | 674.2 | 548.3 | 81.3% | 1993 | 769.5 | 38.6% |
| **SFSL Shillong** | 885.8 | 676 | 76.3% | 180 | 43 | 23.9% | 44.9 | 39.7 | 88.4% |
| **SFSL Thiruvananthapuram** | 2638.5 | 2365.7 | 89.7% | 223 | 111 | 49.8% | 193.8 | 11.7 | 6.0% |
| **SFSL Verna** | 275.6 | 143 | 51.9% | 246.3 | 148.7 | 60.4% | 12.2 | 2.6 | 21.3% |

| Allowances & professional services | | | Travel & transfer expenses | | | Training | | | Grand Total | | | Laboratory |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Forecast | Expenditure | Expenditure/ Forecast | Forecast | Expenditure | Expenditure/ Forecast | Forecast | Expenditure | Expenditure/ Forecast | Forecast | Expenditure | Expenditure/ Forecast | |
| | | | 224 | 221.7 | 99.0% | | | | 14021.8 | 4752.9 | 33.9% | **CBI-CFSL** |
| | | | 240 | 138.3 | 57.6% | | | | 4835.5 | 3454.7 | 71.4% | **CFSL Chandigarh** |
| 10.5 | 8.2 | 78.1% | 6.9 | 5 | 72.5% | | | | 2311.2 | 2474.7 | 107.1% | **RFSL Aurangabad** |
| 2.4 | 3.3 | 137.5% | 8.3 | 7.8 | 94.0% | 0.3 | 0.3 | 100.0% | 541.3 | 521.8 | 96.4% | **RFSL Dharamshala** |
| 24.7 | 20.3 | 82.2% | 15 | 7 | 46.7% | | | | 6752.5 | 2884.4 | 42.7% | **RFSL Nagpur** |
| 21.3 | 20.7 | 97.2% | 11.5 | 9.2 | 80.0% | | | | 2130.8 | 1926 | 90.4% | **RFSL Nashik** |
| | | | 15.5 | 5.8 | 37.4% | | | | 3099.2 | 2457.5 | 79.3% | **RFSL Pune** |
| 2.5 | 2 | 80.0% | 2 | 2 | 100.0% | | | | 210.4 | 174.8 | 83.1% | **RFSL Ranipool** |
| 22.6 | 22.6 | 100.0% | 10.2 | 9.7 | 95.1% | | | | 968.9 | 693.5 | 71.6% | **SFSL Agartala** |
| 2.5 | 2.5 | 100.0% | 19.5 | 19.5 | 100.0% | | | | 1809.5 | 1664.9 | 92.0% | **SFSL Aizawl** |
| | 10 | | | 10.3 | | | | | | 37.8 | | **SFSL Banderdewa** |
| 126.1 | 96.9 | 76.8% | 19.6 | 10.7 | 54.6% | | | | 3325.7 | 3103.5 | 93.3% | **SFSL Bhubaneswar** |
| 80.1 | 67.7 | 84.5% | 8.2 | 3.9 | 47.6% | | | | 1295.2 | 1155.8 | 89.2% | **SFSL Dehradun** |
| | | | 17.9 | 57.2 | 319.6% | | | | 137.2 | 591.6 | 431.2% | **SFSL Imphal** |
| | | | | 9.4 | | | | | | 130.6 | | **SFSL Mangalagiri** |
| 473.3 | 346.7 | 73.3% | 19.8 | 19.9 | 100.5% | 5.7 | 4.3 | 75.4% | 8171.6 | 8368.7 | 102.4% | **SFSL Lucknow** |
| | | | | | | | | | 377.8 | 6.4 | 1.7% | **SFSL Port Blair** |
| | | | 28.5 | 16.3 | 57.2% | 11 | 6 | 54.5% | 3687.7 | 2376.8 | 64.5% | **SFSL Raipur** |
| 25.2 | 26.2 | 104.0% | 34.6 | 29.3 | 84.7% | 3.6 | 2 | 55.6% | 5156.1 | 3814.4 | 74.0% | **SFSL Shimla** |
| 1.3 | 0.3 | 23.1% | 9.3 | 1.4 | 15.1% | | | | 1121.1 | 760.5 | 67.8% | **SFSL Shillong** |
| | | | 64.7 | 37.8 | 58.4% | | | | 3120 | 2526.2 | 81.0% | **SFSL Thiruvananthapuram** |
| 9.9 | 3.5 | 35.4% | 9.1 | 4.4 | 48.4% | | | | 553.1 | 302.1 | 54.6% | **SFSL Verna** |

## Table 2. Laboratory-wise comparison of forecast, receipt & expenditure of funds across the assessment period

| Laboratory | 2013-14 | | | 2014-15 | | | 2015-16 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Received/ Forecast | Expenditure/ Received | Expenditure/ Forecast | Received/ Forecast | Expenditure/ Received | Expenditure/ Forecast | Received/ Forecast | Expenditure/ Received | Expenditure/ Forecast |
| **CBI-CFSL** | 100.7% | 69.6% | 70.2% | 104.4% | 80.4% | 83.9% | 13.8% | 72.1% | 10.0% |
| **CFSL Chandigarh** | 95.8% | 57.4% | 55.0% | 172.0% | 37.4% | 64.2% | 117.3% | 66.1% | 77.5% |
| **RFSL Aurangabad** | | | 91.5% | | | 76.9% | | | 89.2% |
| **RFSL Dharamshala** | 95.7% | 99.9% | 95.7% | 98.1% | 100.0% | 98.1% | 93.0% | 99.5% | 92.5% |
| **RFSL Nagpur** | 14.0% | 99.5% | 13.9% | 112.5% | 99.1% | 111.6% | 97.2% | 99.3% | 96.6% |
| **RFSL Nashik** | | | 74.8% | | | 101.7% | | | 98.1% |
| **RFSL Pune** | | | 103.2% | | | 83.5% | | | 79.0% |
| **RFSL Ranipool** | | | | 100.0% | 94.6% | 94.6% | 100.0% | 66.7% | 66.7% |
| **SFSL Agartala** | 72.5% | 77.1% | 55.9% | 100.0% | 75.6% | 75.6% | 100.0% | 66.0% | 66.0% |
| **SFSL Aizawl** | 100.0% | 97.4% | 97.4% | 100.0% | 100.0% | 100.0% | 100.0% | 87.2% | 87.2% |
| **SFSL Bhubaneswar** | 107.6% | 59.7% | 64.2% | 106.7% | 94.7% | 101.1% | 108.8% | 94.2% | 102.4% |
| **SFSL Dehradun** | 135.4% | 63.8% | 86.3% | 94.7% | 82.7% | 78.4% | 85.9% | 100.0% | 85.9% |
| **SFSL Imphal** | 939.7% | 46.6% | 437.4% | 345.3% | 222.8% | 769.4% | 384.7% | 52.9% | 203.6% |
| **SFSL Lucknow** | 100.0% | 98.0% | 98.0% | 100.0% | 100.0% | 100.0% | 99.9% | 96.9% | 96.9% |
| **SFSL Mangalagiri** | | | | | | | | 11.2% | |
| **SFSL Port Blair** | | | | | | 4.5% | | | 0.6% |
| **SFSL Raipur** | 101.9% | 35.0% | 35.7% | 102.0% | 42.8% | 43.6% | 112.7% | 70.5% | 79.4% |
| **SFSL Shimla** | 62.6% | 94.3% | 59.0% | 121.4% | 104.1% | 126.4% | 90.1% | 104.1% | 93.8% |
| **SFSL Shillong** | | | 73.9% | | | 62.9% | | | 71.6% |
| **SFSL Thiruvananthapuram** | 119.8% | | | 66.2% | 87.9% | 58.2% | 68.9% | 98.0% | 67.5% |
| **SFSL Verna** | 5472.4% | 98.3% | 5382.1% | 20.9% | 129.9% | 27.1% | 104.7% | 100.2% | 104.9% |

| 2016-17 | | | 2017-18 | | | Grand Total | | | Laboratory |
|---|---|---|---|---|---|---|---|---|---|
| Received/ Forecast | Expenditure/ Received | Expenditure/ Forecast | Received/ Forecast | Expenditure/ Received | Expenditure/ Forecast | Received/ Forecast | Expenditure/ Received | Expenditure/ Forecast | |
| 73.8% | 92.2% | 68.1% | 106.9% | 64.6% | 69.1% | 45.4% | 74.6% | 33.9% | **CBI-CFSL** |
| 107.2% | 79.7% | 85.4% | 121.5% | 62.6% | 76.0% | 122.5% | 58.3% | 71.4% | **CFSL Chandigarh** |
| | | 511.6% | | | 107.4% | | | 107.1% | **RFSL Aurangabad** |
| 93.9% | 101.1% | 94.9% | 100.6% | 99.5% | 100.1% | 96.4% | 100.0% | 96.4% | **RFSL Dharamshala** |
| 75.7% | 99.3% | 75.2% | 73.8% | 99.2% | 73.3% | 43.0% | 99.3% | 42.7% | **RFSL Nagpur** |
| 19.6% | 458.1% | 89.8% | | | 86.5% | 4.3% | 2093.4% | 90.4% | **RFSL Nashik** |
| | | 95.0% | | | 43.6% | | | 79.3% | **RFSL Pune** |
| 100.0% | 99.8% | 99.8% | 81.3% | 97.7% | 79.5% | 268.7% | 30.9% | 83.1% | **RFSL Ranipool** |
| 85.8% | 81.9% | 70.2% | 74.0% | 107.5% | 79.6% | 84.7% | 84.5% | 71.6% | **SFSL Agartala** |
| 100.0% | 100.0% | 100.0% | 100.0% | 79.4% | 79.4% | 100.0% | 92.0% | 92.0% | **SFSL Aizawl** |
| 106.4% | 89.9% | 95.6% | 119.7% | 86.8% | 103.9% | 110.4% | 84.5% | 93.3% | **SFSL Bhubaneswar** |
| 113.7% | 77.4% | 88.0% | 125.8% | 81.4% | 102.3% | 110.7% | 80.6% | 89.2% | **SFSL Dehradun** |
| 390.7% | 88.8% | 346.8% | 626.9% | 64.3% | 403.2% | 517.8% | 83.3% | 431.4% | **SFSL Imphal** |
| 100.0% | 103.4% | 103.4% | 100.0% | 108.2% | 108.2% | 100.0% | 102.4% | 102.4% | **SFSL Lucknow** |
| | 8.3% | | | 0.5% | | | 1.4% | | **SFSL Mangalagiri** |
| | | 2.0% | | | 2.8% | | | 1.7% | **SFSL Port Blair** |
| 112.3% | 66.2% | 74.4% | 116.9% | 62.6% | 73.1% | 110.7% | 58.2% | 64.5% | **SFSL Raipur** |
| 105.0% | 101.0% | 106.0% | 47.0% | 97.9% | 46.1% | 73.6% | 100.5% | 74.0% | **SFSL Shimla** |
| | | 69.1% | | | 63.9% | | | 67.8% | **SFSL Shillong** |
| 416.8% | 69.4% | 289.4% | 149.9% | 58.2% | 87.2% | 128.1% | 63.2% | 81.0% | **SFSL Thiruvananthapuram** |
| 74.1% | 28.9% | 21.4% | 91.4% | 58.6% | 53.5% | 95.6% | 57.1% | 54.6% | **SFSL Verna** |

CHALLENGES

## CHALLENGES

### Lack of independence for laboratories under the police department

Several SFSLs and RFSLs shared concerns about the administrative and financial control of state police departments. Of the 27 SFSLs and RFSLs covered within the project, 15 were under the administrative and financial control of the respective state police departments. Some laboratories under the police department described a more cumbersome process for budget and expenditure approvals, as compared to those laboratories that were directly under the state home department. For these laboratories, budget approvals are first received by the state Director General of Police, and after integration with the larger police budget, these approval requests are forwarded to the state home department and thereafter to the finance department.

Some SFSLs also experienced interference in budget and expenditure decisions, which was ascribed to a lack of requisite scientific and technical understanding on the part of the department heads. This issue was further exacerbated in some FSLs where IPS officers from the police departments were given additional charge as the Director of the laboratory. In such cases, the assessment and prioritisation of the laboratory's needs were likely to emerge as an issue.

Apart from financial issues, SFSLs and RFSLs also indicated that officials from police departments can exert pressure to determine the priority of cases for forensic examination, or even influence decision-making in individual casework. Such narratives raise grave concerns about the impartiality of forensic examination and the integrity of the evidence produced before the courts.

### Issues with utilisation of central funding under the MPF Scheme

Many SFSLs and RFSLs had a common narrative about the delay in the receipt of funds under the central government's MPF Scheme. Funding proposals, sanctions and utilisation certifications for this grant are routed through the state police departments, which causes a delay in the receipt of funds. The lapse of allocated funds at the end of the financial year was identified by the state laboratories as a major reason for the underutilisation of central funding. Such concerns have also been noted by the Comptroller and Auditor General (CAG) in its state audit reports.[94]

Some SFSLs also highlighted inconsistencies in their receipt of central funding across different years, which hampered the expansion of forensic science infrastructure within the state. For instance, some SFSLs recounted that while they had initially received central funding for the establishment of MFSUs, their development was interrupted when the scheme lapsed in the next Five Year Plan. In such situations, SFSLs have either had to turn to state funding or to halt such projects.

### Limited financial powers of directors

Laboratories identified limitations in the financial powers of their directors as one of the reasons for delays in procurement and expenditure. This power varied widely across laboratories, with some directors having the power to sanction only Rs. 20,000, while there were others with a limit of Rs. 5 lakhs. Many laboratories shared that such amounts were especially low for equipment and supplies needed by FSLs, with regular expenses on scientific kits and reagents often exceeding this value. For procurements above the director's limit, a Purchase Committee under

94 For instance, the CAG Audit Report for Goa (2009) at pg 12 states that the Rs. 245 lakhs provided by the 11th Finance Commission in 2001 for constructing an FSL lapsed due to bureaucratic delays, and the funds had to be taken from the MPF Scheme to construct the building in 2008. https://cag.gov.in/uploads/download_audit_report/2009/Goa_civil_2009_chap1.pdf. The CAG Audit Report for Bihar (2016) at pg 147 states that the initial tranche of central funds disbursed for construction of four proposed MFSUs was lying unspent for five years. There was a delay in establishing a State Forensic Governing Body and no utilisation certificate was submitted. https://cag.gov.in/uploads/download_audit_report/2017/Bihar_Report_No_2_of_2017_on_GSES.pdf.

the GFR would be constituted, which could entail the involvement of officials from the home and finance departments, leading to further delays in procurement.

### Complexities relating to tender & procurement process

Due to the submission of ineligible or insufficient bids, laboratories face issues arising from the lapse of the tender process under the GFR. Such delays in the procurement process, which consequently lead to a lapse of funds by the end of the financial year have been noted in the CAG Audit Reports.[95] Therefore, delays in receipt of funds from the central government or the parent departments within the state and issues with successful completion of the tender process collectively contribute to the underutilisation of funds received by the laboratories.

***At times, we do not even get three quotations as is required by the tender specifications. We have to redo the tender after taking the government's approval. Meanwhile, the budget lapses while we are in the middle of taking permission.***

- Joint Director at an SFSL on procurement & lapse of budget

**95** For instance, the CAG Audit Report for Jammu & Kashmir (2009) at pg 47 states that Rs. 675 lakhs were released by the central government for procurement of equipment, of which only 33% could be spent due to delays in procurement. 62% of the items approved between 2004-2008 were not purchased, while none of the items approved during 2008-2009 were purchased. https://cag.gov.in/uploads/download_audit_report/2009/Jammu_Kashmir_Civil_2009.pdf. The CAG Audit Report for Uttar Pradesh (2016) at pg 43 states that most of the laboratory equipment is imported from abroad, which suffers from delays in tendering and procurement process. Between 2011-2016, only 45% of Rs. 5355 lakhs disbursed for procurement were spent. https://cag.gov.in/uploads/download_audit_report/2017/Report_No.3_of_2017_Performance_Audit_of_Modernisation_of_Police_Forces_Government_of_Uttar_Pradesh.pdf. Similarly, the CAG Audit Report for Madhya Pradesh (2016) at pg 80 states that mere 16% utilisation

Some FSL officials also expressed a lack of understanding of the financial chain of command, budget process and fund flow from the central and state governments to their individual laboratories, which has implications on their ability to communicate their administrative and budgetary needs to the relevant authorities.

### Financial regulation of RFSLs dependent on SFSLs

RFSLs are financially dependent on their respective SFSLs, with limits on their financial powers varying across states. Some respondents shared that the persons in charge of the laboratory did not have the independent financial power to sanction expenditure, resulting in all supplies and procurement being dependent on approval by the SFSL. Other RFSLs had a Drawing and Disbursing Officer (DDO) with the power to draw bills and approve expenses under the GFR, offering them a limited level of financial independence. However, for all RFSLs covered within the project, the budget submission to their respective parent department heads is routed through the SFSL. The funds received by the SFSLs from the home or police department are then divided between them and the RFSLs.

Given that the bulk of forensic laboratories are RFSLs,[96] their heavy dependence on the SFSL administration for budgeting, disbursal of funds and expenditure has a major impact on the substantial amount of forensic casework that is processed across states. Some RFSL officials recounted that the purchase of basic items such as light bulbs, or often-used reagents such as benzene or distilled water, also required SFSL approval. In such situations, RFSL staff was likely to personally incur these expenses to avoid administrative issues and to allow for the smooth

of the funds allocated for equipment was due to the delay in finalisation of specifications, non-completion of legal formalities and poor procurement management. https://cag.gov.in/uploads/download_audit_report/2017/Report%20No%203%20of%202017%20MP%20General%20and%20Social%20Sectors.pdf.

**96** Out of the 117 FSLs currently functional in India, 78 are RFSLs. See Graphic 2 showing functional FSLs in India in Methodology at pg 51.

functioning of the laboratory.

***RFSL personnel cannot even procure items like benzene or coverslips for microscope slides on their own. We have to ask the SFSL to send these materials. Once, a bulb's fuse was burnt and the Joint Director spent out of his own pocket to get it repaired. Otherwise, he would have to spend money on the speed post.***

- RFSL official while discussing their dependence on the SFSL

**No budget for research & development**

None of the laboratories, including CFSLs, have accounted for any funds for R&D. Many laboratories shared that they are unable to conduct any research work due to the high pendency of cases and limited staff. This is especially a matter of concern for the CFSLs which were imagined as centres for R&D in forensic science. In 1998, the three CFSLs in Hyderabad, Chandigarh and Kolkata were each designated as a 'Centre of Excellence' in Forensic Chemical Sciences, Forensic Physical Sciences and Forensic Biological Sciences respectively.[97] The predominant responsibility of these laboratories was research and states were urged to not send their "routine" cases to CFSLs and instead get them examined in their SFSLs.[98] Following the sanctioning of three new CFSLs at Bhopal, Pune and Guwahati,[99] the above compartmentalised research mandate was abandoned and all CFSLs under DFSS were directed to focus on R&D.[100] Despite this, no funds have been utilised for research

**97** SPAC Report, pg 3.

**98** Perspective Plan, pg 110.

**99** *MHA, Resolution No. 25020/61/13/FW/MHA dated 26.07.2013*, Gazette of India, Part I, Section I, dated 10.08.2013, pg 481.

**100** *MHA Office Memorandum No. DFSS./15(16)2011/MHA/PM-II dated 02.06.2011*, as referred to in the SPAC Report, pg 117.

and development.

### Inadequate employee benefits

Several FSL officials shared accounts about the lack of adequate insurance to cover occupational hazards.[101] Further, the denial of benefits, such as travel and dearness allowances to employees hired on a contractual basis was a significant concern.

Another source of dissatisfaction amongst the scientific staff at SFSLs and RFSLs was the disparity in the levels of salary with the scientific staff at CFSLs and other independent governmental scientific institutions. Considering the lack of adequate pay and benefits along with a heavy workload, many scientific officers felt pressured to leave for "better opportunities" in government universities or administrative services. This explains the issue with recruitment, retention and vacancies in FSL personnel as described in the next chapter.

101 See challenge on lack of safety precautions in Chapter IV: Infrastructure at pg 183.

RECOMMENDATIONS

## RECOMMENDATIONS

### Separate FSLs from police administration

Administrative and financial control of the police departments over FSLs raises concerns about the independence of forensic examinations and exposes it to increased public or political pressures. Such influence, or even the perception thereof, adversely impacts the impartiality of forensic science services and ultimately compromises the judicial and public confidence in FSLs. To fulfil their role in the criminal justice system in ensuring that scientifically reliable evidence of high quality is presented before courts, FSLs must be made independent of investigative and prosecutorial agencies.

The separation of FSLs from the police administration will also ensure greater financial independence and reduce delays in the receipt and utilisation of funds, as such approvals would directly be received and responded to by the state home departments. Laboratories which were previously under the police administration have admitted to a reduction in bureaucratic processes and approvals for budgetary decisions since being brought directly under the home department.[102] This allows for the funds to be utilised effectively by FSLs and improve their delivery of services. DFSS, through its proposed Administrative wing,[103] should

**102** Similar observations were made in the NHRC Report at pg 12-13, which stated that the police administration of laboratories may "adversely affect its scientific work" and "for any financial or administrative approval, the heads of the FSLs have to approach the police, and police in-turn approaches the home department, resulting in enormous delay." See also Committee on Identifying the Needs of the Forensic Sciences Community, National Research Council, *Strengthening Forensic Science in the United States: A Path Forward* (2009) [NAS Report], which at pg 183-184 recommended independence of forensic science laboratories from law enforcement agencies so that laboratories can "set its own priorities with respect to cases, expenditures, and other important issues. Cultural pressures caused by the different missions of scientific laboratories vis-à-vis law enforcement agencies would be largely resolved." https://www.ojp.gov/pdffiles1/nij/grants/228091.pdf.

**103** See section on recommendations for DFSS in Chapter VIII: Overall Recommendations at pg 264.

hold consultations with representatives from all state governments towards this structural modification.

### Reduce delays & maintain consistency in funding to laboratories

Central and state governments must ensure that funds are disbursed to the FSLs at the beginning of the financial year. This will ensure their timely utilisation, especially for schemes under which the funds may lapse at the end of the financial year. The delay in the receipt of funds along with cumbersome procurement procedures under the GFR and state rules and regulations leads to the underutilisation of funds, hampering the operations of FSLs and impeding their development.

While the central government allocates substantial funding towards SFSLs, these funds are not received consistently on an annual basis and thus cannot be relied upon in undertaking any long-term capacity-building programmes. This makes the SFSLs completely reliant on their respective state governments for funding, thus creating a wide disparity in capabilities across SFSLs since the financial resources and policies of different states can vary. Further, FSLs can experience friction with the state police departments in accessing their share of central funding released under the MPF Scheme.

Therefore, consistent central grants earmarked for the development of SFSLs and RFSLs would ensure planned expenditure by the laboratory.[104] Central funds may be specifically sub-allocated under budget heads, like training or R&D, to ensure that laboratories dedicate funding to these heads. DFSS through its needs assessment surveys can determine the budgetary needs of each FSL with respect to each budget head and guide such budgetary allocation along with the proposed state DFSS.[105]

**104** See recommendation on improving equipment procurement process in Chapter IV: Infrastructure at pg 186.

**105** See Table 3 on overall recommendations in Chapter VIII: Overall Recommendations at pg 274.

### Improve financial powers of FSL directors

There is a need to revise the financial powers of FSL directors to ensure that the laboratories' recurring requirements for scientific work are fulfilled without delay and that the impact on casework is reduced. While setting these limits, it is essential to consider that the costs for the regular functioning of laboratories are much higher than the running of non-scientific departments due to their very nature, irrespective of whether the laboratory is a CFSL, SFSL or RFSL.

The NHRC Report in 1999 noted the issue of limited financial powers of the directors of FSLs and recommended that the FSL director must have "well-defined authority commensurate with his responsibilities" as this will reduce the delays in the decision-making process. It further noted that once the budget is sanctioned, as is the case with the Defence Research & Development Organisation (DRDO), the director should be delegated with "full powers to sanction expenditure" within approved budgetary limits under different heads.[106] More than a decade later, the SPAC Report also recommended that the directors of CFSLs should have financial powers at par with scientific laboratories directly under the Indian government.[107] This will ensure the smooth functioning of the laboratories and reduce delays.

### Greater financial independence for RFSLs

There is a need to reduce the financial dependence of RFSLs on their respective SFSL to ensure their effective functioning. All RFSL directors or officers-in-charge should be given the powers of a DDO under the GFR, including sufficient financial powers, to avoid bureaucratic hurdles in the laboratories' regular operations.

There should also be coordinated financial planning between the SFSLs

**106** NHRC Report, pg 19.

**107** SPAC Report, pg 77.

and RFSLs through such designated financial officers, where the needs and requirements of the RFSL are systematically taken into account while preparing the budget for the state and consequently reflected in the disbursal of funds.

### Better financial planning

Financial training must be provided to the senior administration in FSLs and dedicated personnel proficient in financial management must be engaged in each laboratory.[108] Firstly, this will ensure more accurate and systematic budget forecasting. Such financial planning should be done at the RFSL-level as well and should be assimilated in a timely manner into the budget approvals sent to the home department by the respective SFSLs.

Secondly, dedicated financial personnel should conduct yearly forecasting and expenditure analysis in order to accurately estimate the laboratory's financial needs, including expenditure on the annual maintenance of purchased equipment.[109] The collection and analysis of financial data by the FSL themselves will ensure periodic reviews of the financial health of the forensic science landscape on a state-wide or nation-wide level.

The DFSS at the centre and those envisioned at the state level[110] by conducting needs assessment surveys would understand the needs of each FSL through the difference in the funds received and spent by it, and enable respective governments to better plan their financial policy for FSLs.

**108** See Table 5 on recommendations related to Recruitment, Education & Training in Chapter VIII: Overall Recommendations at pg 276.

**109** SPAC Report at pg 51-52, 103 noted similar issues in respect to CFSLs due to inadequate planning of the part of scientific personnel "to identify their requirements of equipment, materials and manpower to ensure their proper utilisation."

**110** See Table 3 on overall recommendations in Chapter VIII: Overall Recommendations at pg 274.

# 2 RECRUITMENT, EDUCATION & TRAINING

## INTRODUCTION

As part of the quantitative survey, FSLs provided data for sanctioned, filled and additionally required posts for scientific and non-scientific staff in a laboratory. Information regarding filled posts has been provided by 27 laboratories[111] while 17 laboratories also provided information on the additional posts required by them. CBI-CFSL has not provided data on sanctioned posts, while three other laboratories[112] did not provide this information for specific posts.

The data regarding recruitment has been collected on the basis of posts and is not classified as per the divisions within the laboratory. A wide variance was seen across laboratories on the nomenclature of the sanctioned posts. Information regarding posts filled on a permanent and contractual basis has been separately collected. This distinction has been maintained due to strong narratives highlighting the limitations of hiring contractual employees, and the variance in the benefits provided to contractual employees compared to permanent staff. In order to understand the process of staffing, the survey also sought information on whether the laboratories had work units and the number of additional work units required.[113]

**111** SFSL Puducherry, SFSL Mumbai and RFSL Agra have been excluded as they have not provided the sought quantitative data regarding posts. SFSL Puducherry does not have any sanctioned posts or framed RRs for them. It has hired a director, a senior analyst, two analysts and three junior analysts on contractual basis.

**112** SFSL Dimapur, SFSL Port Blair and SFSL Shimla did not provide data regarding sanctioned posts.

**113** The BPR&D Work Norms for Forensic Science Laboratories and Government Examiners of Questioned Documents (2002), which were adopted by DFSS, provide the staffing across divisions on the basis of a work unit. The number of cases/exhibits to be examined per year by a work unit are also provided in the norms [BPR&D WORK NORMS 2002]. http://dfs.nic.in/pdfs/worknorms2002.pdf. See inset on the history of work norms at pg 105.

Information regarding the educational qualifications and professional experience of the scientific staff, and training programmes for FSL staff as well as for other stakeholders such as police, lawyers and judges was also collected.

As part of the survey, laboratories were requested to share copies of their training manuals along with recruitment rules (RRs) for their staff. RRs are notified under the Constitution, or a central or state legislation, and provide the eligibility criteria for recruitment against different posts and the details regarding the selection process. Despite consistent follow-up, only SFSL Aizawl, SFSL Bhubaneswar, SFSL Raipur, SFSL Verna and RFSL Ranipool provided their RRs. No laboratory has provided its training manuals. This hindered the comparison of recruitment and training systems across laboratories.

# TRENDS

## Overall vacancies across laboratories

Out of the 26 laboratories[114] for which recruitment-related information was available, there were 1294 vacancies, out of which 901 were vacant scientific posts.[115] Of the total sanctioned posts, 40.3% were vacant as were 38.2% of the sanctioned scientific posts (Graphic 9). Out of the total vacancies, 69.6% of the posts were for scientific staff.

On a comparison of the rate of total filled and vacant posts across laboratories, SFSL Lucknow, RFSL Berhampur and RFSL Jagdalpur have vacancy rates of more than 50%, with SFSL Lucknow having the highest vacancy rate of 72.5%, even with the inclusion of contractual posts as shown in Graphic 11.

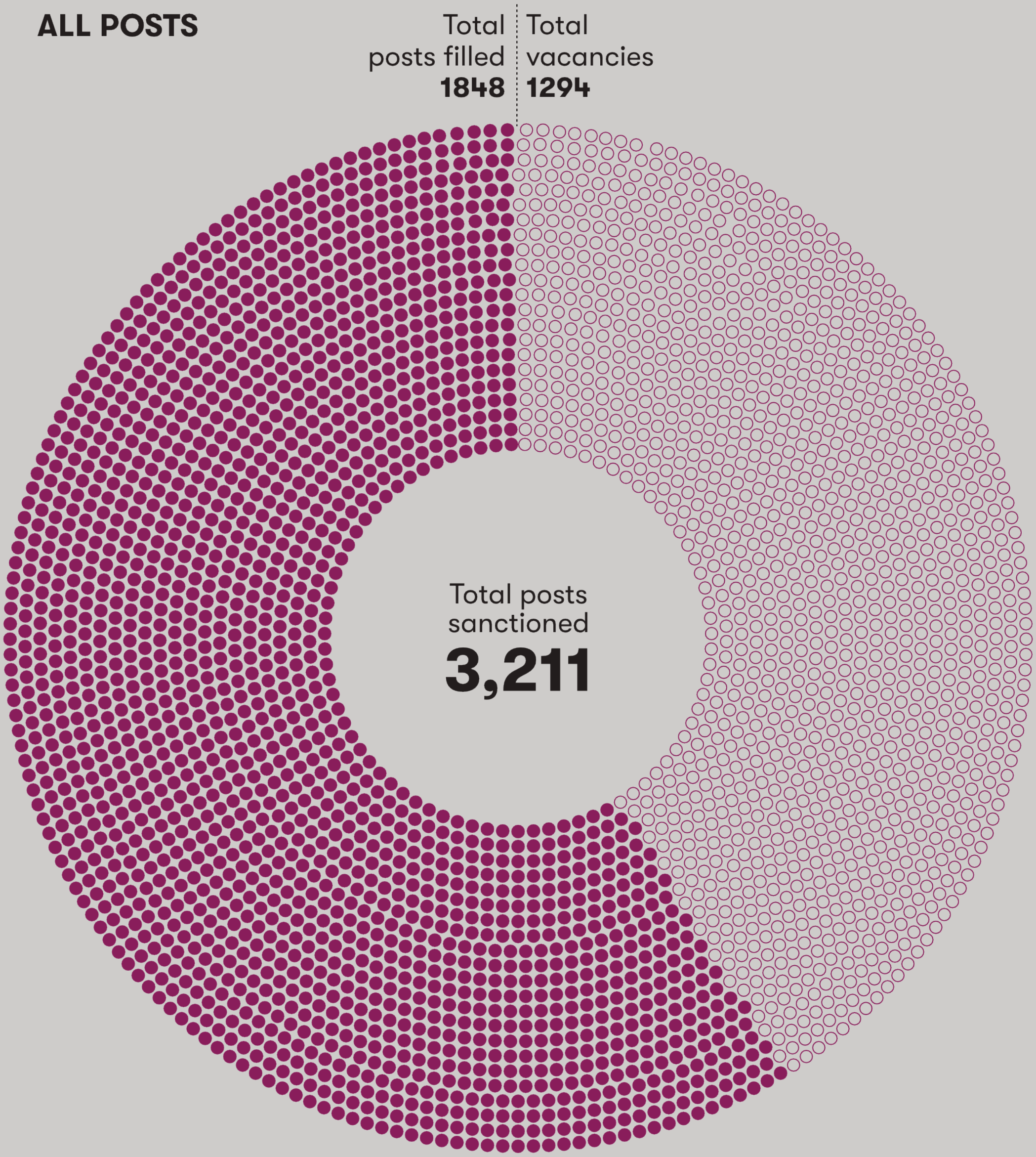
On the other hand, SFSL Dimapur and SFSL Port Blair had no vacancies. Further, RFSL Nagpur and RFSL Pune have negative vacancy rates since the filled posts include contractual staff, which is not counted in permanent sanctioned posts.



**114** Recruitment related data is not available for SFSL Mumbai and RFSL Agra, while SFSL Puducherry does not have any sanctioned posts. CBI-CFSL has also been excluded from vacancy analysis as no information was provided on sanctioned posts. One hundred posts are filled at CBI-CFSL, out of which 77 are scientific staff. CBI-CFSL requires 72 additional posts out of which 70 are scientific posts.

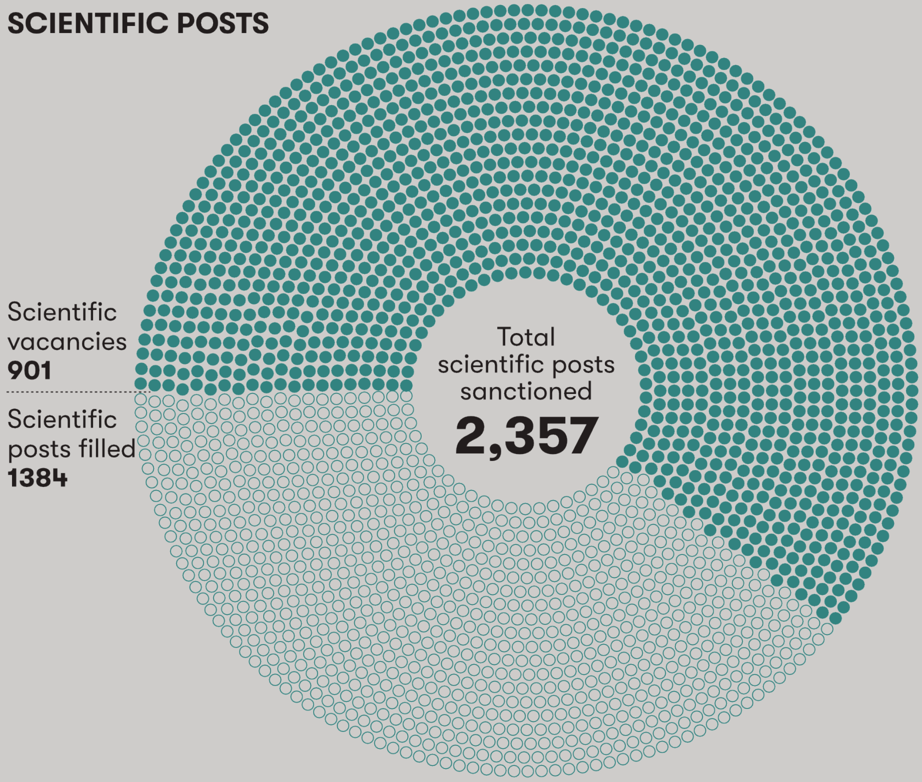
**115** See Graphic 10 on scientific posts across FSLs at pg 100.

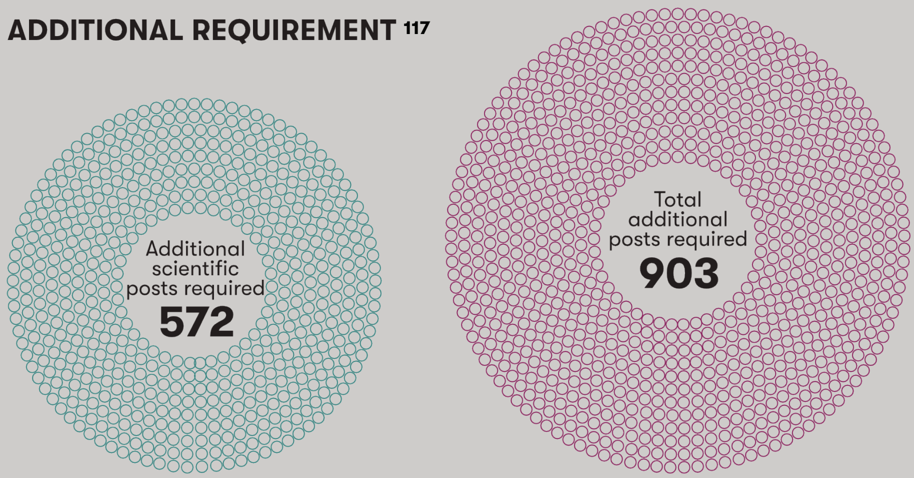
**Graphic 9. Overview of the data on posts filled, vacancies & additional requirement[116]**




**116** As per the data provided by the laboratories, posts filled on contract basis may not be included within the sanctioned posts. For calculating vacancies, posts filled on permanent basis, deputation and on contract have been subtracted from the total sanctioned posts. Therefore, the sum of total posts filled and total vacancies may be higher than the sanctioned posts.

**Graphic 9. Overview of the data on posts filled, vacancies & additional requirement**




**117** Information regarding additional posts required represents the number of the posts required to be sanctioned in addition to the posts already sanctioned. This is the explanation for the number of total additional posts required being higher than the number of total vacancies.

## Vacancies in scientific posts

For the purpose of consistency, personnel involved in any part of forensic examination were considered as scientific posts (Graphic 10). These posts cover a range of personnel who are involved in conducting forensic examination, a technical review of the process or as laboratory support staff.

SFSL Banderdewa, SFSL Lucknow, SFSL Verna, RFSL Berhampur and RFSL Jagdalpur have more than 50% of their scientific posts vacant, even after factoring in any contractual scientific staff (Graphic 12). High levels of vacancies raise serious concerns regarding the pendency of casework,[118] the quality of forensic examination and the increased pressures on existing staff.

The FSLs with the highest number of scientific posts filled by contractual staff are the RFSLs in Maharashtra i.e. RFSL Nagpur, RFSL Nashik and RFSL Pune. In these three laboratories, the total filled scientific posts exceeds the total sanctioned scientific posts due to the inclusion of contractual scientific staff.

**118** High case pendency rates were seen at SFSL Lucknow and RFSL Berhampur as shown in Graphic 22 in Chapter III: Case Management at pg 145.

As discussed previously,[119] Section 293 CrPC allows the admission of reports by specific government scientific experts [120] as evidence in criminal proceedings, without requiring their deposition as witnesses before the court. These experts occupy senior positions in the laboratories and are often known as reporting officers. FSLs predominantly prefer that such reporting officers sign the forensic reports submitted to courts to avail the exemption of testifying as witnesses, unless specifically summoned by the court.[121] As per the information available on filled posts, SFSL Banderdewa and SFSL Port Blair do not have reporting officers that are covered under Section 293 CrPC, while SFSL Imphal, SFSL Verna, RFSL Jagdalpur and RFSL Ranipool have filled only one scientific post in that category.

**119** See section on legal framework in Forensic Science Landscape in India at pg 43.

**120** Section 293(4), Code of Criminal Procedure, 1973 reads: “This section applies to the following Government scientific experts, namely:— (a) any Chemical Examiner or Assistant Chemical Examiner to Government; (b) the Chief Controller of Explosives; (c) the Director of the Finger Print Bureau; (d) the Director, Haffkeine Institute, Bombay; (e) the Director, Deputy Director or Assistant Director of a Central Forensic Science Laboratory or a State Forensic Science Laboratory; (f) the Serologist to the Government; (g) any other Government scientific expert specified, by notification, by the Central Government for this purpose.”

**121** See section on procedural law on examination of experts in Chapter VII: Law on Expert Evidence at pg 253.

**Graphic 10. Scientific posts across FSLs**

### Director

- Director
- Additional Director
- Joint Director
- Deputy Director
- Assistant Director

### Scientific Officer

- Senior Scientific Officer
- Scientific Officer
- Junior Scientific Officer

### Scientific Assistant

- Assistant Chemical Analyser
- Senior Scientific Assistant
- Scientific Assistant
- Junior Scientific Assistant

### Digital Analyst

- Forensic Digital Analyst
- Assistant Forensic Digital Analyst

### Laboratory Assistant

- Senior Laboratory Assistant
- Laboratory Assistant
- Junior Laboratory Assistant

### Laboratory Attendant

- Senior Laboratory Attendant
- Laboratory Attendant
- Junior Laboratory Attendant

### Miscellaneous

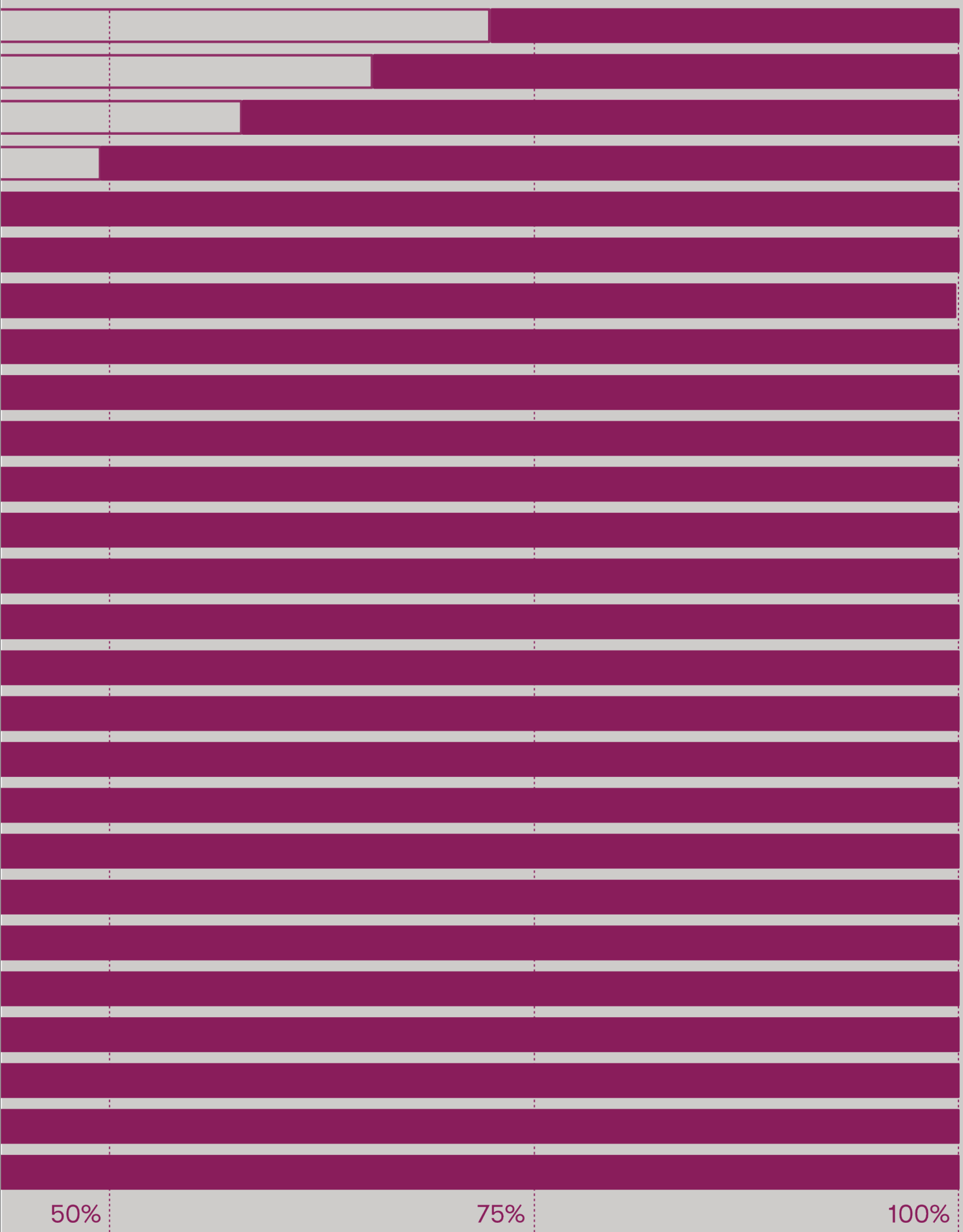
- Viscera Cutter
- Photography

## Graphic 10. Comparison of total rate of filled and vacant posts

Vacant posts | Filled posts

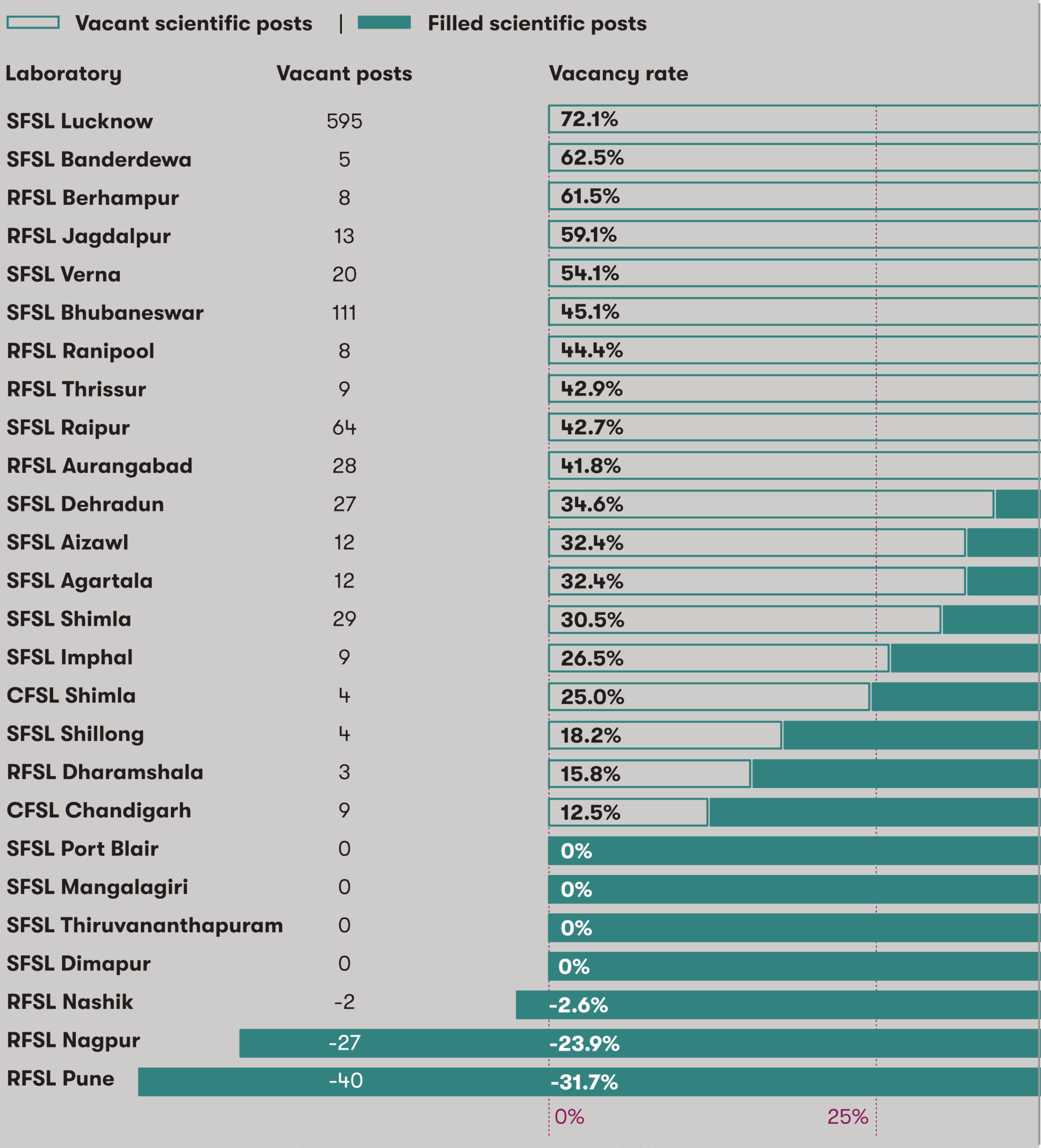
| Laboratory | Vacant posts | Vacancy rate |
|---|---|---|
| SFSL Lucknow | 821 | 72.5% |
| RFSL Jagdalpur | 21 | 65.6% |
| RFSL Berhampur | 11 | 57.9% |
| SFSL Raipur | 111 | 49.6% |
| SFSL Banderdewa | 6 | 42.9% |
| RFSL Ranipool | 9 | 40.9% |
| SFSL Verna | 24 | 40.7% |
| SFSL Bhubaneswar | 120 | 40.4% |
| SFSL Dehradun | 40 | 39.2% |
| RFSL Aurangabad | 36 | 36.7% |
| RFSL Thrissur | 10 | 35.7% |
| SFSL Aizawl | 20 | 35.1% |
| SFSL Shimla | 41 | 29.5% |
| SFSL Agartala | 13 | 27.7% |
| SFSL Imphal | 10 | 23.3% |
| CFSL Shimla | 4 | 15.4% |
| CFSL Chandigarh | 15 | 14.7% |
| RFSL Dharamshala | 3 | 11.5% |
| SFSL Shillong | 4 | 10.8% |
| SFSL Mangalagiri | 7 | 7.4% |
| RFSL Nashik | 6 | 5.3% |
| SFSL Thiruvananthapuram | 8 | 4.7% |
| SFSL Port Blair | 0 | 0% |
| SFSL Dimapur | 0 | 0% |
| RFSL Nagpur | -14 | -9.2% |
| RFSL Pune | -32 | -19.4% |

0% 25%

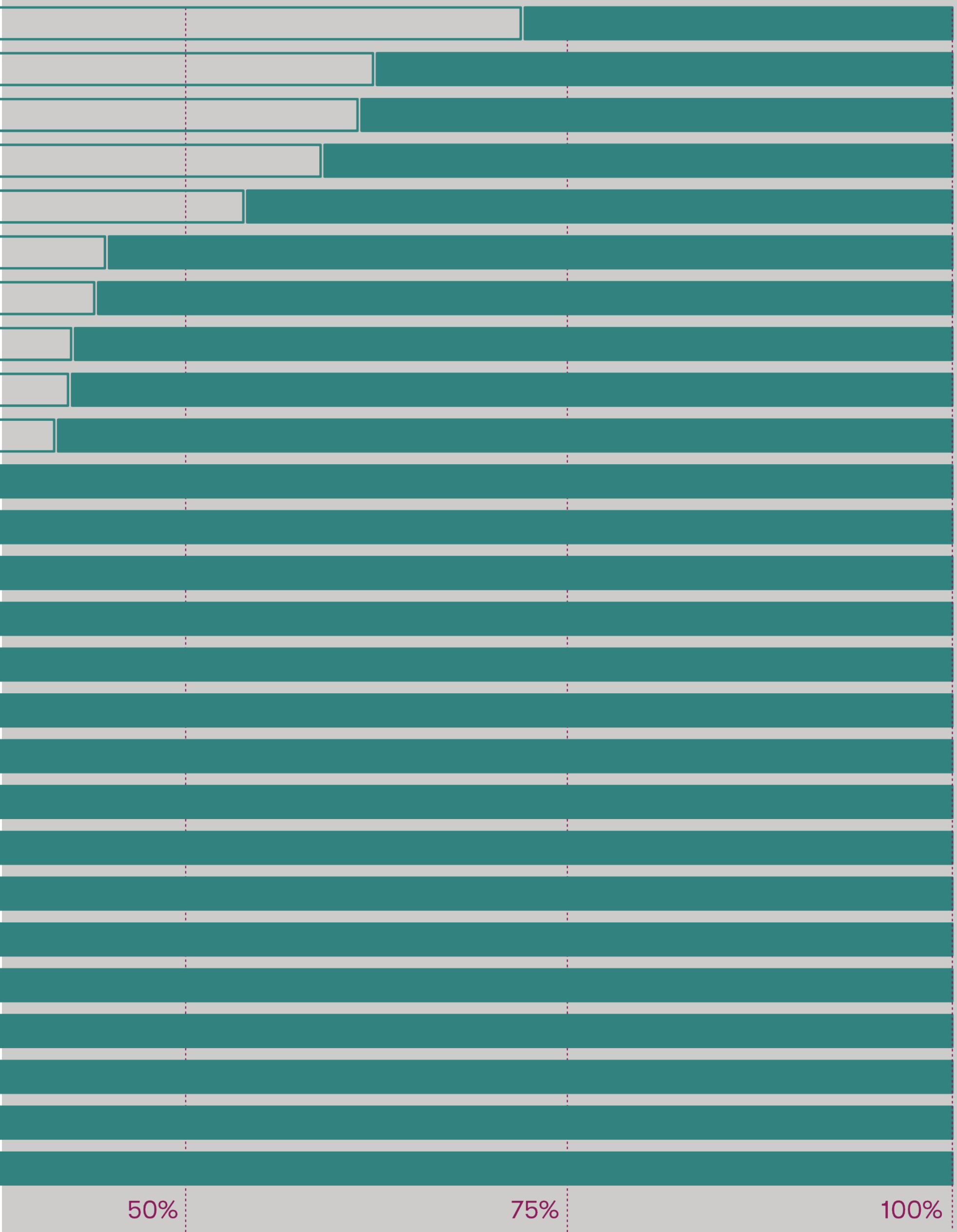



| Filled posts | Sanctioned posts |
|---|---|
| 300 | 1,132 |
| 11 | 32 |
| 8 | 19 |
| 110 | 224 |
| 8 | 14 |
| 13 | 22 |
| 35 | 59 |
| 140 | 297 |
| 39 | 102 |
| 62 | 98 |
| 18 | 28 |
| 37 | 57 |
| 105 | 139 |
| 34 | 47 |
| 27 | 43 |
| 22 | 26 |
| 87 | 102 |
| 23 | 26 |
| 33 | 37 |
| 86 | 94 |
| 107 | 113 |
| 152 | 171 |
| 8 | 4 |
| 19 | 7 |
| 167 | 153 |
| 197 | 165 |

## Graphic 11: Comparison of total rate of filled & vacant scientific posts[122]




122 Vacancies have been calculated against each sanctioned and filled post. Blank responses regarding filled posts have been considered as information was not available. Therefore, vacancies could not be calculated for such posts.




| Filled posts | Sanctioned posts |
|---|---|
| 228 | 825 |
| 3 | 8 |
| 5 | 13 |
| 9 | 22 |
| 17 | 37 |
| 98 | 246 |
| 10 | 18 |
| 12 | 21 |
| 83 | 150 |
| 39 | 67 |
| 30 | 78 |
| 25 | 37 |
| 25 | 37 |
| 66 | 95 |
| 19 | 34 |
| 12 | 16 |
| 18 | 22 |
| 16 | 19 |
| 63 | 72 |
| 2 | 3 |
| 74 | 75 |
| 140 | 141 |
| 4 | 4 |
| 80 | 78 |
| 140 | 113 |
| 166 | 126 |

# HISTORY OF WORK NORMS

*In 2002, the BPR&D as the erstwhile central governing body for forensic science issued work norms,[123] which were adopted by DFSS. They prescribe the maximum number of cases and exhibits a complete work unit should process in a year consisting of 200 working days. The norms provide standards for 13 forensic divisions[124] and prescribe that a work unit comprises one Senior Scientific Officer/Scientific Officer/Junior Scientific Officer, two Senior Scientific Assistant/Scientific Assistant, one Laboratory Assistant and one Laboratory Attendant.[125] They do not describe the qualifications, roles or responsibilities for these posts, nor the methodology of arriving at this composition or the limits for casework.*

*Nevertheless, the idea behind prescribing such norms is to streamline casework and ensure that it is effectively distributed between the scientific officers and laboratory support staff. The norms recognise that forensic divisions are based on different scientific concepts, and that methods and techniques of testing vary, which, in turn, determines their pace of casework. Importantly, they also recognise that the caseload and the methods of examination may change over time, by providing for a review of the strength of the work unit every three years. However, such a review has never been conducted.*

**123** BPR&D Work Norms 2002.

**124** Divisions covered in the BPR&D work norms are Biology, Serology, DNA, Toxicology, Chemistry, Liquor, Narcotics, Explosives, Ballistics, Physics, Questioned Documents, Photography and Psychology.

**125** Toxicology divisions require an additional laboratory attendant per unit to serve as the viscera cutter. For the Document division, the work unit comprises one Class I officer and two Class II officers.

*The limitations of the BPR&D work norms were highlighted in the SPAC Report, which formulated and recommended fresh norms.*[126] *As per the report, in the multiple-scientist model, due to the absence of specific roles for each member of the work unit the accountability for casework remained only with the reporting officer, which affected the quality and timeliness of work. The report suggested a single-scientist-based work unit with technical support staff assigned to the division and not a specific unit. This policy would for the assessment of individual contributions and work output, which is necessary for promotion under the Flexible Complementing Scheme (FCS). Further, time spent by individual scientists on non-examination-based work such as scene-of-crime visits, court depositions, R&D, supervision of casework and other administrative tasks, would also be considered along with casework. The report also provided a revised workload for a single-scientist unit based on normalised cases. However, there is no data to suggest the implementation of the SPAC work norms.*

*As per the staffing patterns observed in this survey, most of the FSLs do not follow the BPR&D work norms. This is likely due to the inherent deficiencies in designing them, their inconsistent enforcement and the lack of any revisions in these norms to address the growing caseload and the adoption of newer techniques or disciplines. However, the reasoning underlying the work norms is worth revisiting to ensure that staffing levels are maintained to match the laboratory's caseload and to ensure quality and reliability.*

**126** SPAC Report, Chapter IV: Standards on Work Norms for Evidence Material Analysis, pg 60.

CHALLENGES

## CHALLENGES

### Challenges in sanctioning posts

The process of sanctioning a post requires financial evaluation by the parent department and the vetting of the relevant RRs. For the sanctioning of posts, CFSLs require approval from the MHA, the Ministry of Finance, the Department of Personnel and Training (DoPT) in the MoPP&P, and the Ministry of Law and Justice. SFSLs typically require approval from their respective home and finance ministries or departments. Additionally, each state may prescribe other ministries or departments from which additional approval may be required. A cumbersome process requiring coordination with various agencies leads to delays in the sanctioning of posts. The creation and approval of RRs for the posts is also known to delay the process.

Many FSLs shared their experiences regarding the delays in sanctioning posts, with one of them recounting that no new posts had been sanctioned since the establishment of the laboratory 30 years ago. Another narrative was that proposals for the creation of posts and additional staff are often decided without understanding their impact on casework.

### Challenges in filling posts

Once the authorities at the central or state level sanction new posts, depending on the type of post, the recruitment is carried out either directly by the laboratory or through the Union Public Service Commission (UPSC), State Public Service Commission (SPSC) or Staff Selection Commission (SSC). Some FSLs complained that the concerned SPSC/SSC may not regularly conduct recruitment drives for forensic science positions, leading to long delays between the sanctioning and filling of posts. One of the SFSLs shared that the posts sanctioned seven years earlier were yet to be filled. Such delays create gaps in the hierarchy of scientific personnel and hamper the continuity of the laboratory as an institution, since senior scientific staff retires before new recruits can be inducted. Consequently, the training and supervision of new recruits is also impacted.

Additionally, as with the tedious tender and procurement procedures, beyond a broad understanding of the different stages, many FSL directors were unaware of the exact procedures and considerations that went into sanctioning and filling posts after they had submitted their approvals to their immediate department heads. This lack of a comprehensive understanding of the entire recruitment process hampers their ability to effectively follow up on approvals for sanctioning or filling of posts and contributes to the overall delay.

### High variance in recruitment process

A study of the RRs received from FSLs[127] during the survey and those created by DFSS[128] reflects a lack of uniformity in the educational qualifications and professional experience for similar posts. While laboratories may have specific criteria such as language requirements to suit their needs, the necessary qualifications for scientific posts must be guided by certain minimum standards.[129] For instance, RFSL Ranipool requires three years of prior work experience for an SO position while SFSL Raipur requires eight years. While DFSS does not have RRs available for the SO position, the minimum prior work experience required for an SSO as per DFSS is seven years.

**127** SFSL Aizawl, SFSL Bhubaneswar, SFSL Raipur, SFSL Verna and RFSL Ranipool shared their RRs.

**128** DFSS Recruitment Rules. http://dfs.nic.in/rrs.html.

**129** MB Rao, *Appraisal of Forensic Reports in the Judicial Proceedings*, Sardar Vallabhbhai Patel National Police Academy, Hyderabad (2009), pg 641-642 [MB Rao]. This book analyses important decisions by the Supreme Court and various High Courts relating to forensic science. While sharing his views on measures to improve forensic investigation, Rao noted that the service rules, qualifications and the experience required for recruitment in CFSLs and the SFSLs vary widely. The pay structure, methods of analysis and infrastructure also vary widely, which discourages qualified scientists from joining FSLs. He suggested that scientists selected through the UPSC must be trained for at least a year before they begin case examinations.

Further, the DFSS Rules consider professionals with a postgraduate degree in forensic science as eligible for scientific posts. However, many FSLs consider only degrees in pure science subjects as part of the educational criteria for scientific posts.

The process of filling the posts also varies across FSLs, with some laboratories conducting written exams and others conducting only interviews. These differences, along with the variation in the education and training provided to forensic science practitioners, hinder the consistency of forensic scientific practice across India.

### Lack of adherence to work norms

Several laboratories shared that due to multiple issues with recruitment process and the resultant vacancies, they do not have complete work units or end up examining cases beyond the levels envisioned by the BPR&D work norms.[130]

Some FSLs asserted that given the high levels of case intake, it was important to adhere to work norms to ensure the quality of forensic examinations and to reduce the burden on existing employees. One laboratory also suggested that adherence to such norms should be made a part of the accreditation process.

### Employee dissatisfaction & consequent attrition

Forensic scientists routinely face high levels of workload, historical pendency of cases, and pressure from investigative authorities and courts. Further, as articulated in Chapter V on Quality Management, forensic casework requires a rigorous commitment to quality standards due to the high stakes involved in the outcome of their daily work. It is

130 MB Rao, pg 641. Rao makes a similar observation that work norms do not exist in various laboratories and even if they do, they are not followed. He also highlights this is because the recruitment of forensic scientists in various states is highly unsatisfactory, marred by nepotism and other unethical practices.

also important to note that they deal with casework that is often related to violent offences such as homicide and sexual assault, which can lead to vicarious trauma and stress.

There is immense dissatisfaction among the scientific staff due to the lack of parity between their job pressures and the employment benefits received by them. They often draw comparisons with teaching positions in government universities and those in administrative services, where the pay and benefits are better and the pressures of the job are much lower.[131]

***Scientists have left the laboratory because better opportunities have come up. Their salaries aren't similar to CFSLs and should be increased. People leave and join as lecturers in government universities or colleges or the government administrative services, as the pay is better.***

- Deputy Director at an SFSL

**131** Similar observations were made in the NHRC Report at pg 22-23, which stated that the pay scale in FSLs is far below that in other governmental scientific organisations. It also stated that the lack of motivation and fear of obstructions in promotions has led to demoralisation among the scientific staff. The FSLs are neither able to attract new recruits nor retain scientists.

## ISSUES REGARDING CONTRACTUAL SCIENTIFIC STAFF

*The data on recruitment shows a drop in the proportion of filled scientific posts from 63% to 52.5% if the contractual scientific staff is excluded.*

*While FSLs have had to resort to hiring scientific personnel on a contractual basis because of delays in sanctioning and filling posts, the laboratories have expressed discomfort with this method given the temporary nature of the engagement. FSLs, for example, are unable to hold such staff members accountable for their work as their contract could expire before their cases are even heard by the court. This could give rise to further difficulties if a court were to issue summons to a laboratory on cases examined by previous contractual staff. Some laboratories have also raised concerns about the quality of work of such employees due to this lack of accountability. Despite these concerns, 14 out of 26 laboratories hired scientific staff on a contractual basis.[132] This is because the procedures for the direct recruitment of scientific staff are protracted and unable to address the gaps in human resources that need to be filled to deal with the increase in case intake and high pendency.*

*Despite the laboratories' heavy reliance on them, contractual workers shared narratives of disparate treatment meted out to them as against permanent staff. They expressed grievances about lower pay in comparison to permanent staff, the absence of research opportunities, the lack of travel allowance for court visits and their ineligibility for other kinds of employee benefits.*

**132** SFSL Aizawl, SFSL Agartala, SFSL Bhubaneswar, SFSL Dehradun, SFSL Port Blair, SFSL Shillong, SFSL Shimla, SFSL Raipur, RFSL Dharamshala, RFSL Jagdalpur, RFSL Nagpur, RFSL Nashik, RFSL Pune and RFSL Ranipool hired scientific staff on a contractual basis.

## Concerns with forensic science education & profession

Unlike the regulation of educational institutions in other fields such as law or medicine,[133] there is no standard-setting body for forensic science courses offered in India. Considering the significance of not only theoretical but practical learning for forensic science students, the regulation of forensic educational institutions is necessary to ascertain their infrastructural capabilities for simulating different aspects of crime scene and laboratory work.[134] This problem of unregulated forensic science education and lack of standardisation in curricula was specifically highlighted by one of the FSLs.

During the survey, most laboratories expressed a preference for candidates with undergraduate degrees in pure sciences as opposed to a bachelor's in forensic science, as they were believed to be better suited for scientific work, despite their lack of a forensics background. This raises concerns regarding the employability of forensic science graduates and the availability of potential candidates for FSLs. While there is a preference among laboratories for pure science graduates over forensic science ones, pure science graduates have a wider set of employment opportunities available to them and may not even consider FSLs as their primary choice.

These issues are further heightened due to the lack of a regulatory body for setting professional standards of forensic science in India and for registering and licensing forensic science professionals. The concerns with the quality of forensic science professionals must also be examined

**133** The Bar Council of India and National Medical Commission regulate the standards for education in law and medicine respectively, as well as provide the necessary professional license for practice.

**134** Similar observations were made in the NHRC Report, which recommended at pg 25 that "the syllabus of M.Sc. (Forensic Science) in different universities should be thoroughly updated to be commensurate with the requirements of forensic science institutions". Similar issues continued to persist and were recognised by the Perspective Plan at pg 66 which recommended the regulation of forensic science education.

in light of the inadequate legal framework on expert evidence wherein the qualifications and expertise of the forensic scientist are not subject to rigorous scrutiny.[135]

## Inadequate training in the laboratories

There is a lack of well-planned and documented training programmes for new scientific recruits within laboratories. In most FSLs, new recruits did not undergo a dedicated training period and were directly entrusted with casework. The initial period of supervision by senior staff on their cases was considered 'on-the-job training'. A wide variance was also noticed in the duration of the training period across FSLs, ranging from a few weeks to six months. The manner of evaluation, if any, before recruits were allowed to independently work on casework also varies.

With the introduction of newer forensic technologies and as ongoing scientific research reveals the limitations of existing forensic techniques and disciplines, it is imperative to provide opportunities for continuous learning for scientific staff in laboratories. An important reason cited for the lack of impetus for the training of scientific staff was the high levels of vacancies. The scientific staff available to conduct casework is limited, and is therefore unable to allocate time undergo training without compromising on casework. Another reason cited was the lack of forensic training institutes, with some FSLs suggesting upgrades in the continuous training programmes run by the LNJP NICFS campus of NFSU. Laboratories also suggested expanding participation in these programmes to cater to different levels of seniority in scientific staff. They also sought government sponsorship of opportunities to participate in workshops, seminars and training programmes in India and abroad.

**135** See section on understanding law of expert evidence in India in Chapter VII: Law on Expert Evidence at pg 242.

## RECOMMENDATIONS

### DFSS consultations towards streamlining recruitment process

Historically, the NHRC Report and Perspective Plan have suggested a move towards complete centralisation of the recruitment process through the creation of an All India Forensic Science Service[136] or the creation of the Directorate of Forensic Service (DIFOSER)[137] respectively, which inter alia would be responsible for recruitment for all central laboratories and those state laboratories that are willing to join that system. Recruitment through DIFOSER was envisaged to be outside the purview of the UPSC/SPSC/SSC and similar to hiring by the DRDO under the central government. While neither of these suggestions has been implemented, the common logic underlying both is a move towards centralisation in order to improve efficiency in the hiring process and achieve standardisation across different FSLs, divisions and states.

While complete centralisation may not be possible, as a starting measure, it is suggested that DFSS through its proposed Human Resources wing[138] must organise consultations involving FSL directors, concerned officials in the state police, home and finance departments, and SPSCs/SSCs to understand the bottlenecks in and devise an incremental plan towards streamlining the recruitment process across divisions, FSLs and states. This may provide a better understanding of the different challenges

**136** The NHRC Report at pg 24 suggested the creation of an All India Forensic Science Service which would cover forensic scientists in all central and state forensic science institutions. The recruitment would be conducted through a written exam and interview, and the selected officers would undergo a year-long training before joining their respective laboratories.

**137** Similar recommendations were made in the Perspective Plan at pg 42 which states that the proposed DIFOSER should regulate recruitment outside the purview of the UPSC or SSC, and should institute and monitor the Central Forensic (Scientific) Service, Central Forensic (Support) Service and Central Forensic (Administrative and Allied) Service.

**138** See section on recommendations for DFSS in Chapter VIII: Overall Recommendations at pg 264.

RECOMMENDATIONS

faced by each state in the processes for sanctioning and filling posts. Such consultations may also help in identifying the role that the DFSS or the proposed state DFSS can play in facilitating the recruitment process.[139] Without such consultations, it would be difficult to accurately diagnose the issues that impact the timeliness and quality of forensic recruitment.

### Preparation of a National Forensic Recruitment Strategy

Based on these consultations with different stakeholders across states, DFSS with NFSU and the proposed FCOI[140] should draft a strategy document to standardise the eligibility criteria i.e. educational qualifications and work experience required for different posts.[141] The plan should suggest a uniform method of recruitment, to ensure that individuals are properly assessed on all relevant aspects before being hired by FSLs.[142]

To ensure effective decision-making in post sanctioning and filling processes, the strategy document would suggest necessary changes to the existing recruitment process that should be considered by central and state governments.

**139** See section on recommendation for state DFSS in Chapter VIII: Overall Recommendation at pg 266.

**140** See recommendation on the creation of FCOI in Chapter VIII: Overall Recommendations at pg 272.

**141** See Table 5 on recommendations related to Recruitment, Education & Training in Chapter VIII: Overall Recommendations at pg 276.

**142** Recognising the wide variance in the forensic education standards and the reliance on contractual hiring to manage the high caseload, MHA launched an all-India Forensic Aptitude and Caliber Test (FACT) as a standardised test to assess the knowledge and skills of forensic science postgraduates. Based on the test results, a consolidated list of qualified professionals is prepared to aid recruitment by CFSLs and SFSLs. https://www.nfsu.ac.in/fact

### Standardisation of posts across laboratories

In order to create uniform eligibility criteria for recruitment, facilitate the centralised certification and licensing of scientific staff and enable regular needs assessment surveys, it is essential to standardise the scientific and non-scientific posts across all FSLs and their divisions. In this survey, a significant challenge during data analysis was the difference in the nomenclature, hierarchy, salary, and qualifications for posts across laboratories. For the implementation of any nationwide policy, staff organisation within a laboratory must be standardised.

### Revisiting the 2002 work norms

Considering the wide dissonance with the 2002 BPR&D work norms, it is important to reinvestigate the aim and feasibility of such standards within the Indian forensic system. Based on this assessment, DFSS in conjunction with the proposed Forensic Science Regulator (FSR)[143] should prepare new work norms through a consultative process involving the FSR's Scientific Working Groups (SWGs), forensic science experts, directors of CFSLs and SFSLs, as well as concerned officials from the respective police, home and finance departments. The updated work norms should consider developments in science and technology within different divisions, the caseload trends and the levels of personnel across laboratories.

### Regular assessment of personnel needs by FSLs

FSLs should undertake a regular assessment of the different positions of scientific and non-scientific staff required by them based on crime rates and cases received by them.[144] This would enable the laboratories

**143** See recommendation on the creation of FSR in Chapter VIII: Overall Recommendations at pg 270.

**144** A similar model was proposed in California where the California Crime Laboratory Review Task Force, established in 2007, was mandated to make recommendations for improving forensic science. In its report *An Examination of Forensic Science in California* to not only be adequately staffed but also to ensure that its recruitment strategy traces the trends of forensic casework in that state or region. DFSS must also collect such information as part of its periodic needs assessment surveys and coordinate with the proposed state-level directorates to check if these needs are met.

### Improvement in working conditions

As detailed above, poor working conditions in FSLs cause dissatisfaction amongst employees, leading to attrition and compromise in quality standards. Laboratories should identify the different types of occupational hazards that scientific and non-scientific staff are exposed to, and provide medical insurance for their employees.[145]

> ***We should get more benefits, we are working with rotten things without any medical benefits, why would one work?***
>
> - Scientist working in the Biology division at an RFSL

Given that forensic scientists deal with casework pertaining to violent crimes which may cause trauma, fatigue, stress and burnout, they should have access to psychological support and counselling.[146] This would

(2009) at pg 8, the Task Force recommended that a "laboratory staffing formula" should be created which ascertains the acceptable number of cases per analyst in each forensic discipline, the analyst-to-manager ratio within laboratories, and the required laboratory support staff. It also recommended exploring the feasibility of state-wide guidelines that establish the ideal number of analysts to serve a particular size population with a specified crime rate. https://oag.ca.gov/sites/all/files/agweb/pdfs/publications/crime_labs_report.pdf.

**145** The NHRC Report at pg 30 made a similar recommendation of providing risk allowance to forensic scientists as they are continuously exposed to health hazards and vulnerable to infections leading to fatal diseases.

**146** A similar recommendation was made in the National Institute of Justice (NIJ), assist in improving workplace productivity, and improve employee satisfaction and retention.

Employment benefits, such as pay, research opportunities and travel allowances for court visits, provided to FSL employees must be regularly evaluated to be in proportion with the intensity of workload and to maintain parity with similar positions in other government services.

### Implementing Flexible Complementing Scheme across states

Promotions are often a point of contention for the scientific staff working in the SFSLs and RFSLs. Delays in promotions and stagnation often affect the motivation of forensic scientists and can lead to attrition. The Flexible Complementing Scheme (FCS) created by the DoPT allows for the promotion of personnel, independent of the availability of a vacant position at a higher level. While this scheme has been applicable in CFSLs since 2011,[147] it should be implemented across states as well. Similar recommendations for implementation of the FCS were made in the NHRC Report[148] and Perspective Plan[149] The proposed Human Resources wing of DFSS may liaise with the appropriate state departments to achieve this aim.

United States Department of Justice, *Report to Congress: Needs Assessment of Forensic Laboratories and Medical Examiners/Coroner Offices Report*, 2019 at pg 36, that civilian employees, particularly dispatch, forensic, and crime scene investigation staff, should be afforded the same mental health and wellness services as their colleagues in law enforcement [NIJ Report]. https://www.justice.gov/olp/page/file/1228306/download.

**147** *MHA, Office Memorandum No. 25020/60/2010-PM-II*, dated 10.08.2011, http://dfs.nic.in/pdfs/rrs/fcs1.pdf; details of the FCS to be implemented for CFSLs can be viewed in the Gazette Notification for December, 2013 at http://dfs.nic.in/pdfs/rrs/fcs.pdf.

**148** Similar observations were made in the NHRC Report at pg 28 which recommended that forensic scientists should be recruited only at two levels within FSLs and their promotion should be governed by the FCS.

**149** The Perspective Plan at pg 42 also recommended that as per the proposed DIFOSER should create a personnel policy which implements FCS.

## Improvement in forensic science education

With the proliferation of forensic science courses and institutes in India, there is an urgent need for regulating such courses. As a first step, a detailed survey of the forensic science degree and diploma courses offered by government and private institutions in India should be carried out by the proposed Forensic Council of India (FCOI)[150] along with NFSU and DFSS. The main objective of the survey would be to gather information about the curriculum for the different programmes offered, the faculty and infrastructure available and their quality, and the employment prospects for graduates. The survey should include qualitative interviews with the management, faculty and students of these forensic science institutions.

Like the Bar Council of India or the National Medical Commission, a regulatory body, such as the proposed FCOI, must be set up to oversee forensic science education in India and set standards for professional practice through the registration and licensing of all forensic science practitioners. Such registration should be based on qualifying examinations conducted by FCOI and NFSU and must be made mandatory while hiring a forensic scientist in a government FSL either through permanent recruitment or through contract. A similar structure is already functional for fingerprint examiners in India through the All India Board Examination for Fingerprint Experts conducted by the CFPB, which is necessary for an individual to practice as a fingerprint expert in a central or state institution.[151] Such a setup may also allay fears of the FSLs in engaging scientific staff on a contractual basis regarding their proficiency and accountability.[152] The registration should also

**150** See recommendation on the creation of FCOI in Chapter VIII: Overall Recommendations at pg 272.

**151** Central Fingerprint Bureau Manual for All India Board Examination for Fingerprint Experts (2001). https://ncrb.gov.in/sites/default/files/Eligibility%20Criteria%20as%20per%20CFPB%20Manual.pdf.

**152** Deepika Bhandari et al., *Forensic Science Education in India: Challenges and Opportunities*, 14(2) Journal of Forensic Sciences and Criminal Investigation (2020) be necessary for certifying crime scene examiners, with the requisite qualifications and skills.[153]

For setting standards for forensic science education, the models adopted by the Forensic Science Education Programs Accreditation Commission (FEPAC)[154] in the United States and the Chartered Society of Forensic Science[155] in the United Kingdom for accreditation of undergraduate and postgraduate forensic science courses may be considered by NFSU and the proposed FCOI. These standards include requirements for practical knowledge regarding different disciplines and the infrastructural capabilities required within the institution.

### Improvement of training for new recruits & continuous education of existing employees

Minimum standards for training new recruits and the continuous forensic education of scientific staff should be created by the proposed FSR and FCOI respectively, in conjunction with NFSU. These standards should cover training in theoretical and practical components, and competency in both should be tested before assigning any casework. For reference, the training manuals approved by the Organization of Scientific Area Committees for Forensic Science (OSAC) under the aegis of the National Institute of Standards & Technology (NIST) in the United States could be taken as a reference point. After conducting a

comments that due to older and existing RRs, graduates and postgraduates in forensic science are unable to secure a regular job and end up in poorly remunerated contract position. Hence, it is recommended to set up a Forensic Council of India which will be analogous to the Medical Council of India and Bar Council of India.

**153** See inset on forensic examination of crime scenes and recommendation for creation of protocols for evidence collection & crime scene management in Chapter III: Case Management at pg 153 and 156.

**154** American Academy of Forensic Sciences, FEPAC Accreditation Standards (2021). https://www.aafs.org/sites/default/files/media/documents/2021%200924%20FEPAC%20Standards_0.pdf.

**155** The Chartered Society of Forensic Science, Educational Quality Standards. https://www.csofs.org/quality-standards/educational-standards/.

technical review, OSAC has approved training standards across forensic disciplines, including DNA profiling, serology, and trace evidence.[156] Based on these minimum standards, CFSLs and SFSLs should formulate their training programmes for new recruits in every division.

The proposed FCOI in collaboration with NFSU should curate training programmes for forensic scientists to remain abreast with the latest developments in their fields, including scientific studies and the use of new instruments and software. Other jurisdictions such as the United States have resources for the continuous education of forensic scientists made available through sources such as Forensic Technology Center of Excellence (FTCoE) supported by the National Institute of Justice (NIJ). The FTCoE assists in implementation of new forensic technology and best practices through its online training programmes for forensic experts and legal professionals.[157] Besides training in scientific practice, forensic scientists and recruits must also be trained in legal developments relating to forensic science, report drafting and delivering court testimony.

**156** OSAC approved standards for training programs in DNA profiling, serology and trace evidence can be found at https://www.nist.gov/osac/osac-registry.

**157** FTCoE provides resources for forensic scientists, forensic researchers and legal professionals to enable knowledge transfer and advancement of new technologies. https://forensiccoe.org/#.

# 3 CASE MANAGEMENT

## INTRODUCTION

Casework data from 29 laboratories has been analysed in this chapter.[158] As part of the survey, year-wise information from 2013 to 2017 was sought on cases and exhibits received, examined and pending by each functional division in each laboratory. Across these FSLs, 17 different divisions were found to be functional,[159] with one division in at least one FSL operating during one assessment year. Annexure II lists the divisions that are functional in each FSL. No data was received from any laboratory for the remaining five divisions which were mentioned in the quantitative survey.[160]

**158** As SFSL Mangalagiri became functional in 2020, no casework data was available for the assessment period. Further, RFSL Thrissur did not provide data on examined cases while SFSL Verna did not provide data on pending cases.

**159** For this analysis, we have considered those divisions as functional for which laboratories have provided casework data. Those divisions which had been sanctioned, established or staffed but were not processing casework have been excluded.

**160** No casework data received for Anthropology, Brain-mapping, Odontology, Trace Evidence and Wildlife Forensics divisions.

**Graphic 13. Different divisions in FSLs & the types of evidence they examine**

Number of FSLs surveyed having this division

**Biology**
**23**
Examination of biological specimens found at a crime scene, from the accused or the victim

**Chemistry**
**22**
Analysis of chemical composition of crime scene evidence, including trace evidence like paint, accelerants and fuel from suspected arson cases

**Toxicology**
**19**
Examination of viscera to identify and quantify toxic substances

**Ballistics**
**17**
Examination of firearms and ammunition, gunshot residues, etc.

**Serology**
**17**
Identification of body fluids such as blood, semen, saliva, etc, grouping analysis and species origin examination

**Document**
**16**
Examination of fake currency, forged documents, suicide letters

**DNA Profiling**
**15**
Examination of DNA profiles extracted from biological evidence

**Narcotics**
**14**
Examination of different types of drugs and psychotropic substances

## Graphic 13. Different divisions in FSLs & the types of evidence they examine

● Number of FSLs surveyed having this division

**Physics**
**13**
Soil examination, pattern evidence like footwear and tyre analysis

**Cyber Forensics**
**11**
Examination of mobiles, computers, online search history, location tracking, etc.

**Excise**
**10**
Examination of ceased or prohibited alcohol, blood alcohol analysis

**Explosives**
**8**
Examination of explosion sites, improvised explosive devices, fuel sources, etc.

**Voice Identification**
**7**
Examination of audio and video material for identification

**Photography**
**5**
Involved in crime scene recording, enlarging fingerprint evidence, etc.

**Fingerprint**
**5**
Examination and comparison of fingerprints

**Polygraph**
**4**
Analysis of physiological responses of the subject for lie detection examination

**Narco-Analysis**
**1**
Psychological examination of a person in a semi-conscious state induced by intravenous drug

Some FSLs added case numbers relating to multiple divisions to provide a single dataset, with no indication of the proportion for each division. To allow for a comparison of data across laboratories and in the absence of any information on case trends, the data for cases received, examined and pending was equally divided among the individual divisions in the combined dataset.[161] Further, for the sake of standardisation, medico-legal cases reported separately by SFSL Lucknow were considered under Biology. Similarly, case numbers for blood alcohol detection and prohibition reported separately by RFSLs in Maharashtra have been considered under Excise.[162]

**161** The following laboratories provided a combined dataset for multiple divisions, listed below:

- CBI-CFSL: Biology & DNA; Chemistry, Narcotics & Toxicology; Physics & Voice Identification; Ballistics & Explosives
- SFSL Shimla: Ballistics, Physics & Explosives; Chemistry, Toxicology & Excise; Biology & Serology
- RFSL Dharamshala: Biology & Serology were combined for cases received only
- SFSL Mumbai: Chemistry, Explosives & Narcotics
- SFSL Puducherry: Biology & Serology
- SFSL Raipur: Explosives & Ballistics
- SFSL Shillong: Biology & Serology
- RFSL Pune: Biology & Serology
- SFSL Imphal: The case data for Chemistry was considered under Narcotics as the laboratory mentioned this clarification in their survey response “Most of the cases examined in the Chemistry division are Narcotics cases. FSL Manipur does not have a separate Narcotics division.”

**162** In Maharashtra, the Prohibition and Excise division are combined and they examine cases related to illicit liquor as well as blood alcohol levels of a person suspected to have committed a crime. https://dfsl.maharashtra.gov.in/en/prohibition-and-excise.

# TRENDS

## Division-wise Analysis

*Cases received*

Excise (38.6%), Toxicology (15.4%) and Biology (14.7%) divisions reported the highest number of cases received. These divisions cumulatively account for 68.7% of the total cases received and ranked the highest based on the median number of cases received, as shown in Graphic 14.[163]

*Examination rate*

The examination rate compares the number of cases examined to the number of cases received by the division in a particular year. Examination rates greater than 100% are indicative of the divisions examining more cases than they received in that particular year due to historical pendency. Toxicology (116.7%), Excise (106%) and Explosives (105%) had the highest examination rates, as shown in Graphic 15. Chemistry (102.1%) and Narcotics (100.9%) also had examination rates higher than 100%.[164]

Excise, Explosives, Chemistry, Narcotics, Photography and Toxicology also recorded an examination rate higher than 90% across all years of the assessment period.[165] The highest yearly examination rate of 145.7% was recorded in Toxicology in 2014.

*Pendency rate*

The pendency rate compares the number of cases pending at the end of a year compared to the number of cases received in that particular year. Pendency rates greater than 100% are also indicative of historical

163 For year-wise data on cases received across divisions, see Table 10 in Annexure III at pg 311.

164 For year-wise data on cases examined across divisions, see Table 11 in Annexure III at pg 312.

165 For year-wise examination and pendency rates across all divisions, see Table 13 in Annexure III at pg 314.

pendency due to a higher number of cases pending than received in the particular division. The highest pendency rate was seen in Cyber Forensics (111.2%), Ballistics (100.2%) and DNA Profiling (79%), as shown in Graphic 15.[166] Other divisions which recorded a pendency rate higher than 50% were Toxicology (75.8%), Serology (58.3%), Biology (55.1%), and Document (52%).

Cyber Forensics is the only division to record a pendency rate higher than 90% across all assessment years, with the highest pendency rate recorded at 159.2% in 2014.[167]

*Examination v. pendency rate*

A comparison of examination and pendency rates is important in understanding the pace at which casework is being processed by the laboratory and whether it is sufficient in tackling its pendency. Towards this, the difference between the examination and pendency rates has been examined for all the divisions, as shown in Graphic 15. A negative difference signifies that the pendency rate is higher than the rate of examination of cases. A low difference between the examination and pendency rates signifies the subsistence of historical pendency, since at any point, similar levels of examined and pending cases remain within the division at the laboratory.

The Excise division had the most difference between its examination and pendency rates (97.8%). Despite ranking the highest in total and median number of cases received, the Excise division maintains one of the lowest pendency rates (8%). On the other hand, Ballistics, Cyber Forensics and DNA Profiling recorded a higher pendency rate than the examination rate, with the pendency rate being over 44% more than the examination rate in Cyber Forensics. This may be the result of the increasing caseload in these divisions, indicating an urgent need for expansion.

**166** For year-wise data on cases pending across divisions, see Table 12 in Annexure III at pg 313.

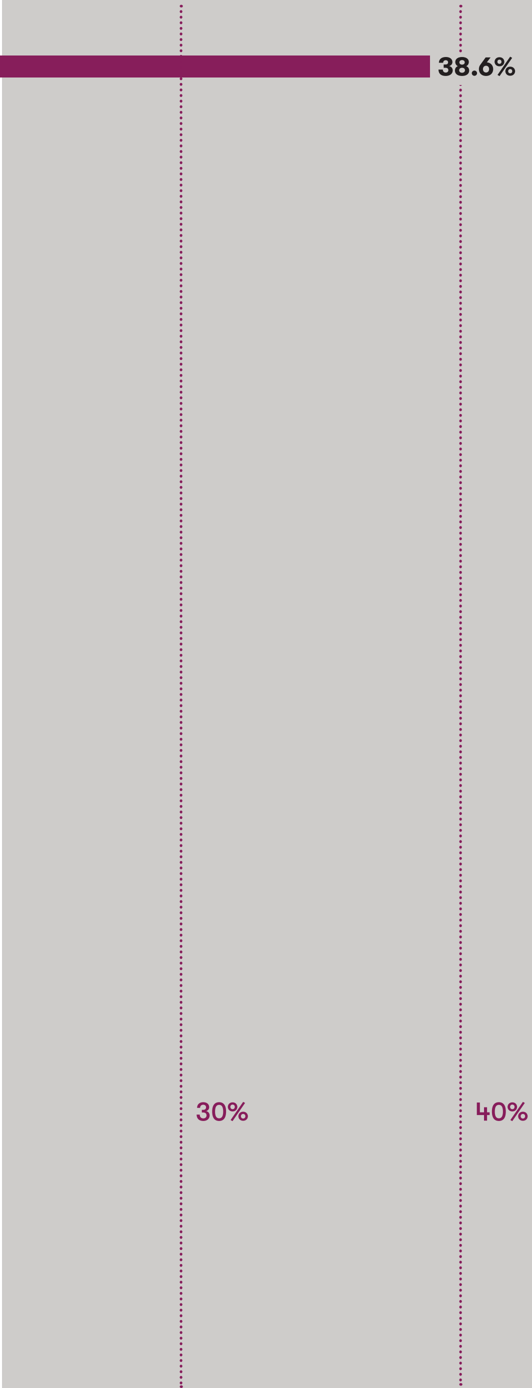
**167** For year-wise examination and pendency rates across all divisions, see Table 13 in Annexure III at pg 314.

**Graphic 14. Total number of cases & median number of cases received by different divisions across FSLs**

| Division | Median number of cases received | Percentage of grand total |
|---|---|---|
| Excise | 4155 | |
| Toxicology | 942 | 15.4% |
| Biology | 402 | 14.7% |
| Chemistry | 396 | 8.4% |
| Serology | 348 | 9% |
| DNA Profiling | 215 | 3.4% |
| Document | 149 | 1.4% |
| Explosives | 148 | 1.3% |
| Physics | 134 | 1.3% |
| Ballistics | 133 | 2.5% |
| Voice Identification | 129 | 0.3% |
| Narcotics | 99 | 1.9% |
| Cyber Forensics | 90 | 0.7% |
| Polygraph | 72 | 0.2% |
| Fingerprint | 68 | 0.3% |
| Narco-analysis | 14 | 0% |
| Photography | 5 | 0.5% |

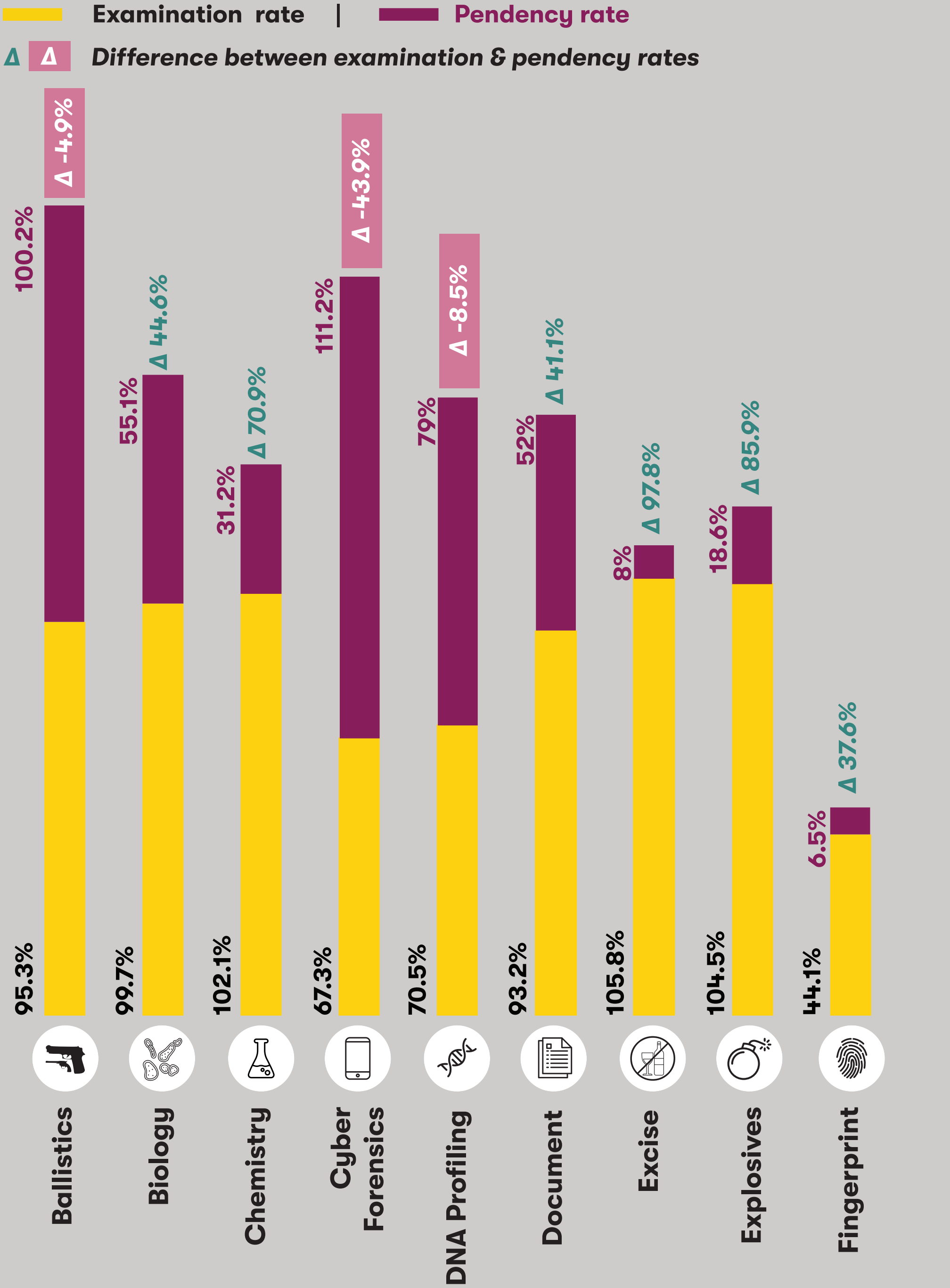
0% 10% 20%

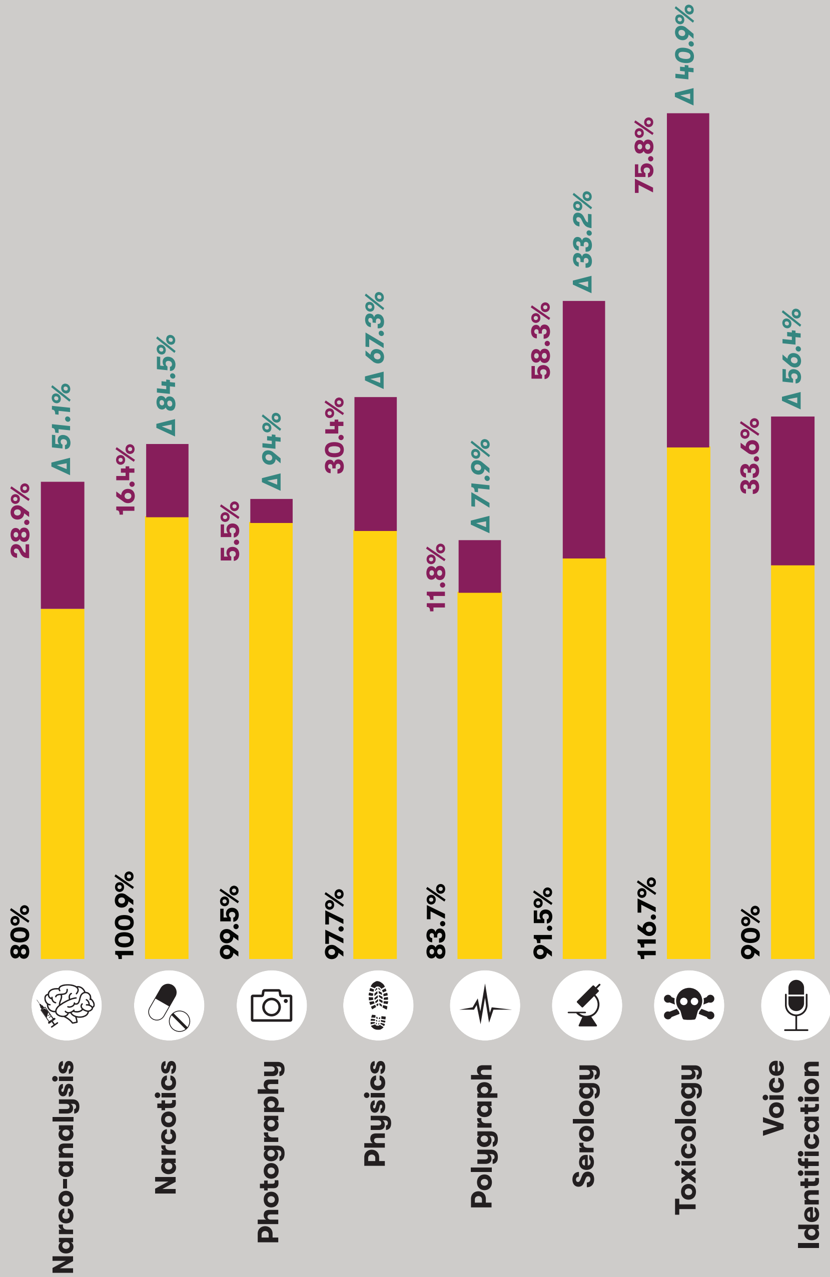
168 As some laboratories provided case numbers for multiple divisions in one dataset, the data for cases received was equally divided among the individual divisions. For ease of reference, the total numbers have been rounded off.




| Total number of cases received[168] | Division |
|---|---|
| 365011 | Excise |
| 144940 | Toxicology |
| 138659 | Biology |
| 79261 | Chemistry |
| 85250 | Serology |
| 32042 | DNA Profiling |
| 13317 | Document |
| 12392 | Explosives |
| 11962 | Physics |
| 23704 | Ballistics |
| 3219 | Voice Identification |
| 17902 | Narcotics |
| 6391 | Cyber Forensics |
| 1983 | Polygraph |
| 3181 | Fingerprint |
| 45 | Narco-analysis |
| 5145 | Photography |
| **Grand Total 944402** | |

**Graphic 15. Examination & pendency rates in different divisions across FSLs**





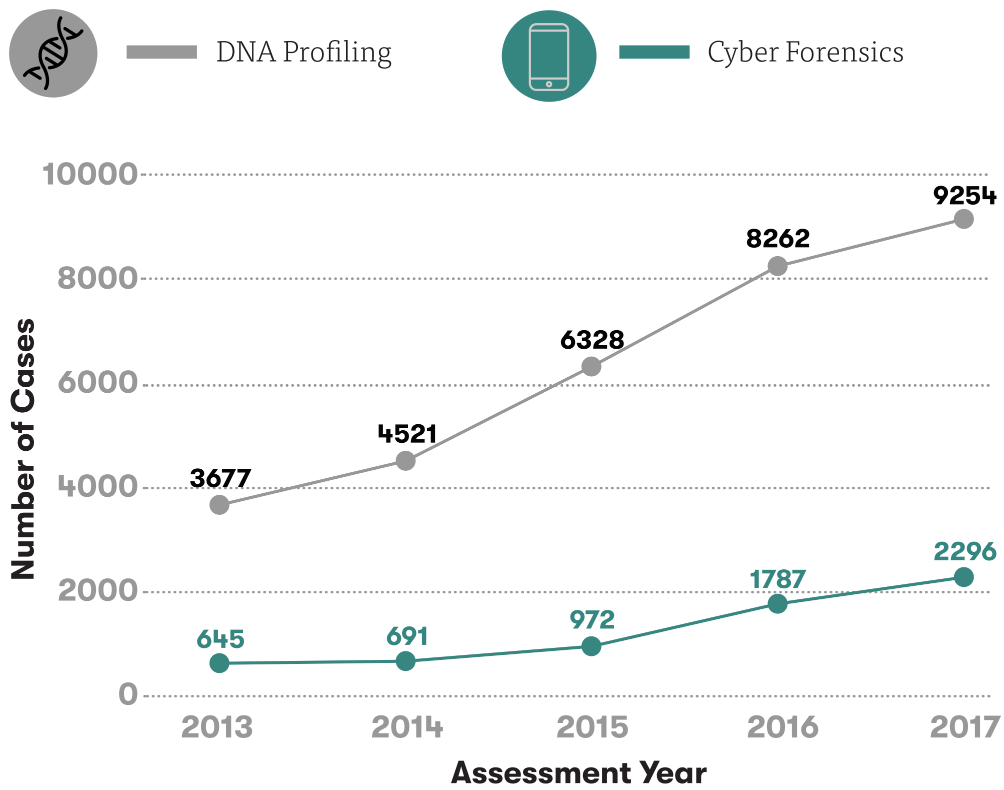
28.9%
Δ 51.1%
80%
Narco-analysis
16.4%
Δ 84.5%
100.9%
Narcotics
5.5%
Δ 94%
99.5%
Photography
30.4%
Δ 67.3%
97.7%
Physics
11.8%
Δ 71.9%
83.7%
Polygraph
58.3%
Δ 33.2%
91.5%
Serology
75.8%
Δ 40.9%
116.7%
Toxicology
33.6%
Δ 56.4%
90%
Voice Identification

## Trends in the DNA Profiling & Cyber Forensics divisions

### Cases received

DNA Profiling and Cyber Forensics are the only divisions which have shown a consistent increase in the number of cases received across the assessment period, as shown in Graphic 16. The rise in cases of DNA Profiling and Cyber Forensics is indicative of their increasing relevance in the investigation of crimes.

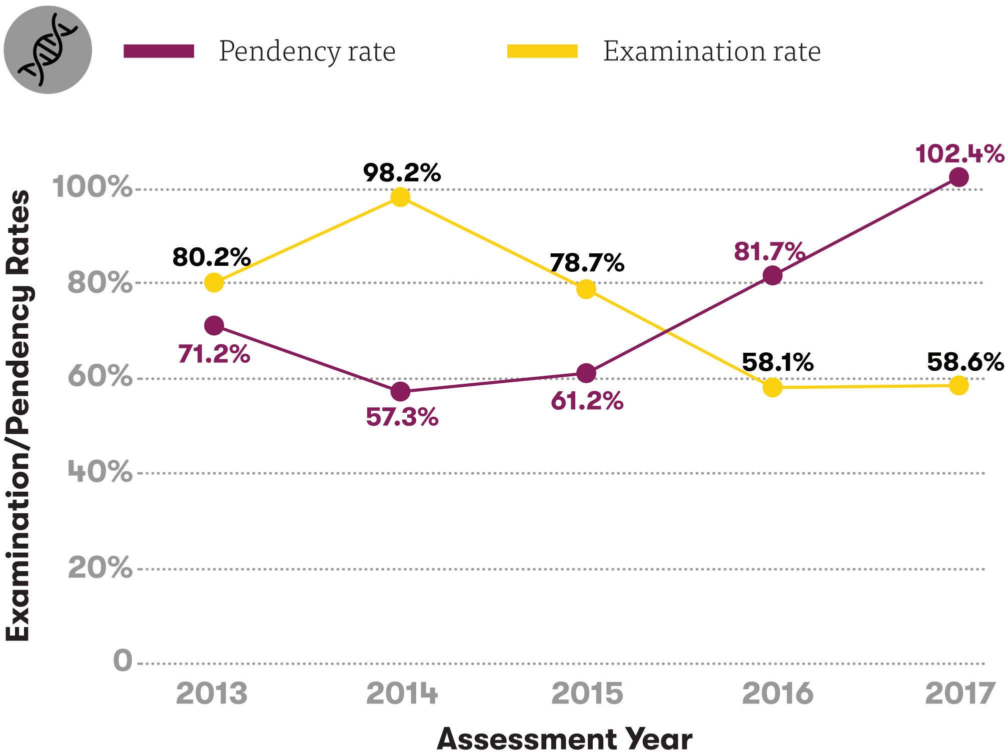
**Graphic 16. Continuous increase in cases received by the Cyber Forensics & DNA Profiling divisions**



*DNA Profiling examination & pendency rates*

A comparison of the examination and pendency rates in the DNA Profiling divisions across FSLs shows that the examination rate drastically declined in 2016 and 2017, which was accompanied by a rise in pendency rates (Graphic 17). With the continuous increase in the number of cases received, such high pendency rates is a cause for concern.

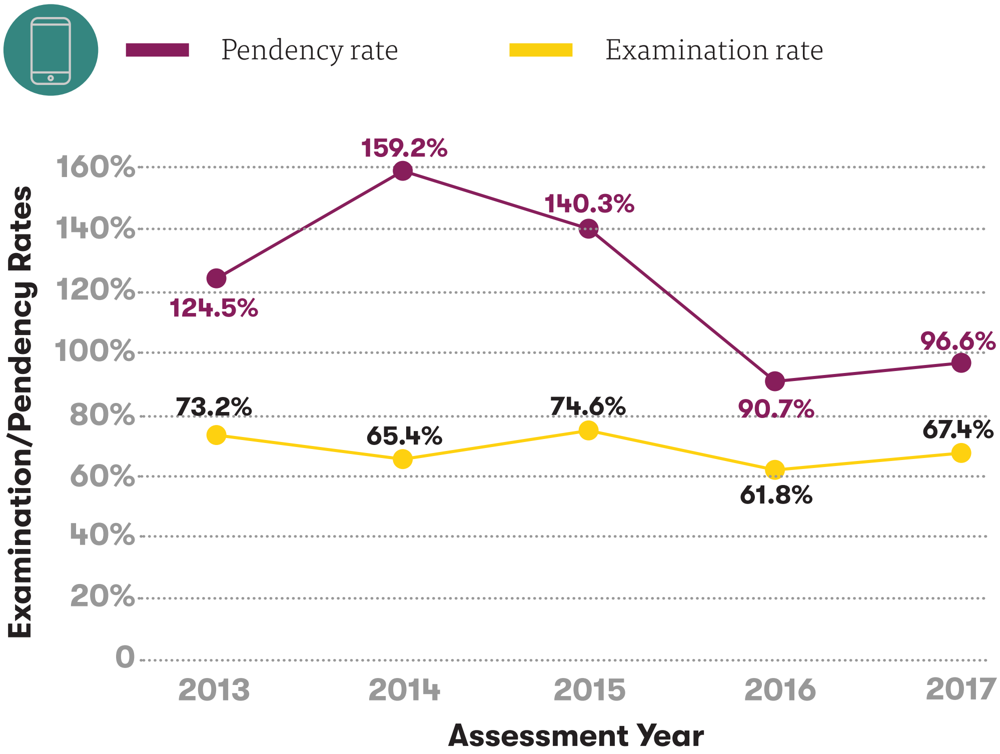
**Graphic 17. Year-wise examination & pendency rates of the DNA Profiling division**




*Cyber Forensics examination & pendency rates*

A comparison of the examination and pendency rates in the Cyber Forensics divisions across FSLs shows that the examination rate in Cyber Forensics has always been lower than the pendency rate (Graphic 18). This is a matter of concern as Cyber Forensics is a relatively new division and it signals the need for reassessing the resource allocation needs of this division.

**Graphic 18. Year-wise examination & pendency rates of the Cyber Forensics division**




### Exhibit-to-case ratio across divisions

Two laboratories[169] did not share any data on exhibits across the different cases statuses of received, examined or pending, while ten laboratories[170]

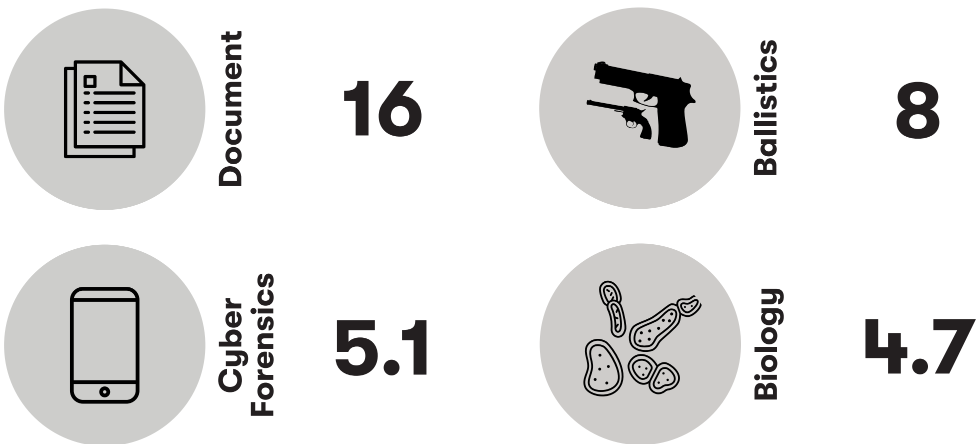
169 SFSL Lucknow and RFSL Agra did not provide any data relating to exhibits.

170 SFSL Verna provided exhibit information for received cases; CBI-CFSL & SFSL Dehradun provided it for examined cases; CFSL Chandigarh, SFSL Raipur, RFSL Aurangabad and RFSL Jagdalpur (which provided pending data only for some divisions) provided it for received and examined cases; RFSL Thrissur and SFSL Puducherry provided it for received and pending cases. RFSL Nagpur provided exhibit information,

provided such information only for some case statuses. Due to this inconsistency in the data received from the FSLs, a closer examination of the trends relating to exhibits was not possible. However, a limited analysis of the exhibit-to-case ratio has been conducted, as shown in Graphic 19.[171]

Since any forensic examination is dependent on the exhibits received in every case, a high number of exhibits per case can severely impact the turnaround time per case and increase the case pendency within the division. Therefore, it is important to assess the exhibit-to-case ratio along with the number of cases received, examined and pending in order to gather a more realistic perspective of workload per division. The resource allocation to each division may also be impacted by the number of exhibits they receive per case. As per the exhibit-to-case ratio, Document (16.0), Ballistics (8.0) and Cyber Forensics (5.1) had the highest median number of exhibits received per case.

**Graphic 19. Median exhibit-to-case ratio for different divisions across FSLs**




except for its Serology division from 2015-2017.

**171** No exhibit numbers were available for the Narco-analysis division.

| | | | |
|---|---|---|---|
| Serology | 4.1 | Chemistry | 3.6 |
| Physics | 3.2 | DNA Profiling | 3.2 |
| Voice Identification | 2.8 | Toxicology | 2.5 |
| Explosives | 2.5 | Narcotics | 2.2 |
| Photography | 1.9 | Excise | 1.7 |
| Fingerprint | 1.2 | Polygraph | 0.8 |

## Laboratory-wise Analysis

*Cases received*

Out of the 29 laboratories, RFSL Nagpur (21.6%), RFSL Pune (14.2%) and RFSL Aurangabad (12.3%) received the highest number of cases during the assessment period. Based on the median number of cases received across years, RFSL Pune, RFSL Aurangabad, and RFSL Nashik ranked the highest, as shown in Graphic 20. SFSL Banderdewa, SFSL Dehradun, SFSL Shimla, RFSL Dharamshala and RFSL Nashik saw a continuous increase in the number of cases received across the years of the assessment period, as shown in Graphic 21.[172]

*Examination rate*

SFSL Bhubaneswar (122.2%), RFSL Nashik (118.3%), and SFSL Raipur (114.1%) had the highest examination rate, as shown in Graphic 22.[173] SFSL Bhubaneswar and RFSL Dharamshala recorded a yearly examination rate above 100%, signifying that they examined more cases than they received throughout the assessment period.[174]

*Pendency rate*

SFSL Imphal (400.7%), RFSL Berhampur (167.7%) and SFSL Thiruvananthapuram (119.4%) have the highest pendency rate, as shown in Graphic 22.[175] SFSL Imphal and SFSL Thiruvananthapuram recorded a pendency rate higher than 90% across all years of the assessment period.

**172** For year-wise data on cases received across laboratories, see Table 14 in Annexure III at pg 315.

**173** RFSL Thrissur did not provide data on examined cases.

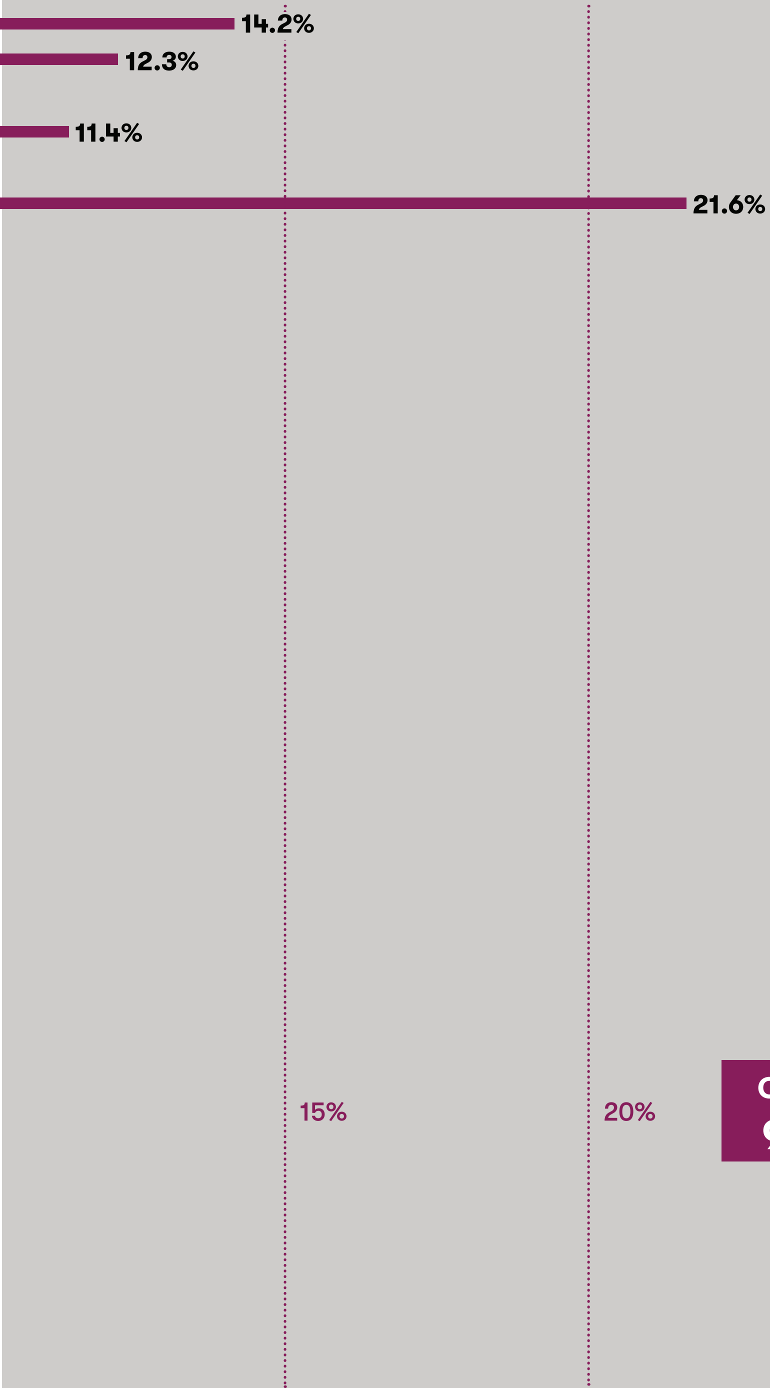
**174** For year-wise examination and pendency rates across all laboratories, see Table 17 in Annexure III at pg 318.

**175** SFSL Verna did not provide information regarding pending cases.

**Graphic 20. Total number & median number of cases received by different FSLs**

| Laboratory | Median number of cases received | Percentage of grand total |
|---|---|---|
| RFSL Pune | 3407 | |
| RFSL Aurangabad | 2607 | |
| RFSL Nashik | 2131 | 8.2% |
| SFSL Mumbai | 1296 | |
| RFSL Agra | 900 | 5% |
| RFSL Nagpur | 775 | |
| SFSL Lucknow | 755 | 6.2% |
| RFSL Jagdalpur | 446 | 0.4% |
| SFSL Bhubaneswar | 361 | 3.8% |
| SFSL Verna | 275 | 0.2% |
| CFSL Chandigarh | 266 | 1.3% |
| SFSL Shimla | 247 | 2.9% |
| SFSL Thiruvananthapuram | 234 | 1.6% |
| SFSL Raipur | 224 | 4.1% |
| RFSL Dharamshala | 208 | 1.1% |
| RFSL Thrissur | 196 | 0.5% |
| RFSL Berhampur | 150 | 1% |
| CBI-CFSL | 143 | 1.5% |
| SFSL Dehradun | 124 | 0.8% |
| CFSL Shimla | 85 | 0.2% |
| SFSL Imphal | 85 | 0.3% |
| SFSL Shillong | 69 | 0.3% |
| RFSL Ranipool | 63 | 0.2% |
| SFSL Aizawl | 51 | 0.5% |
| SFSL Agartala | 49 | 0.5% |
| SFSL Puducherry | 27 | 0% |
| SFSL Port Blair | 21 | 0.1% |
| SFSL Banderdewa | 21 | 0.1% |
| SFSL Dimapur | 6 | 0% |

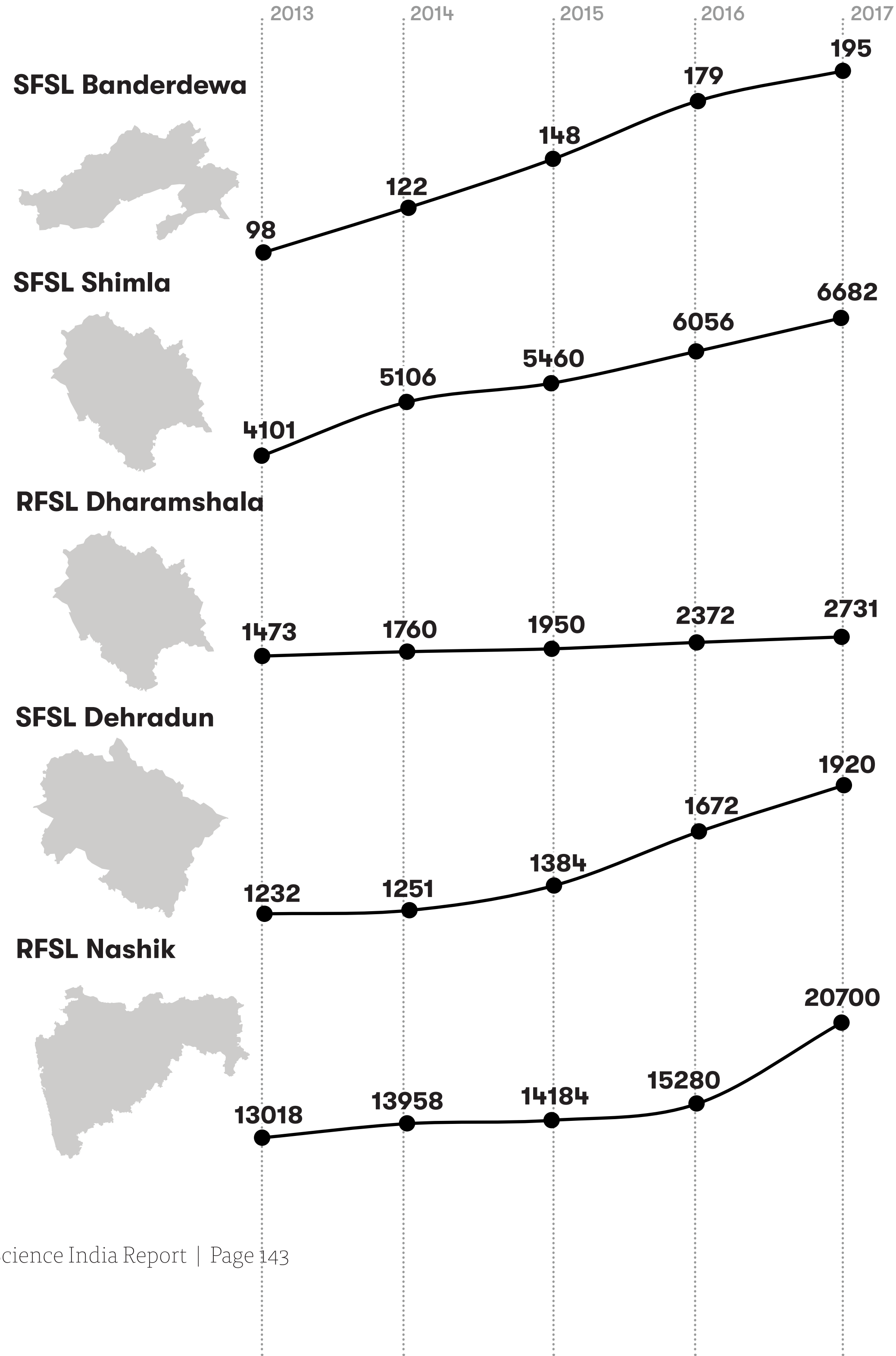
0% 5%




| Total number of cases received | Laboratory |
|---|---|
| 134033 | RFSL Pune |
| 116314 | RFSL Aurangabad |
| 77140 | RFSL Nashik |
| 108065 | SFSL Mumbai |
| 47190 | RFSL Agra |
| 203666 | RFSL Nagpur |
| 58327 | SFSL Lucknow |
| 3541 | RFSL Jagdalpur |
| 35917 | SFSL Bhubaneswar |
| 1573 | SFSL Verna |
| 12022 | CFSL Chandigarh |
| 27405 | SFSL Shimla |
| 14962 | SFSL Thiruvananthapuram |
| 38357 | SFSL Raipur |
| 10286 | RFSL Dharamshala |
| 4518 | RFSL Thrissur |
| 8990 | RFSL Berhampur |
| 14481 | CBI-CFSL |
| 7459 | SFSL Dehradun |
| 1546 | CFSL Shimla |
| 2616 | SFSL Imphal |
| 2857 | SFSL Shillong |
| 1592 | RFSL Ranipool |
| 4855 | SFSL Aizawl |
| 4608 | SFSL Agartala |
| 134 | SFSL Puducherry |
| 964 | SFSL Port Blair |
| 742 | SFSL Banderdewa |
| 242 | SFSL Dimapur |

**Grand Total**
**944402**

**Graphic 21. FSLs with continuous increase in the number of cases received**

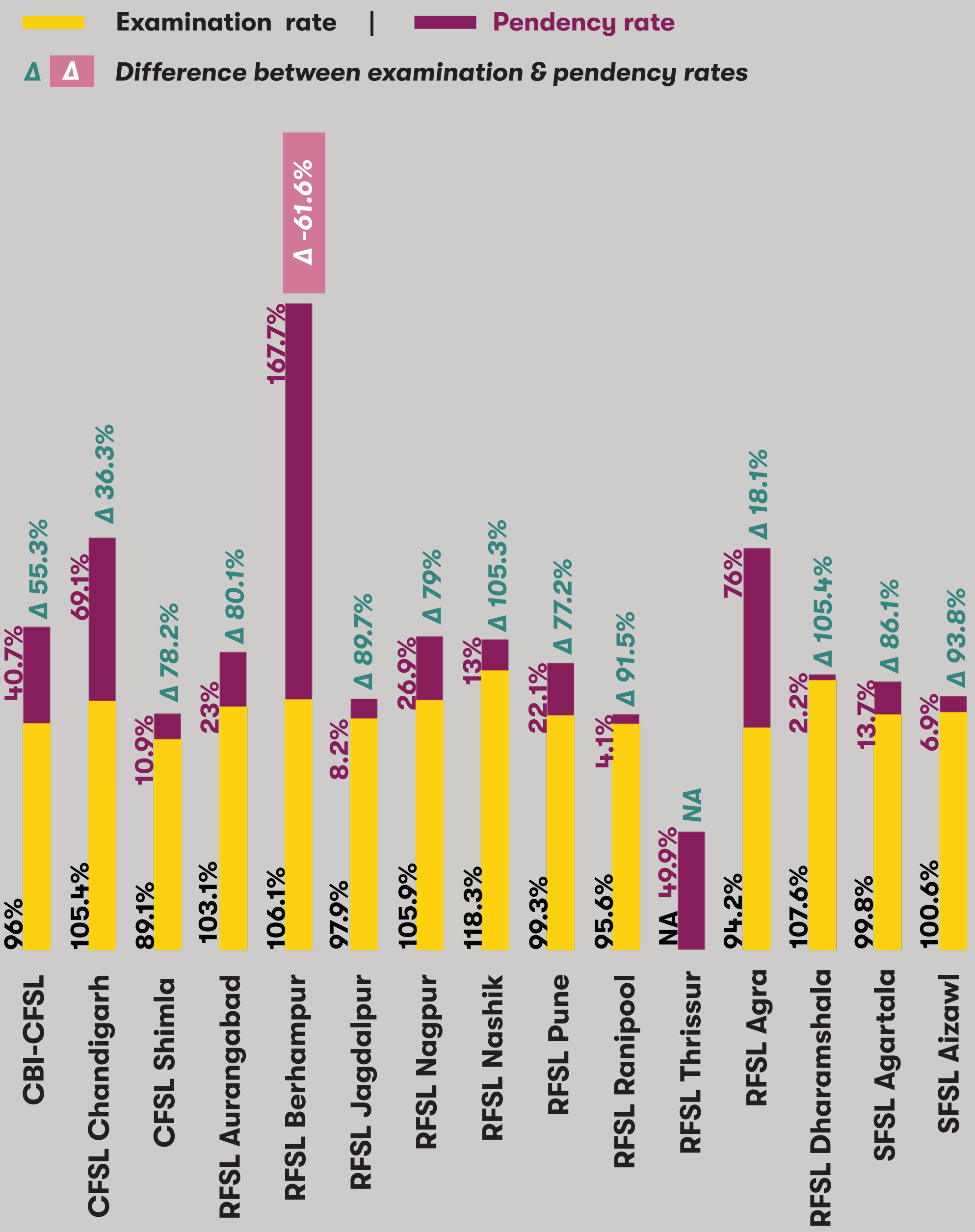


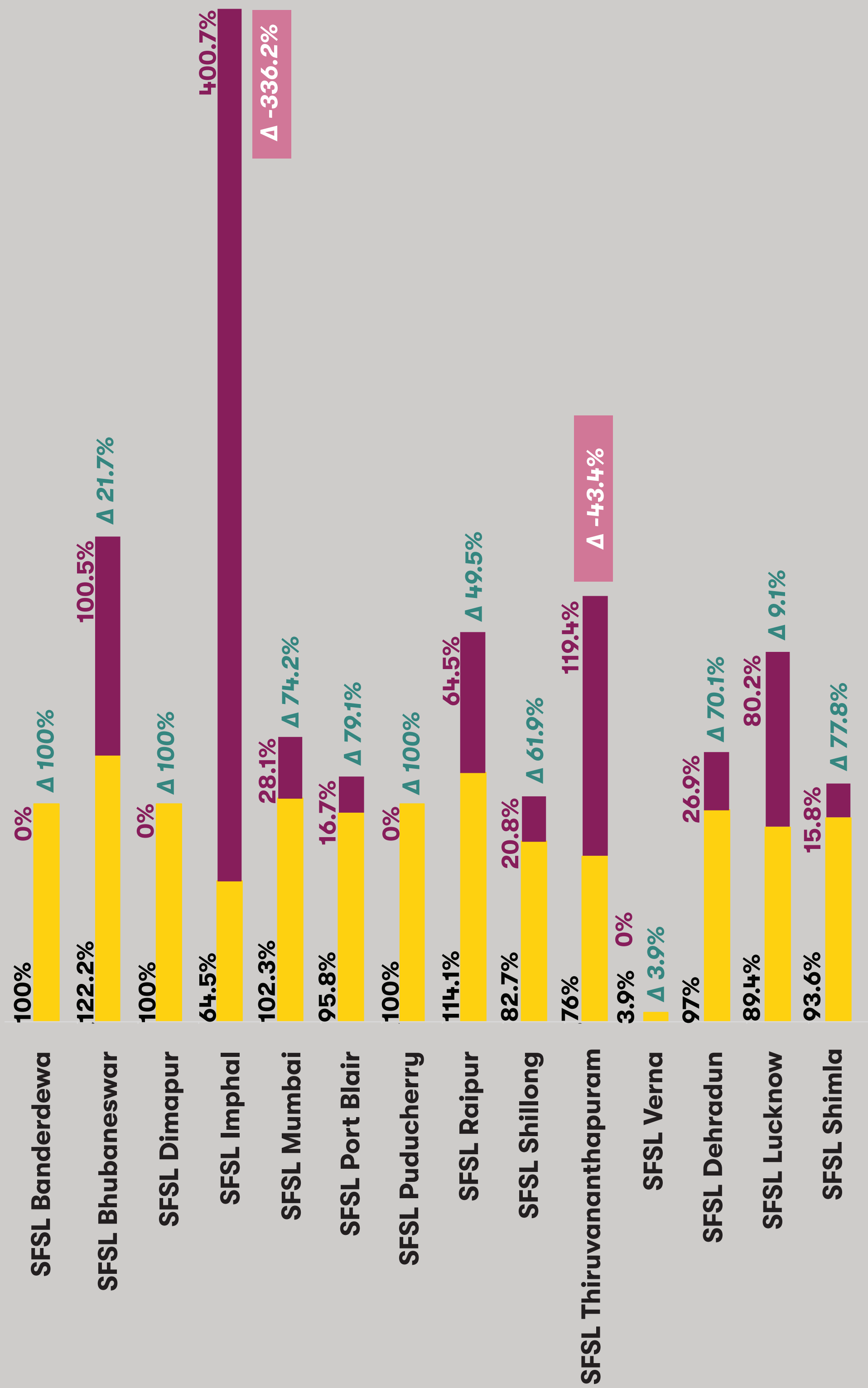
*Examination v. pendency rate*

As shown in Graphic 22, RFSL Dharamshala and RFSL Nashik recorded the lowest pendency rates when compared to their examination rates, recording a difference of 105.4% and 105.3%, respectively. This is especially significant for RFSL Nashik, which ranked third highest in terms of the median number of cases received. On the other hand, SFSL Imphal and RFSL Berhampur had the highest pendency rates when compared to their examination rates, recording a difference of 336.2% and 61.6% respectively. It is also important to note that CFSL Chandigarh, SFSL Bhubaneswar, SFSL Imphal, SFSL Lucknow, SFSL Raipur, SFSL Thiruvananthapuram, RFSL Agra and RFSL Berhampur recorded both examination and pendency rates above 60%. This signifies high levels of historical pendency within these laboratories.

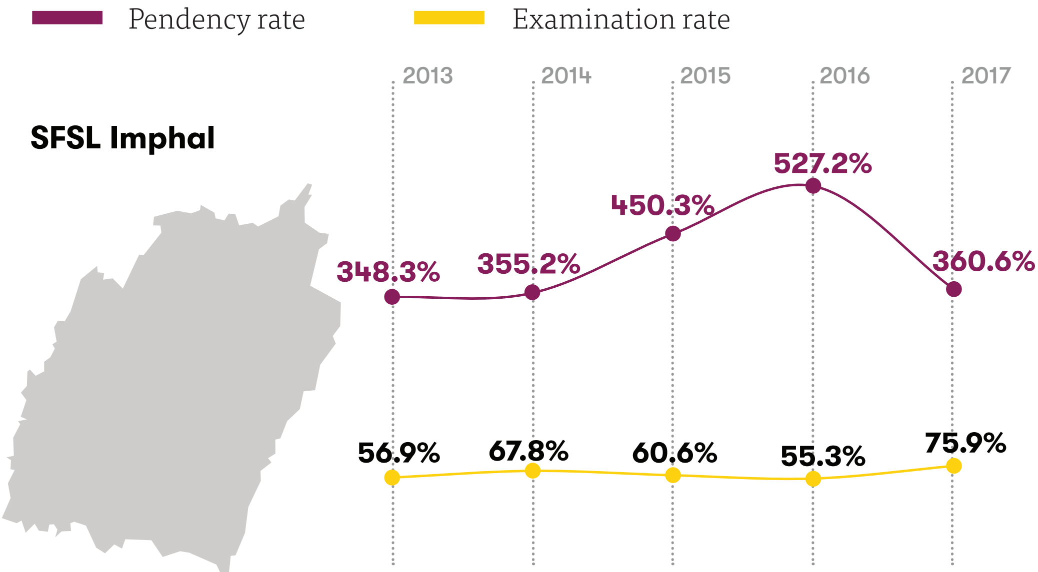
Graphics 23 and 24 show that SFSL Imphal and SFSL Thiruvananthapuram have a yearly pendency rate higher than the examination rate throughout the assessment period. SFSL Imphal's yearly pendency rate was consistently higher than 300%, which signifies a historical backlog of cases.

**Graphic 22. Examination & pendency rates in the FSLs**

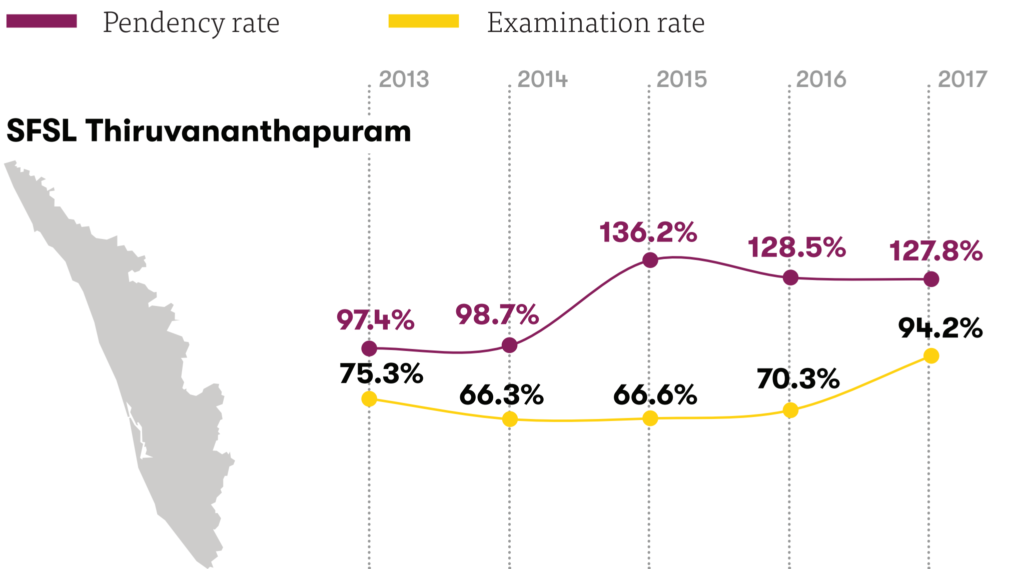



SFSL Banderdewa
100%
0%
Δ 100%
SFSL Bhubaneswar
122.2%
100.5%
Δ 21.7%
SFSL Dimapur
100%
0%
Δ 100%
SFSL Imphal
64.5%
400.7%
Δ -336.2%
SFSL Mumbai
102.3%
28.1%
Δ 74.2%
SFSL Port Blair
95.8%
16.7%
Δ 79.1%
SFSL Puducherry
100%
0%
Δ 100%
SFSL Raipur
114.1%
64.5%
Δ 49.5%
SFSL Shillong
82.7%
20.8%
Δ 61.9%
SFSL Thiruvananthapuram
76%
119.4%
Δ -43.4%
SFSL Verna
3.9%
0%
Δ 3.9%
SFSL Dehradun
97%
26.9%
Δ 70.1%
SFSL Lucknow
89.4%
80.2%
Δ 9.1%
SFSL Shimla
93.6%
15.8%
Δ 77.8%

**Graphic 23.** **Year-wise examination & pendency rates of SFSL Imphal**




**Graphic 24.** **Year-wise examination & pendency rates of SFSL Thiruvananthapuram**



## CHALLENGES

### Increase in pendency due to submission of high number of irrelevant exhibits

Many FSLs shared that a high number of exhibits bearing no forensic value are sent by the police as part of individual casework. For instance, the police repeatedly send all mobile phones, sim cards or other digital devices for data extraction, without any investigative strategy. Similarly, all kinds of biological and trace samples collected from the accused, victims or at the crime scene are sent without a preliminary assessment of their forensic relevance. This is particularly common with regard to the collection of multiple biological samples for preparing the reference DNA profile of the accused, such as blood, different kinds of hair samples and semen. With the advent of DNA profiling, the grouping and origin (human v. animal) analysis of biological samples has reduced in evidentiary value due to a lack of individualisation. Despite that, samples are often sent for such biological analysis before DNA analysis, risking loss and contamination of crucial evidence.

***There is a lot of intake and pendency in this (DNA) division. The director has taken out two to three drives to reduce the pendency. He was himself working till 1:30 am.***

- Assistant Director working in the DNA division at an SFSL

Such sweeping requests for examination display a lack of basic understanding of forensic science among investigative agencies and contribute to the pendency in laboratories. Receiving unnecessary exhibits for analysis is burdensome, especially for those laboratories that lack adequate infrastructure and storage facilities, as described in Chapter IV on Infrastructure. While many FSLs are making efforts to train investigative authorities on evidence collection and handling, such training programmes are not organised consistently.

## CONCERNS REGARDING PENDENCY DRIVES

*During interviews, four FSLs shared narratives of working overtime or conducting 'pendency drives' to reduce the number of pending cases. Although working overtime for long periods may result in reduced pendency rates, these extraordinary measures do not tackle the root of the problem. These measures lead to serious concerns about compromise in the quality of forensic examination, which ultimately affect the accuracy and reliability of individual casework. Further, they increase the burden on an already overstretched staff and are not sustainable from an employee wellness perspective.*

*Laboratories also shared that in sensational cases, the police or courts may seek expedited results, which disrupts the sequence of casework. Further, some recent legislative changes in cases relating to sexual assault, rape, or liquor have reduced the period of investigation, ranging from as little as seven days to two months.*[176] *Given that such cases can involve a range of forensic evidence, it would affect the quality and continuity of work across multiple divisions in every laboratory. Despite such legislative changes, comparable measures to adequately staff and equip FSLs to deal with these tight statutory timelines have not been undertaken. The allocation of manpower, equipment and other resources to divisions and FSLs should be guided by an analysis of the increase in crime rates and rates of receipt, examination and pendency of cases.*[177]

**176** As per the Criminal Law Amendment Act, 2018, the amended Section 173 CrPC requires investigation in cases pertaining to rape (Sections 376, 376A, 376AB, 376B, 376C, 376D, 376DA, 376DB or 376E IPC) to be completed within two months. This section has been further amended through state amendments, such as the Shakti (Criminal Laws) Maharashtra Amendment Act, 2020 which further reduces investigation in such cases to 15 days, extendable by seven days with reasons to be recorded in writing. Similarly, as per the Andhra Pradesh Disha Act - Criminal Law Act, 2019, the period of investigation is further shortened to seven days in such cases. Special legislations relating to alcohol also include provisions on completing investigation in a time-bound manner, such as the Bihar Prohibition and Excise Act, 2016 which requires the investigation to be completed within two months.

**177** See recommendation on regular assessment of personnel needs in Chapter II: Recruitment, Education & Training at pg 116.

## Lack of case-receiving sections

The case-receiving section is a department within the laboratory which receives case exhibits and necessary paperwork from police personnel. They must ensure that the quality of the forensic evidence is preserved while taking over its custody. During case receipts, they also check whether the exhibits are in a sealed condition and if the sample seals of the official or institution that sealed the sample have been provided for comparison. These sections also provide the forensic reports and the case samples to the police personnel after examination.

Presently, FSLs do not follow a uniform method for receiving cases from investigative authorities. While many laboratories have some form of a separate receiving section, the personnel in these sections range from administrative staff and police constables to scientific officers. Laboratory narratives regarding case-receiving sections have raised concerns about the objectivity of the examination process as there are no filters on the information received by the scientist to avoid cognitive bias, including confirmation or contextual bias.[178] While it is essential for scientists to receive all the information relevant to a forensic examination, the receipt of task-irrelevant information connected to the case can cause bias.

## Absence of technical review in individual casework

Given the lack of adequate scientific staff and an absence of quality control guidelines,[179] a technical review of the forensic examination in individual casework was widely absent. A review mechanism was

**178** Itiel Dror, *Cognitive and Human Factors in Expert Decision Making: Six Fallacies and the Eight Sources of Bias*, 92 (12) Analytical Chemistry (2020) at pg 7998 explains the main sources of bias as divided into three categories, factors relating to the specific case, individual expert and human nature and cognition. https://pubs.acs.org/doi/10.1021/acs.analchem.0c00704.

**179** See Graphic 12 on laboratory-wise total rates of filled and vacant scientific posts in Chapter II: Recruitment, Education & Training at pg 103; challenge on lack of quality management systems in Chapter V: Quality Management at pg 212.

operational only in two FSLs, where both technical and administrative processes were reviewed. In some laboratories, there was only one reporting scientist per division, thereby precluding the verification of results by another examiner. One of the FSLs even shared that forensic results were reviewed only in cases where the results were "negative".

The process of review minimises the risk of human error and cognitive bias. Best practices for different disciplines suggest that such verification should be conducted,[180] including even a blind review where the reviewer is unaware of the findings by the first examiner.[181] International quality standards also mandatorily require test results to be reviewed before the finalisation of the report.[182] This review would entail checking the validity of tests, adherence to established procedures and the quality of instruments used for testing. A review is not considered an additional or extraordinary measure, which is selectively applied to certain categories of cases or disciplines.

**180** Scientific Working Group on DNA Analysis Methods (SWGDAM), *Interpretation Guidelines for Autosomal STR Typing by Forensic DNA Testing Laboratories* (2021) at pg 3 recommends that the data and conclusion for DNA profiling results should be subjected to administrative and technical review prior to issuing a final case report [SWGDAM Interpretation Guidelines]. https://www.swgdam.org/_files/ugd/4344b0_3f94c9a6286048c3924c58e2c230e74e.pdf.

**181** For fingerprint examination, the Scientific Working Group on Friction Ridge Analysis, Study and Technology, *Standard for the Application of Blind Verification of Friction Ridge Examinations* (2012) on pg 1 (https://www.nist.gov/system/files/documents/2016/10/26/swgfast_blind-verification_2.0_121124.pdf) and the UK FSR guidance, *Cognitive Bias Effects* (2020) on pg 56 (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/914259/217_FSR-G-217_Cognitive_bias_appendix_Issue_2.pdf) recommend a blind verification for analysis, comparisons and evaluations in cases of fingerprint examination that are either considered at great risk of contextual, confirmation or cultural bias, complex or cause a variance in opinion between examiners.

**182** Accreditation guidelines applicable to forensic laboratories such as the ISO/IEC 17025:2017 *General Requirements for the Competence of Testing and Calibration Laboratories* requires the laboratory to ensure the validity of results, which shall include review of reported results before their release (Clauses 7.7 and 7.8).

## Challenges in crime scene & court visits

A common narrative across FSLs was about the issues faced by scientific personnel in attending crime scenes and courts. Due to the lack of adequate human resources and high pendency, scientists believed the investment of several hours or even days towards attending a crime scene or court proceedings in every case disrupted their casework. In the absence of video-conferencing facilities in the FSLs or across trial courts, scientists shared that they would often lose entire days of work during court visits, especially due to adjournments or other delays in recording witness testimonies. These concerns of disruption were heightened in those states which had only one or two functional laboratories to service the forensic needs within the state.

Scientists pointed out problems in travelling through difficult terrain or remote parts, and issues with road infrastructure within the state that made their visits to courts and crime scenes more difficult. These issues were offered as practical considerations for seeking exemption from appearing before courts as expert witnesses under Section 293 CrPC[183] or in agreeing to participate in crime scene visits only when the police make specific requests. The scientists, however, agreed that their presence at crime scenes would ensure that evidence is properly collected and stored and that their interactions with judges and lawyers would help bridge the gap in forensic knowledge and assist in the proper appreciation of forensic evidence in individual cases.

**183** See data regarding availability of scientific officers covered under Section 293 CrPC in Chapter II: Recruitment, Education & Training at pg 99; detailed discussion on issues with Section 293 in Chapter VII: Law on Expert Evidence at pg 253.

## FORENSIC EXAMINATION OF CRIME SCENES

*Of the 30 laboratories covered in the survey, 20 provided data regarding crime scene visits conducted by them during the assessment period.*

*CBI-CFSL (1596), SFSL Verna (1471) and SFSL Raipur (1282) recorded the most crime scene visits during the assessment period. RFSL Ranipool (29), RFSL Pune (66) and SFSL Mumbai (71) recorded the lowest number of visits, despite RFSL Pune and SFSL Mumbai being ranked first and fourth in the median number of cases received. While some laboratories shared that they visited crime scenes for evidence collection regularly, others visited crime scenes only in certain cases, when specifically requested by the police.*

*In other jurisdictions, scientific assistance at crime scenes is ensured through the formation of Crime Scene Units (CSUs) or the designation of CSOs (Crime Scene Officers). This entails the empanelment of civilian personnel qualified in forensic science within the fold of investigative agencies as a specialised team for crime scene response. This ensures that forensic scientists working in laboratories are not exposed to task-irrelevant information that may cause bias and are not tasked with this additional responsibility. In India, while designated crime scene units largely do not exist, such initiatives are being explored. For instance, the Karnataka State Police has created posts for Scene of Crime Officers (SoCOs), to engage civilian forensic experts to assist with crime scene management.*

### Lack of a document management system within laboratories

A serious need for developing systems for evidence processing and casework information management systems was noticed across FSLs. While all laboratories have a version of a case documentation system, it is either entirely undigitised or fragmented. Most laboratories shared that only the start and the end dates of the examination in a case are recorded, instead of a daily case log recording the examination of exhibits within the case.

Further, the current systems do not support a robust chain-of-custody documentation within the FSLs, which would record the handling and examination of every exhibit within a case. Considering issues with high case pendency and inadequate storage facilities,[184] robust documentation of evidence-handling in individual casework is important to avoid issues of contamination, tampering or destruction of evidence.

184 See inset on shortage of space in Chapter IV: Infrastructure at pg 181.

## IMPACT OF COVID-19 ON CASE MANAGEMENT WITHIN FSLS

*Like with investigative authorities and courts across the country, the functioning of FSLs was significantly impacted by the COVID-19 pandemic. The disruptions in the functioning of the laboratories due to COVID-19 may increase the case pendency levels, and consequently, impact investigations or court proceedings.*

*From publicly available information, it is currently difficult to accurately assess the impact of COVID-19 on the administration and functioning of FSLs. With the mutations of the COVID-19 virus, there is a risk of exposure to personnel at the FSLs from samples collected at a crime scene, accused or victims. Most laboratories described the poor state of crime scene and evidence management by police personnel, making it far more difficult to implement COVID-safety measures such as the use of personal protective equipment (PPE) kits, proper sealing, or sanitisation of packaging of evidence items.*[185] *These challenges are further exacerbated by the lack of adequate resources at police stations across India. There are similar concerns within FSLs themselves due to poor infrastructure, as elaborated in Chapter IV on Infrastructure. With pre-existing issues regarding the availability of PPE kits for laboratory staff, its heightened use in handling samples during the COVID-19 pandemic would likely be difficult. It is important to trace the impact of COVID-19 on casework examination, which may help understand the challenges faced by laboratories and build preparedness for any future crises.*

185 To ensure safety of police officials and laboratory staff, SFSL Jaipur released guidelines for police officers to be observed while sending exhibits for forensic examination. https://home.rajasthan.gov.in/content/dam/homeportal/stateforensicsciencelaboratorydepartment/orders/covid19circular.pdf. SFSL Jaipur also released guidelines for the protection of scientists from COVID-19 pandemic by implementing the use of gloves, N95 masks and PPE. It also provided guidelines on the treatment and storage of exhibits received during the pandemic. https://home.rajasthan.gov.in/content/dam/homeportal/stateforensicsciencelaboratorydepartment/orders/covid19circulartoxiexhibit.pdf.

## RECOMMENDATIONS

### Creation of protocols for evidence collection & crime scene management

Like its 2018 guidelines for the collection, storage and transportation of biological samples for investigating officers,[186] DFSS with the proposed FSR should formulate standardised protocols based on best practices for the collection, storage, and transport of other types of forensic evidence as well. These guidelines should adequately indicate the factors to be considered for identifying evidence to be sent for forensic examination so that only evidence relevant to the investigation reaches the laboratories. This will ensure that FSLs do not commit resources and time to deal with unnecessary samples.

*Police collect the evidence, keep it in their malkhana (evidence room) and then send it to the FSL. No idea how it is preserved there.*

- Assistant Director at an SFSL on the collection of evidence

For the successful implementation of such guidelines, the concerned central and state departments should ensure that the police and investigative agencies are adequately supplied with the necessary protective gear, equipment, and kits relevant for the collection of different types of forensic evidence. Additionally, training programmes on evidence collection and crime scene management with a focus on practical learning should be rolled out through the National and State Police Academies. Such forensic training should be made a compulsory part of induction into the police forces. These training programmes

**186** DFSS, *Guidelines for collection, storage and transportation of Crime Scene Biological samples For Investigating Officers* (2018) [DFSS Crime Scene Biological Sample Guidelines for IOs]. http://dfs.nic.in/pdfs/IO%20-Forensic%20evidence-Guidelines%20for%20%20IO.pdf.

may be developed by NFSU, after conducting a needs assessment through consultations with police officials, forensic scientists and legal practitioners across different states.[187]

Another avenue for continued training of police personnel is programmes conducted by FSLs themselves. Better planning and coordination between the laboratories and state police departments towards developing an annual training calendar for police personnel should be done so that such programmes are conducted regularly. This will require additional efforts to ensure adequate staffing in the laboratory so that human resources can be assigned to conduct training programmes for investigative agencies or other stakeholders without impacting casework. Further, ongoing training programmes by laboratories for police personnel in their respective states must be audited by NFSU with the proposed FSR for the quality of the curriculum and their mode of instruction. Without the twin efforts in both training and adequately equipping investigative agencies, adherence to best practices for the collection, handling, transportation and storage of evidence cannot be achieved.

In the long run, every police district should also have one or multiple units of crime scene examiners (CSOs) which can assist the investigative team visiting every crime scene.[188] Instead of pulling scientific staff away from casework in laboratories for crime scene examination, having a separate unit of CSOs would be a better solution as it would also reduce the chances of contextual bias for forensic scientists who may eventually examine the evidence in laboratories.

**187** The NHRC Report at pg 16 also made a similar observation, that if police officers are properly trained they are better able to ensure that the crime scene is not disturbed and clues with high evidentiary value are not lost or contaminated.

**188** A similar recommendation was made in the NHRC Report at pg 5, that a forensic scientist should act as an "essential scientific advisor" to the investigative team in every case, which will ensure that only evidence bearing any forensic value in that case is collected and sent for examination. See Table 5 on recommendations related to Recruitment, Education & Training in Chapter VIII: Overall Recommendations at pg 276.

## IMPROVING THE PRACTICE OF FORENSIC MEDICINE

*The practice of forensic medicine remains largely unregulated in India, with reports stating that post-mortem examinations are conducted by untrained staff in ill-equipped autopsy rooms.[189] While various High Courts have taken cognisance of the abysmal state of autopsies,[190] there is limited information on the current state of forensic medicine in India. It is imperative that, like this survey, forensic medicine departments across the country be examined as well, along with a review of the current practices in forensic medicine. Based on such a survey, targeted measures should be taken to ensure that forensic medicine departments across government hospitals and medical colleges in India are adequately staffed and equipped.*

*Currently, there are no standard guidelines or protocols for post-mortem examination or medical examination in cases other than sexual assault.[191] The MoHFW, after consulting with medical practitioners and forensic scientists practising forensic biology, DNA profiling, toxicology and trace evidence analysis, should publish guidelines for conducting medical examinations of persons and post-mortem examinations. Further, to address issues regarding*

**189** Rudraneil Sengupta, *The autopsy report*, LiveMint (2018). This investigative piece reveals that a vast majority of post-mortem examinations conducted in India are 'of little value', and are 'riddled with errors, or done incompetently'. https://www.livemint.com/Politics/Lofa7q6gweBypR05IoERrO/The-autopsy-report.html.

**190** In *Adil Khatri v. State of Maharashtra*, PIL No. 9 of 2018, the Bombay High Court noted that post-mortems were being conducted by untrained safai karamcharis and the doctors would merely sign the final report. Similarly, in *RM Arun Swaminathan v. The Principal Secretary to the Government, Health and Family Welfare Department, Government of Tamil Nadu*, Chennai, WP (MD) No. 78 of 2019, the Madras High Court observed that doctors use the same content in all post-mortem reports and only change the name of the deceased and the police station.

**191** Guidelines for medical examination in cases of sexual offences have been issued by the MoHFW in 2014 and DFSS in 2018 [DFSS MEDICAL EXAMINATION GUIDELINES FOR MOs]. https://main.mohfw.gov.in/sites/default/files/953522324.pdf; http://dfs.nic.in/pdfs/MO-Forensic%20examiniation-%20Guidelines%20%20for%20MO.pdf.

*the quality of medical examinations and autopsies, mandatory training for new recruits, existing medical practitioners and support staff in forensic medicine departments should be conducted. Towards this, training curricula based on best practices for conducting autopsies[192] should be designed, along with an injection of resources to enable the actualisation of such standards.*

*Lastly, there is little evidence of accountability or quality control mechanisms enforced by the erstwhile Medical Council of India (MCI) or the current National Medical Commission (NMC). While the NMC, State Medical Councils (SMC) and the Ethics and Medical Registration Board (EMRB) hold the power to ensure compliance with quality standards and professional ethics by medical professionals practising forensic medicine and pathology, such measures have not been undertaken. The NMC should create a code of ethics for the practice of forensic medicine in India, which should be proactively enforced by SMC and EMRB.* [193]

**192** The *Minnesota Protocol on the Investigation of Potentially Unlawful Death*, 2016 is a set of international guidelines for the investigation of suspicious deaths, published by the Office of the United Nations High Commissioner for Human Rights. https://www.ohchr.org/Documents/Publications/MinnesotaProtocol.pdf.

**193** The Code of Medical Ethics Regulations, 2002 currently in force applies to any doctor with an MBBS degree, including forensic pathologists and forensic medical examiners. However, given their duties towards law and justice, it is important that professional ethics specifically applicable to forensic medicine separately. https://www.nmc.org.in/rules-regulations/code-of-medical-ethics-regulations-2002/.

### Streamlining case receipt in FSLs

The receipt of exhibits in the case receipt section should be guided by standardised protocols created by DFSS with the proposed FSR. The section should be staffed with dedicated personnel who are trained to properly evaluate the chain of custody of the samples received and make a preliminary assessment of the queries asked by the police to ensure the laboratory's capability in assessing those questions.[194] Such personnel should be trained administrative staff rather than police officers appointed to carry out this work.

To ensure the objectivity of the forensic examination process, context management procedures to remove any task-irrelevant case information before assigning the case to the forensic examiner should be adopted.[195] Thus, contact between the investigative agencies and the scientists carrying out the forensic examination would be minimised, and no task-irrelevant information about the case would be made available to the scientists.

### Review of casework

All reports released by the FSLs should mandatorily undergo technical and administrative reviews as part of quality management. In line with best practices, a blind review by a second analyst without the knowledge of the first examiner's opinion should be done, especially in those cases that are complex or deemed to be susceptible to contextual bias.[196] The

**194** See Table 5 on recommendations related to Recruitment, Education & Training in Chapter VIII: Overall Recommendations at pg 276.

**195** In the United States, as per the erstwhile National Commission on Forensic Science, forensic laboratories should take appropriate steps to avoid exposing analysts to task-irrelevant information through the use of context management procedures detailed in written policies and protocols. https://www.justice.gov/archives/ncfs/file/818196/download. Similar references may be found in the DNA Profiling manual of CDFD, Hyderabad at pg 18, which prescribes coding of exhibits by a 'coding officer' as part of the case receipt procedure.

**196** Itiel Dror, Justice Bridget M McCormack & Jules Epstein, *Cognitive Bias and Its* technical review should include a review of the instruments used, as well as a re-evaluation of the data and material related to the examination to ensure that the findings in the report are scientifically valid and reliable. The requirement of such technical and administrative reviews should be part of the laboratories' quality manuals.[197] Chapter V deals with quality manuals and quality management in more depth.

Such review must also ensure that the findings and opinions are reported in a standardised manner and do not convey any fact or degree of certainty outside the domain of the expert's knowledge and skills.[198] Such standards should be developed by the proposed FSR in consultation with DFSS and must identify the laboratory documentation that should be submitted along with the reports that will assist the courts to independently review them.[199] This gains significance since forensic reports are often the only material available to courts for insight into the forensic analysis of crucial evidence, given the exemption under Section 293 CrPC to experts from testifying before the courts.

*Impact on Expert Witnesses and the Court*, 54(4) The Judges Journal (2015) at pg 8 discusses the science behind cognitive bias and measures that can be undertaken to minimise its effects in criminal proceedings.

**197** As per FBI's *Quality Assurance Standards for Forensic DNA Testing Laboratories, 2020*, Clause 12 on Review: "The laboratory shall have and follow a procedure to conduct and document technical and administrative reviews of all case files and reports to ensure conclusions and supporting data are reasonable and within the constraints of scientific knowledge." https://www.cacnews.org/policies/Forensic_QAS_APPROVED_by_FBI_Director_eff_07012020.pdf

**198** Similar standards have been prepared by the United States Department of Justice to guide the testimony and reports of forensic experts for different forensic disciplines. These standards mention the conclusions that may be stated by the experts, and explain the qualifications and limitations of the discipline, based on which the expert should prepare their opinion. https://www.justice.gov/olp/uniform-language-testimony-and-reports.

**199** See section on understanding law of expert evidence in India in Chapter VII: Law on Expert Evidence at pg 246 on the requirement of submitting 'data and materials' which form the basis of the expert opinion.

## Need for a case management system

A robust case management system within FSLs will ensure that all information regarding casework is recorded and maintained in a standardised manner. Such a system will ensure efficient and transparent documentation in individual casework, and allow an effective review of cases. Considering the sensitive nature of casework, it is essential to develop a digitised and secure case management system. Such a system also ensures the maintenance of chain-of-custody documentation within the laboratory, thus securing the sanctity of evidence.

In the United States, the Laboratory Information Management System (LIMS) has been implemented across many FSLs to ensure the integrity of evidence and to enable laboratories to function efficiently.[200] The laboratories shifted to this model after a 2014 survey of publicly funded crime laboratories,[201] where it was felt that the existing concerns of heavy caseload, slow turnover times and high pendency rates necessitated an efficient document management system. LIMS is a software-based tool that "collects, creates and stores all data related to forensic examinations in a crime laboratory." It helps track the movement and status of various exhibits within a case across the laboratory and its different divisions. This ensures that proper documentation is maintained by forensic scientists and also results in maintaining a strict chain of custody. The information from this system can also be used to analyse the individual workloads and turnover times, and help the laboratory's management to make better decisions. A digitised document management system like

**200** FTCoE NIJ, *A Landscape Study of Laboratory Information Management Systems (LIMS) for Forensic Crime Laboratories* (2020), pg 5. Based on interviews with crime laboratories and a literature review, the report provides information on LIMS and its use as an evidence management system across US laboratories. https://forensiccoe.org/private/62a8d0a8f071c.

**201** Matthew R Durose & Andrea M Burch, *Publicly Funded Forensic Crime Laboratories: Resources and Services, 2014*, Bureau of Justice Statistics (2016), pg 4. A backlog was observed in relation to DNA evidence and when asked about the received, examined and backlogged requests on sexual offence cases, the laboratories were not able to separately report the requests. https://bjs.ojp.gov/content/pub/pdf/pffclrs14.pdf.

LIMS is essential for all FSLs in India, to ensure better record-keeping and standardisation of data storage. It will enable better coordination between divisions within a laboratory and also when cases are transferred between laboratories, such as to CFSLs or certain SFSLs. It will also ensure preparedness for managing casework during crises such as the COVID-19 pandemic.[202]

### Need for administrative staff trained in data input & statistical analysis

One of the major issues encountered during the current survey was the lack of administrative data management and analysis across FSLs. At a policy level, gaps and variances in the basic information maintained by laboratories regarding casework lead to obstacles in data analysis and needs assessment. To combat this issue, the administrative staff in FSLs should have data input skills in order to collate information on all cases and exhibits, received, examined and pending across all divisions in each laboratory. Further, the team of administrative staff should include a statistician to compute statistics related to staff efficiency, trends relating to case receipts, examination and pendency and turnaround times.[203] This would allow the laboratory management to make informed decisions and seek targeted assistance from the state and central governments, backed by data. Once LIMS-like software is installed in each laboratory, a statistician in the administrative staff can also collate information from the software to aid policy-making for the FSL. This will also assist in data collection for period surveys such as the current project.

**202** FTCoE, *Leveraging Laboratory Information Management Systems (LIMS) to Maintain Continuity of Operations: Lessons from the COVID-19 Pandemic* (2021). This brief indicates the benefits of the LIMS system in managing casework while adjusting to the restrictions due to COVID-19 pandemic. https://forensiccoe.org/private/6008977fd584b.

**203** See Table 5 on recommendations related to Recruitment, Education & Training in Chapter VIII: Overall Recommendations at pg 276.

# 4 INFRASTRUCTURE


CPCRI ENT. MICS 04
CPCRI ENT. MICS 05
PHILIPS

## INTRODUCTION

As part of the survey, data regarding sanctioned space and additional requirements for space and equipment was sought from the FSLs. In order to understand these requirements in the context of the laboratory's current casework, this information is analysed as per the needs of the functional[204] and non-functional divisions. Out of the 29 FSLs functional during the assessment period, 25 laboratories[205] shared information regarding sanctioned and additional space required by them. Further, 21 laboratories specified the additional equipment required by them.[206]

The requirements for additional space and equipment for functional divisions represent the current needs of the FSLs, which have a direct bearing on their present operational capacity and ongoing performance. On the other hand, the demand for additional space or equipment for non-functional divisions reflects the prospective needs of the laboratory. These include proposed divisions or those which have been sanctioned but do not currently process casework.

The narratives of the scientists and our observations on different aspects of laboratory infrastructure have been included in this chapter. It covers the infrastructural challenges faced by the FSLs in terms of lack of space, dearth of facilities to carry out scientific and non-scientific work, lack of safety precautions and protocols, and security concerns. While we have briefly discussed these concerns, an in-depth audit of the infrastructural capacity of our FSLs is required to understand and address these issues.

**204** For this analysis, the divisions that processed casework during the assessment period have been considered as functional. See Annexure II for the list of functional divisions in each FSL at pg 309.

**205** CFSL Chandigarh, SFSL Lucknow, RFSL Agra and RFSL Thrissur did not provide data regarding sanctioned or additional space required by them. CFSL Shimla did not provide data on sanctioned space and stated that it does not require additional space.

**206** SFSL Puducherry did not require any additional equipment. CFSL Chandigarh, SFSL Shillong, SFSL Verna, RFSL Agra, RFSL Aurangabad, RFSL Berhampur and RFSL Dharamshala did not provide information regarding additional equipment required.

## TRENDS

### Additional Space Requirements

*Laboratory-wise analysis*

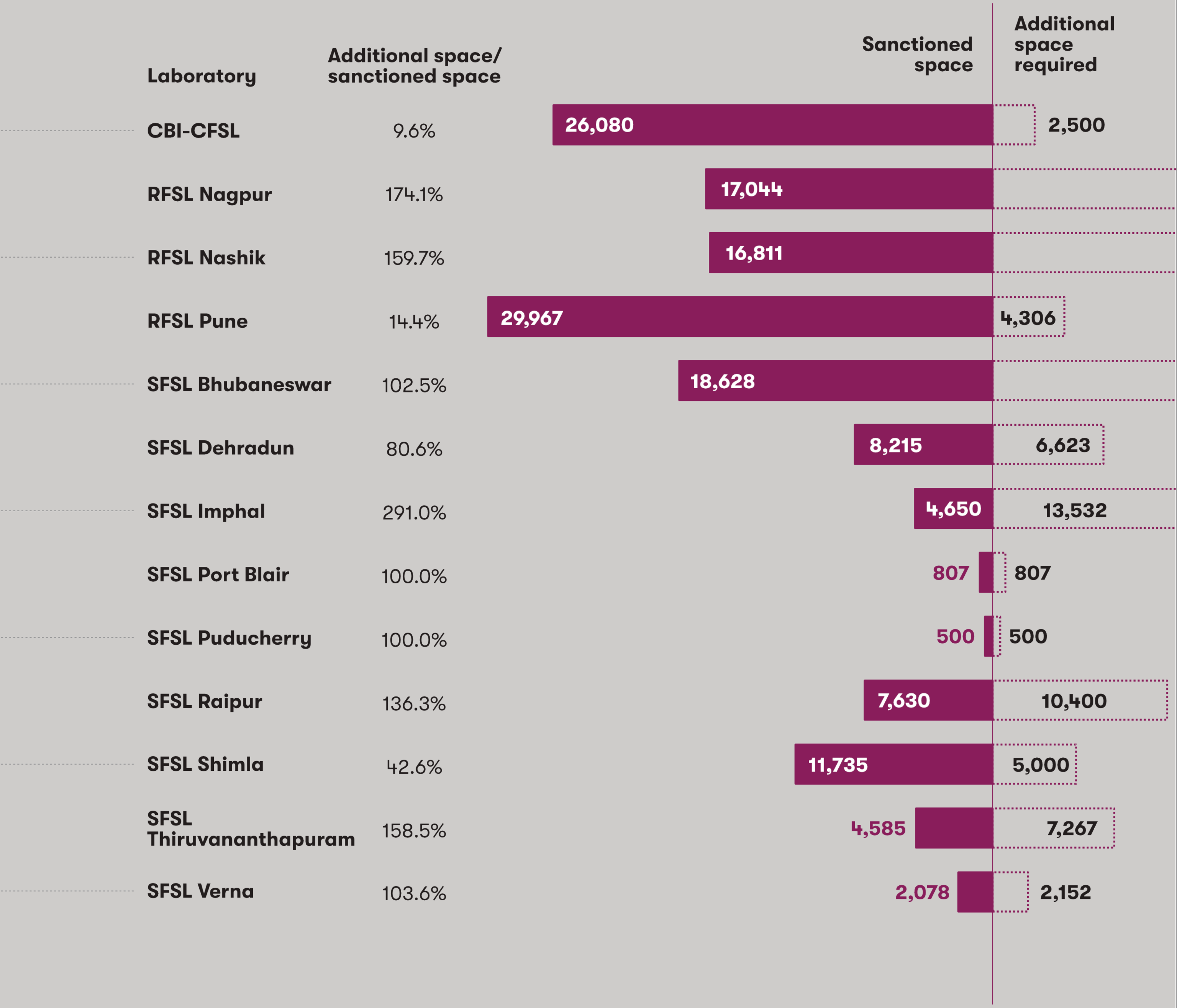
Of the 25 laboratories that shared information regarding sanctioned or additional space, 13 laboratories said that they required more space.[207] RFSL Nagpur (29,672 sq. ft.), RFSL Nashik (26,851 sq. ft.) and SFSL Bhubaneswar (19,092 sq. ft.) had the highest requirement for additional space in terms of area (Graphic 25). In comparison with the presently sanctioned space, seven FSLs required more than double the currently allocated space for their functional divisions. Out of these laboratories, SFSL Imphal (291%), RFSL Nagpur (174.1%) and RFSL Nashik (159.7%) ranked the highest.[208]

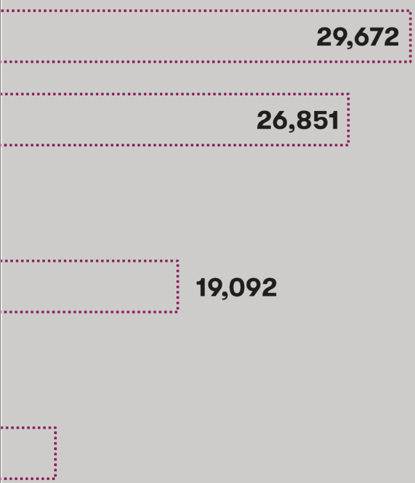
To understand the prevalence of space shortage within a laboratory, the number of divisions requiring more space was compared to the total number of functional divisions within the laboratory. SFSL Bhubaneswar and SFSL Verna needed more space for all their functional divisions. SFSL Dehradun, SFSL Imphal, SFSL Raipur, SFSL Thiruvananthapuram and RFSL Nagpur required additional space for more than half of their functional divisions. The high levels of additional space required raise serious concerns regarding the severe constraints that FSLs may be currently operating under and the resultant impact on the quality of forensic examinations.

**207** SFSL Agartala, SFSL Dimapur, SFSL Mumbai, SFSL Shillong, RFSL Aurangabad, RFSL Berhampur, RFSL Jagdalpur and RFSL Ranipool did not share any data for functional or non-functional divisions on additional space required. However, during the field visit, personnel at RFSL Berhampur expressed an urgent need for additional space. RFSL Dharamshala did not share any data for functional divisions on additional space required. SFSL Aizawl and SFSL Banderdewa shared that they did not require any additional space.

**208** SFSL Bhubaneswar, SFSL Raipur, SFSL Thiruvananthapuram and SFSL Verna also required more than double their sanctioned space.

**Graphic 25.** **Additional space required by FSLs for functional divisions (in sq. ft.)**






**No. of functional divisions which require additional space**

**3** out of 15

**8** out of 10

**2** out of 7

**1** out of 8

**9** out of 9

**7** out of 10

**5** out of 6

**1** out of 4

**1** out of 2

**8** out of 10

**2** out of 14

**8** out of 10

**2** out of 2

As shown in Graphic 26, six laboratories required more space for divisions that were currently not functional.[209] As a newly established laboratory, SFSL Mangalagiri has an additional space requirement (76,980 sq. ft.) that is higher than the currently sanctioned space for functional divisions amongst the laboratories covered within the survey.

*Division-wise analysis*

Out of 17 divisions functional across laboratories, additional space was required for 15 divisions.[210] Biology (34,150 sq. ft.), DNA Profiling (23,263 sq. ft.) and Ballistics (15,046 sq. ft.) had the highest requirement for additional space in terms of area (Graphic 27). In proportion to the sanctioned space, four divisions i.e., Cyber Forensics (195.3%), Serology, (145.2%), Explosives (140.9%) and DNA Profiling (134.6%) required more than double the currently allocated space.

It is important to note that out of the abovementioned divisions, Ballistics, DNA Profiling and Cyber Forensics had higher pendency rates than examination rates.[211] Therefore, the urgency to address the need for additional space for these divisions should be considered in light of their high case pendency.

**209** SFSL Imphal, SFSL Mangalagiri, SFSL Port Blair, SFSL Raipur, SFSL Verna and RFSL Dharamshala required additional space for non-functional divisions.

**210** The Photography division did not require any additional space, and no data was available for the Narco-analysis division.

**211** See Graphic 15 on examination and pendency rates in divisions across FSLs in Chapter III: Case Management at pg 133.

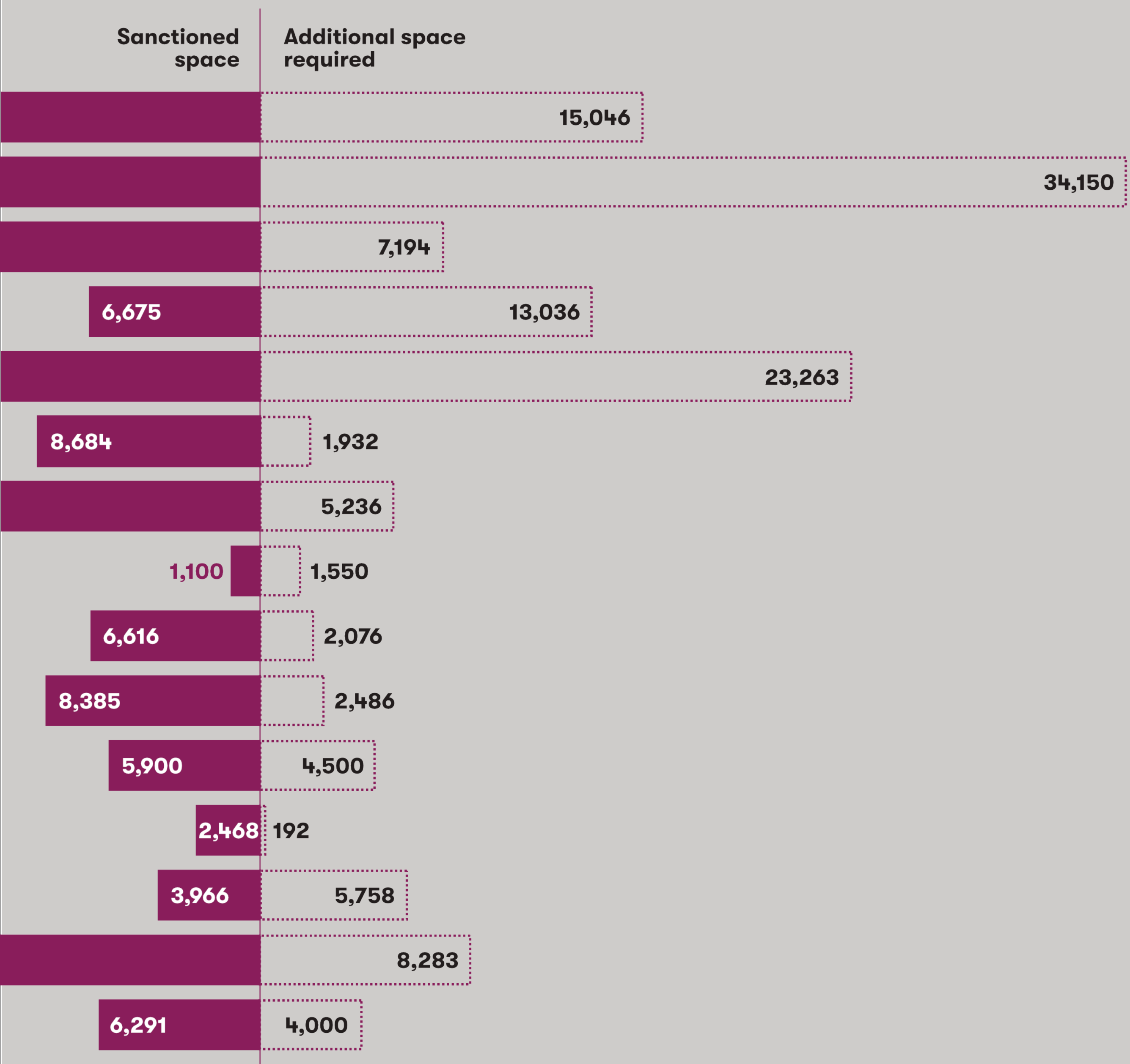
## Graphic 26. Additional space required by FSLs for non-functional divisions (in sq. ft.)

- Ballistics
- Biology
- Chemistry
- Cyber Forensics
- DNA Profiling
- Documents
- Explosives
- Narcotics
- Photography
- Physics
- Polygraph
- Serology
- Toxicology
- Voice Identification

| Laboratory | Additional space required | Divisions which require additional space |
|---|---|---|
| RFSL Dharamshala | 600 | Cyber Forensics |
| SFSL Imphal | 2,711 | Cyber Forensics, Photography |
| SFSL Mangalagiri | 76,980 | Ballistics, Biology, Chemistry, Cyber Forensics, DNA Profiling, Documents, Explosives, Narcotics, Physics, Polygraph, Serology, Toxicology, Voice Identification |
| SFSL Port Blair | 6,995 | Ballistics, Cyber Forensics, DNA Profiling, Documents, Photography, Physics, Serology |
| SFSL Raipur | 3,000 | Cyber Forensics, Polygraph, Voice Identification |
| SFSL Verna | 18,299 | Ballistics, Chemistry, Cyber Forensics, DNA Profiling, Documents, Explosives, Narcotics, Photography, Physics, Polygraph, Serology, Toxicology, Voice Identification |

## Graphic 27. Additional space required for functional divisions across FSLs (in sq. ft.)

| Division | Additional space/ sanctioned space | |
|---|---|---|
| Ballistics | 88.5% | 16,993 |
| Biology | 91.4% | 37,349 |
| Chemistry | 20.6% | 34,984 |
| Cyber Forensics | 195.3% | |
| DNA Profiling | 134.6% | 17,279 |
| Documents | 22.2% | |
| Excise | 33.6% | 15,605 |
| Explosives | 140.9% | |
| Fingerprint | 31.4% | |
| Narcotics | 29.6% | |
| Physics | 76.3% | |
| Polygraph | 7.8% | |
| Serology | 145.2% | |
| Toxicology | 20.3% | 40,895 |
| Voice Identification | 63.6% | |


Sanctioned space
Additional space required
15,046
34,150
7,194
6,675
13,036
23,263
8,684
1,932
5,236
1,100
1,550
6,616
2,076
8,385
2,486
5,900
4,500
2,468
192
3,966
5,758
8,283
6,291
4,000

## Additional Equipment Requirement

*Functional divisions*

As shown in Graphic 28, of the 21 FSLs which required additional equipment, CFSL Shimla, SFSL Banderdewa, RFSL Ranipool and RFSL Thrissur needed it for all the functional divisions in the laboratory. Nine laboratories required additional equipment for more than half of their functional divisions.[212] This raises serious concerns regarding the impact of limited or insufficient equipment on the productivity and performance of these divisions.

While considering a division-wise analysis, the requirement for additional equipment was highest for functional Chemistry divisions (12 laboratories), followed by DNA Profiling (11 laboratories), Biology (nine laboratories) and Ballistics, Documents and Toxicology (eight laboratories each). As discussed in Chapter III on Case Management, these divisions rank the highest in terms of the total number of cases received.[213] Since a substantial portion of the forensic casework is conducted in these divisions, the deficiency of equipment in them is a cause for concern.

*Non-functional divisions*

In addition, as shown in Graphic 29, five laboratories required additional equipment for newly sanctioned divisions in the laboratory.[214] Out of these, four laboratories requested additional equipment for Cyber Forensics, which indicates the growing need for this division.

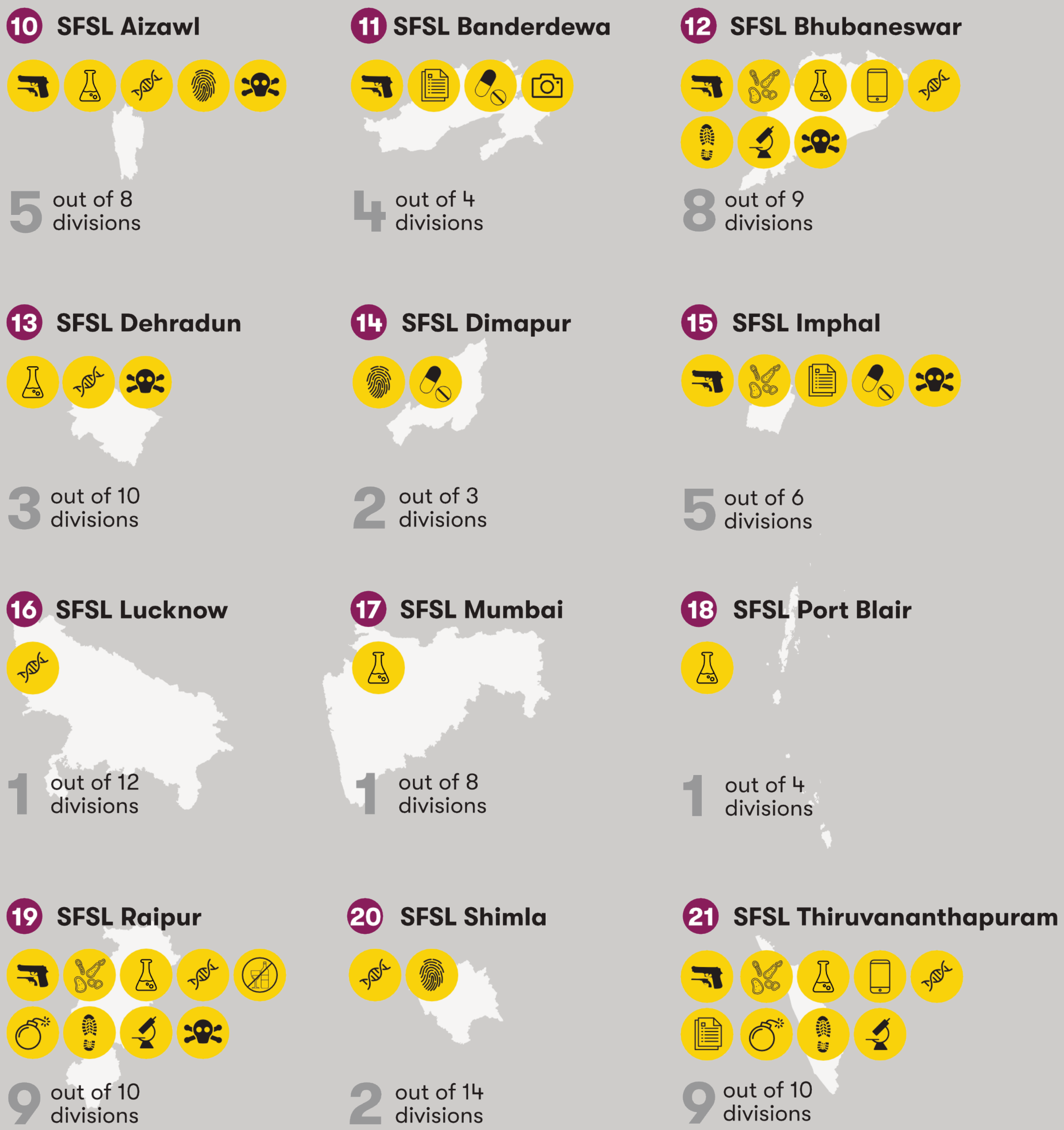
**212** CBI-CFSL, SFSL Agartala, SFSL Aizawl, SFSL Bhubaneswar, SFSL Dimapur, SFSL Imphal, SFSL Raipur, SFSL Thiruvananthapuram and RFSL Pune required additional equipment for more than half of their divisions.

**213** See Graphic 14 on the total number of cases received by different divisions across FSLs in Chapter III: Case Management at pg 131.

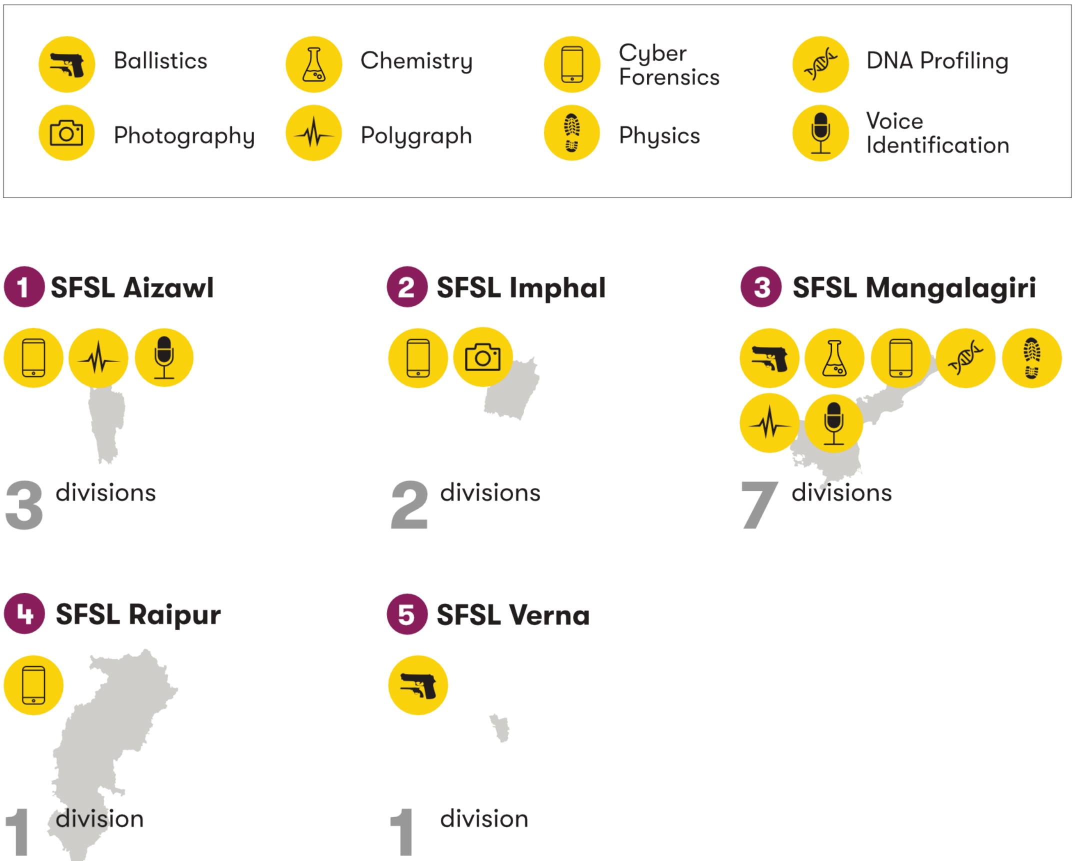
**214** SFSL Aizawl, SFSL Imphal, SFSL Mangalagiri, SFSL Raipur and SFSL Verna required additional equipment for their non-functional divisions.

**Graphic 28. Additional equipment required by FSLs for functional divisions**

**Graphic 28. Additional equipment required by FSLs for functional divisions**



## Graphic 29. Additional equipment required by FSLs for non-functional divisions



CHALLENGES

## CHALLENGES

### Absence of laboratory planning & design

Establishing a laboratory requires an understanding of the processes followed in every forensic division and their needs while examining different types of casework. The planning involved in setting up an FSL must include adherence to measures for ensuring health and safety, minimisation of contamination, limiting access to areas of examination only to relevant scientific staff, creation of separate spaces for scientific and non-scientific tasks and the assessment of the future needs of the division.[215]

***Who will call this a laboratory? We did not get any say its construction. The Police Housing Commission built this like housing quarters. They only knew the area and the number of divisions that are to be made.***

***This is my office. In this room, the shelves are for storing examined and unexamined exhibits, the wash basin is my wet lab, and this table is my workspace as an Assistant Director. The firing chamber is also here. We have to make do.***

- Assistant Director of the Ballistics division at an RFSL

**215** The United Nations Office on Drugs and Crime, *Forensic Services and Infrastructure*, Criminal Justice Assessment Toolkit: Policing (2010), Chapter 5: Forensic analyses and examinations in a laboratory or medical facility, at pg 21-23 provides a tool for assessing the infrastructure for forensic facilities and sample handling within the laboratory. https://www.unodc.org/documents/justice-and-prison-reform/cjat_eng/Forensic_services_and_infrastructure.pdf. Further, the NABL 113 *Specific Guidelines for Accreditation of Forensic Science Laboratories* at pg 39-43 also emphasise the need for

Several laboratory personnel shared the daily challenges they face due to the lack of planning and design while establishing the FSL. These included a shortage of space for storing exhibits, the absence of separate workstations for scientific and non-scientific tasks, the lack of basic facilities and deficient protocols for ensuring health and safety. Some FSLs were originally planned by the police departments for their use and later repurposed as laboratories. The layout of the building along with the internal aspects of plumbing, electrical power, internet connectivity and ventilation were not tailored to the basic needs of a laboratory.

proper space, design, security, health and safety measures, which would have a bearing on laboratory infrastructure and design [NABL 113 GUIDELINES].

## SHORTAGE OF SPACE

*Laboratories require additional space for properly managing their cases and for establishing new divisions.*

*The narratives of laboratory personnel and our observations during our visits to the FSLs highlight the severe inadequacy of space for properly storing exhibits and reliably conducting forensic examinations.*

*Several laboratories do not have proper storage facilities equipped with the necessary temperature, humidity, light and ventilation control for biological samples. Given the extreme weather conditions that may be experienced by some FSLs, the need for such measures is much higher in some laboratories. One of the laboratories we visited was storing exhibits in the employees' offices, beneath staircases and in the wet laboratory because of a severe space crunch. Such poor infrastructure and storage practices raise grave concerns about the degradation, contamination and tampering of samples.*

*Further, the laboratories do not have separate areas for different stages of scientific and non-scientific work. During our laboratory visits, we repeatedly observed an absence of designated areas for carrying out different kinds of work. There was also a lack of measures to restrict access of non-essential personnel to the examination areas. This raises concerns regarding contamination and quality management. It also impacts the productivity and morale of the staff in having to constantly grapple with space concerns.*[216]

**216** The NHRC Report at pg 17 had similarly observed that the infrastructure of the FSLs was far below the adequate level, which compromises the efficiency and productivity of the scientists and increases the risk of mishandling and contamination of the crime scene evidence.

### Availability & maintenance of equipment

As discussed in Chapter I on Budget & Expenditure, the forecast and expenditure across laboratories show that they consistently spend less than the forecasted amounts on equipment & materials.[217] Apart from lengthy procurement procedures which delay the purchase of equipment, laboratories shared that the lack of space also prevented them from purchasing essential equipment or expanding their divisions, despite increasing casework and historical pendency.

***We have to share equipment between Biology and Serology. We don't have the required instruments and for some cases, we have to go to the SFSL, ask for permission from the authority and then conduct the examination there. There is one microscope, so two scientists cannot work simultaneously.***

- Assistant Director of the Biology division at an RFSL

The availability of backup equipment is important to ensure continuity of work in case the regular equipment malfunctions. Delays in repairing equipment lead to a breakdown in casework, which may affect the quality of the examination and contribute to case pendency. To ensure the efficient use of equipment, the laboratory infrastructure and design must support their functioning. However, during the fieldwork, scientists raised concerns regarding the lack of ventilation, air conditioning and dehumidifiers necessary for the proper functioning of the equipment.[218]

**217** See trend of year-wise analysis of forecast and expenditure in Chapter I: Budget & Expenditure at pg 72.

**218** A similar concern was highlighted in the NHRC Report at pg 18, emphasising the need for instrument rooms to be dust- and contamination-free as well as for the air conditioning for instruments to function properly.

Further, some laboratories did not purchase annual maintenance contracts (AMCs) while procuring their equipment. As AMCs are essential in ensuring regular calibration and maintenance of equipment, the lack of such coverage can compromise the quality of the examination and adversely affect the accuracy of results in casework.

### Lack of safety precautions

Given the potential exposure to infectious biological materials and hazardous chemicals, the laboratory must be designed and equipped to ensure a safe working environment. However, several FSLs complained about the lack of proper safety procedures in the laboratory. Staff was not provided with personal protective equipment (PPE) such as laboratory coats, gloves and protective goggles. The physical infrastructure in the FSLs was also not conducive to ensuring staff safety. In some laboratories, we observed that the Chemistry divisions did not have fume hoods and relied, instead, on natural ventilation.

> ***We work in hazardous and difficult situations. Materials like aprons and gloves, which should be mandatory, are not available. There is no safety management.***
>
> \- Joint Director of an RFSL

Further, the facilities and protocols for the safe disposal of hazardous biological and chemical waste are also inadequate.[219] This has implications not just for the safety of the staff at the FSL, but also poses greater environmental concerns. Another major concern was the lack of emergency preparedness in case of accidents or natural disasters.

**219** The NABL 113 Guidelines at pg 41 require the laboratories to maintain a documented waste management programme for the safe disposal of all waste generated from the laboratories. Similarly, the NHRC Report at pg 18 also states that laboratory rooms should be equipped with proper exhaust and waste disposal facilities.

Most laboratories are not equipped with safety showers and eye washing stations in case of chemical spills, or with an adequate number of fire extinguishers.[220]

### Lack of security

Laboratories lack adequate measures to ensure the safe custody of exhibits and the security of their staff. Many FSLs did not have the necessary systems to secure access to exhibits in pending casework, such as restricting entry to evidence storage areas to authorised personnel, supplemented with camera surveillance and an entry logbook. Further, they did not maintain an internal chain of custody to record the movement and handling of exhibits upon their receipt until their examination was completed. In FSLs situated in high-risk areas, scientists shared narratives about the dismal lack of measures to ensure the safety of laboratory personnel. This was also cited as one of the factors contributing to low recruitment and high attrition rates in these FSLs.

220 The NABL 113 Guidelines at pg 41 state that laboratories should have safety showers, eye wash facilities, fire extinguishers, spill kits and first aid kits, which must be easily accessible and spread throughout the laboratory. Laboratories should also conduct regular safety audits to ensure that all safety precautions have been followed and that the safety equipment is in good working condition.

## RECOMMENDATIONS

### Infrastructure survey & creation of minimum standards

To understand the space, equipment, security, health and safety needs of the laboratories, DFSS should conduct an all-India forensic laboratory infrastructure survey, covering all functional FSLs. The survey should be conceptualised by forensic scientists from different disciplines, health and safety experts, specialists in architecture and civil engineering and security experts. The survey should be conceptualised in collaboration with NFSU and the proposed state DFSS.[221] Such a comprehensive survey will assist in prioritising the infrastructural needs of all FSLs and developing a national plan towards addressing them.

Based on the findings of this survey, DFSS and its state counterparts should coordinate with the respective state home departments to discuss the measures they can take towards addressing the needs of the functional divisions within their SFSLs and RFSLs, and the aid required from the central government. These requirements can be accordingly budgeted in the next annual financial year,[222] with central and state funds specifically earmarked for these purposes.

DFSS in collaboration with the proposed FSR[223] should also create minimum infrastructural standards and protocols for the planning and construction of laboratories.[224] These standards must include measures

**221** See section on recommendation for state DFSS and Table 3 on overall recommendations in Chapter VIII: Overall Recommendations at pg 266 and 274.

**222** See recommendation on better financial planning in Chapter I: Budget & Expenditure at pg 90.

**223** See recommendation on the creation of FSR in Chapter VIII: Overall Recommendations at pg 270.

**224** NIST, *Forensic Science Laboratories: Handbook for Facility Planning, Design, Construction, and Relocation* (2013) may be a useful reference for laboratory administrators to guide the construction or renovation of FSLs. https://nvlpubs.nist.gov/nistpubs/ir/2013/NIST.IR.7941.pdf.

for contamination minimisation, ensuring the health and safety of personnel, waste disposal and regulating environmental impact, and workflow management. These principles can also guide the sanctioning and construction of new divisions in the laboratories.

### Improving the equipment procurement process

As the purchase of equipment requires high capital investment, a central grant specifically earmarked for the development of SFSLs and RFSLs should be released consistently to ensure planned expenditure on equipment.[225] Additionally, since the instrumentation used across divisions can be standardised,[226] measures to centralise the procurement of equipment should also be explored. This will ensure that the scientific work is not hampered or impacted by delays in the cumbersome financial approval process within the respective state governments.[227]

### Health & safety management protocols and regular audits

There is an urgent need to establish and monitor the health and safety protocols in FSLs. Currently, NABL may conduct a safety inspection as part of the accreditation process. However, as only ten FSLs are currently accredited in India, most laboratories are not covered by this process.

Therefore, to ensure compliance, DFSS in collaboration with the proposed FSR must first develop health and safety guidelines, as part of the minimum infrastructural standards for forensic science

**225** See recommendation to reduce delays & maintain consistency in funding to laboratories in Chapter I: Budget & Expenditure at pg 88.

**226** DFSS, *Standard List of Equipment for Establishing/Upgrading of Forensic Science Laboratories* (2020) [DFSS STANDARD EQUIPMENT LIST 2020]. http://dfs.nic.in/pdfs/standard%20equipment%20list_unlocked.pdf.

**227** See challenges on limited financial powers of directors, complexities relating to tender & procurement process and financial regulation of RFSLs dependent on SFSLs in Chapter I: Budget & Expenditure at pg 82-84.

laboratories.[228] Based on these standards, the respective state DFSS must oversee the creation of health and safety protocols by each FSL within their jurisdiction, in order to match their local needs. Further, a system for conducting regular audits to ensure compliance with these standards should be established.

**228** See recommendation on infrastructure survey & creation of minimum standards at pg 185.

# 5 QUALITY MANAGEMENT

## INTRODUCTION

As per the International Organisation for Standardization (ISO), quality is defined as the "degree to which a set of inherent characteristics (i.e. distinguishing features) of an object (i.e. a product, service, process, person, organization, system or resources) fulfils requirements."[229] In the context of forensic science, the inherent characteristics of quality are understood as the competence of the organisation and the individual, and the validity of the testing methods.[230] This is to ensure the accuracy and reliability of the forensic examinations relied upon by law enforcement and courts for resolving civil and criminal disputes.

Quality management refers to coordinated activities, including policies, objectives and processes, undertaken to ensure quality.[231] It involves two types of processes i.e. quality control and quality assurance. Quality control includes backward-looking measures, such as monitoring and testing mechanisms to detect non-conformity with quality requirements. On the other hand, quality assurance includes forward-looking mechanisms to prevent non-compliance and build confidence that the process will meet its expectations.[232] Quality management in forensic science is particularly important given its role within the justice delivery system. As explained by the United States

**229** Clause 3.6.2, ISO 9000:2015 *Quality management systems — Fundamentals and vocabulary*. Clause 7.7.1, ISO 17025:2017 *General Requirements for the Competence of Testing and Calibration Laboratories* also emphasises that the validity of results must be ensured through monitoring mechanisms, including equipment checks, review of reported results, interlaboratory comparisons and testing of blind samples.

**230** Sean Doyle, *Quality Management in Forensic Science*, Section 1: Brief Introduction to Some Important Concepts and Key Terms, Elsevier Inc (2019), pg 8 [Sean Doyle].

**231** Clause 3.3.4, ISO 9000:2015 *Quality management systems — Fundamentals and vocabulary*.

**232** Sean Doyle, pg 12.

Supreme Court in *Daubert v. Merrell Dow Pharmaceuticals*,[233] there is a difference in the nature of a scientific inquiry as compared to a legal enquiry. While the legal process demands absolute certainty, scientific conclusions carry an uncertainty of measurement and are subject to change with technological advancements. For instance, in a criminal trial, the court seeks to determine whether the accused has committed an offence. While no forensic technique may be able to provide this level of certainty in identifying the true perpetrator, the degree of individualisation of any forensic examination and the accuracy of results depends on the validity of the methods used and their application in that case. Further, like any other science, forensic science is susceptible to error. Therefore, quality management processes are necessary to ensure that errors are detected and minimised.

Given the grave consequences that poor quality of forensic services has for criminal justice and the interests of both victims and accused persons alike, quality management in forensic science is essential. The survey sought information from the FSLs on the laboratory procedures followed relating to quality management, including information about the availability of WPMs for different divisions within the laboratory, review of casework, maintenance of equipment, proficiency testing, error rate calculation and accreditation. As part of the survey, we also sought WPMs, training manuals and quality manuals from the laboratories. Of the 30 laboratories, only SFSL Aizawl, SFSL Port Blair and RFSL Dharamshala provided their WPMs. SFSL Shimla provided its quality manual. No laboratory provided its training manual. Only five of the 30 laboratories are accredited by NABL.[234]

**233** 509 US 579 (1993) [DAUBERT]. The US Supreme Court observed at pg 597: "There are important differences between the quest for truth in the courtroom and the quest for truth in the laboratory. Scientific conclusions are subject to perpetual revision. Law, on the other hand, must resolve disputes finally and quickly."

**234** CBI-CFSL, CFSL Chandigarh, CFSL Shimla, SFSL Shimla and RFSL Dharamshala. As of 2022, there are only ten NABL-accredited FSLs in India.

This chapter seeks to explain of the various components of quality management and their significance. As with previous chapters, it identifies the trends from the survey responses and the challenges faced by the FSLs in quality management and proposes recommendations to bridge this crucial gap in the Indian forensic system.

## Components of quality management in forensic science

Quality management in forensic science can only be attained through quality control and quality assurance measures at different levels, i.e. the laboratory, the methodology and testing procedure, and the forensic examiner.

*Forensic science laboratories*

Multiple forensic disciplines are functional as various divisions within a forensic laboratory. Although the scientific and technical processes and setups are different in each division, there is a laboratory-wide management system which cuts across all divisions. This includes infrastructural planning, procurement of equipment, health and safety protocols, mechanisms for case receipts and handling of evidence within divisions, administrative and technical review of cases, internal audits, preventative and corrective actions to address non-conformities and laboratory documentation such as manuals and logs. These measures cannot be implemented in specific divisions without a wider commitment at the laboratory level. They form the basis of the quality management system within the laboratory, which applies to all staff, across all processes and cases. These laboratory-wide measures are recorded as part of the quality manual and such documentation is required for accreditation.[235]

**235** The NABL 113 Guidelines, which are based on the previous ISO 17025:2005 standards, state at pg 10 that all elements of a laboratory's quality management system should be documented in a quality manual. This requirement has been carried forward in the revised version i.e. ISO 17025:2017 standards which require documentation of the management systems within the laboratory. Based on the revised ISO standards, DFSS has released a quality manual to help FSLs build their own manuals and foster uniformity in examination, analysis and reporting [DFSS Quality Manual 2021]. http://dfs.nic.in/pdfs/Quality%20Manual-protected_unlocked.pdf.

*Forensic methods*

In order to ensure the credibility of forensic examinations, it is important to ensure that the forensic methods used are foundationally valid. This requires the accuracy (provides the correct result and is fit for purpose), reproducibility (different examiners get the same result on the same sample) and repeatability (an examiner gets the same result when analysing the same sample again) of the forensic method to be established through empirical data.[236] The lack of research into the validity and reliability of many forensic disciplines has been acknowledged by renowned scientific bodies in other jurisdictions.[237] This has prompted scientific bodies to undertake foundational reviews of different forensic disciplines, which includes a comprehensive review of the existing scientific literature on the accuracy and reliability of specific disciplines.[238]

Apart from foundational validity, it is also important to ensure that the forensic examiner has accurately and reliably conducted the examination in that particular case. This is termed 'validity as applied', which includes an examination of whether the expert has the necessary qualifications and competence to conduct the forensic testing, and has

**236** The PCAST Report at pg 47-48 proposes the scientific criteria to examine the foundational validity of forensic methods based on feature-comparison.

**237** The NAS Report at pg 22 notes that forensic "disciplines are supported by little rigorous systematic research to validate the discipline's basic premises." It recommends that studies are conducted to examine the validity of different forensic methods, develop quantifiable measures of accuracy and reliability and determine the measure of uncertainty of forensic disciplines.

**238** Recognising the crucial gap in foundational research for forensic disciplines, in 2018, the US Congress approved funding for NIST to conduct scientific foundation reviews, which have so far included DNA mixture interpretation, bitemark analysis, digital evidence and firearms examination. The draft reports for the first three disciplines have been published by NIST. https://www.nist.gov/forensic-science/interdisciplinary-topics/scientific-foundation-reviews; the PCAST Report in Chapter 5 on Evaluation of Scientific Validity for Seven Feature-Comparison Methods at pg 67-123 reviews the foundational validity of selected feature-comparison methods i.e. DNA analysis (single source and mixtures), bitemark, latent fingerprints, firearms identification, footwear analysis and hair analysis.

reliably conducted the test as reflected in the laboratory documentation. Foundational validity and as-applied validity are both necessary to ensure that the forensic report that is presented in court can be relied upon. To achieve this, the following aspects within the quality management system are necessary:

**Creation of WPMs:** WPMs document the SOP for all aspects of casework conducted within every functional division in the laboratory. Unlike best practices which are general guiding principles, WPMs provide detailed stepwise instructions, such as preparation of bench and instrumentation before an examination, reagent preparation, use of instrumentation, steps to minimise contamination, and measures to address cognitive bias. The WPM must also provide guidance for issues that are likely to arise in forensic casework and methods for troubleshooting. Each laboratory must create its own WPM for each division to ensure standardisation in scientific testing and reporting across casework. Further, the WPM must be guided by the technology available within the laboratory and in compliance with the administrative and technical review procedures within the laboratory. Although DFSS or any other apex body may develop model WPMs for guidance,[239] such documents cannot be adopted by other laboratories without determining their appropriateness to the laboratory's own procedures and infrastructure. WPMs must be periodically revised to reflect any changes arising from scientific developments or the technical or reporting practices related to that particular discipline.

**Internal & developmental validation:** Towards developing its SOP, a laboratory must conduct tests and gather data as part of internal validation to demonstrate that established methods operate as expected within the laboratory's conditions and

239 DFSS has published WPMs for different forensic divisions to aid development of manuals by FSLs and aid standardization in testing methods across laboratories. http://dfs.nic.in/downloads.html.

setup. Further, developmental validation studies are necessary for testing those methods which have been developed within the laboratory. Various laboratory standards require validation studies to be conducted for forensic techniques employed in every division, and the results should be documented.[240]

**240** Clause 7.2.2., ISO 17025:2017 requires validation of non-standard methods, laboratory developed methods and modified methods. Such requirements for validation are seen in discipline-specific standards and WPMs of other laboratories, such as American Academy of Forensic Sciences Standards Board, *Standard for Validation Studies of DNA Mixtures, and Development and Verification of a Laboratory's Mixture Interpretation Protocol* (2018) (https://www.aafs.org/sites/default/files/media/documents/020_Std_e1.pdf); New York Office of Chief Medical Examiner, *Forensic Biology Quality Assurance/Quality Control Manual* (2019), pg 2-3 (https://www1.nyc.gov/assets/ocme/downloads/pdf/technical-manuals/qaqc-procedures-manual/validation.pdf); and FBI *Laboratory Quality Assurance Manual* (2021), pg 45 (https://fbilabqsd.fbi.gov/file-repository/-laboratory/quality-assurance-manual.pdf/view).

## ERRORS IN FORENSIC SCIENCE

*Errors are an inevitable feature of all kinds of scientific processes, not just forensic science. In science, errors are the difference between the observed value and the true value of an object. They can occur due to intrinsic limitations in the scientific technique or instrumentation, observational issues with the examiner*[241] *or environmental factors. Although the inherent nature of error has been acknowledged within the forensic community, its rate of occurrence or error rates have not been adequately researched across forensic disciplines.*[242]

*Error rates are the number of times where inaccurate results were observed versus the total number of times that an experiment is run. An error may occur either when an incorrect match is reported (false positive error) or when the correct match is not reported (false negative error).*

*Studies have shown that forensic examiners are unaware of the error rates within their disciplines and estimate them to be much lower than reported through empirical studies.*[243] *While error rates are essential for examining the reliability of forensic evidence and determining its probative value,*[244] *in the absence of such information, courts are left to be guided by their own perceptions of error in forensic examination. Therefore, it is essential to commit resources to calculate error rates across disciplines. Further, forensic examiners must be trained about the known rates of error and their potential sources, in order to improve forensic examination and to correctly submit the results while testifying before the court.*

**241** Glinda S Cooper & Vanessa Meterko, *Cognitive bias research in forensic science: A systematic review*, Forensic Science International 297 (2019), pg 35-47.

**242** NAS Report, pg 188-189.

**243** Daniel C Murrie et al., *Perceptions and estimates of error rates in forensic science: A survey of forensic analysts*, 302 Forensic Science International (2019), pg 109887.

**244** The US Supreme Court in Daubert recognised ‘known or potential rate of error’ as one of the admissibility criteria for expert scientific evidence at pg 594.

**Root cause analysis (RCA)**: As a quality control measure to address any non-conformity, laboratories should investigate its possible causes. An RCA will help identify appropriate corrective measures and assist in identifying preventative steps towards quality assurance.[245] It requires an in-depth analysis of potential causes, including complications with the exhibits, issues with the forensic method or procedure followed, lack of adequate knowledge and skills on the part of the staff and malfunctioning of the equipment and its calibration. These investigations review only the non-conforming event and should not be considered as a performance assessment.[246] It requires the laboratory to have established systems for responding to errors, including procedures for formulating an RCA team and the scope of such investigation, documentation of the non-conformity and guidelines on how to detect similar non-conformities.

*Forensic examiner*

The competence and proficiency of all the scientific staff within the laboratory are crucial towards ensuring the quality of forensic examinations. One of the key measures employed by laboratories is regular proficiency testing, which are discipline-specific examinations to evaluate the competence of forensic scientists.[247] These tests are conducted internally by laboratories, as interlaboratory programmes or

**245** Clause 8.7.1, ISO 17025:2017 requires the determination of the causes of non-conformity and if similar non-conformities exist and could potentially occur. A similar requirement for RCA was featured in Clause 4.11.2 of the previous ISO 17025:2005 standards.

**246** The erstwhile National Commission on Forensic Science in the US recommended the adoption of RCA by all federal forensic science service providers (2016). https://www.justice.gov/archives/ncfs/file/786581/download.

**247** Jonathan J Koehler, *Proficiency tests to estimate error rates in the forensic sciences*, 12(1) Law, Probability and Risk (2013), pg 89-98.

independently by third parties.[248] Such tests are essential to regularly check the competency of scientists and are helpful parameters to gauge areas for improvement which should be addressed through training. Proficiency tests should ideally be blind i.e. the scientists should be unaware that they are being tested, and the test should mimic ordinary case exhibits. This would ensure that the results are representative of the scientists' regular performance while processing casework.

Forensic examiners must have the requisite knowledge and skills in scientific and technical aspects, and should be equipped for report writing and providing expert testimony. Quality assurance requires that experts are adequately trained in all aspects of casework. Considering the developments in technology, continuous forensic education should be ensured for all forensic scientists.[249] Further, experts must report their result within the limits of their expertise and should not imply absolute certainty or greater certainty than what is scientifically valid.[250]

**248** The UK FSR, *Code of Conduct and Practice*, Issue 3 (2016) at pg 31 states that to provide consistent, reproducible, valid and reliable results, the staff must demonstrate their competency by participating in inter-laboratory comparisons, including proficiency testing. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/499850/2016_2_11_-_The_Codes_of_Practice_and_Conduct_-_Issue_3.pdf. Similarly, SWGDAM in its *Quality Assurance Standards for Forensic DNA Testing Laboratories* (2020) at pg 34 states that analysts, technical reviewers and technicians that carry out casework examination shall undergo a semi-annual external proficiency testing. https://www.swgdam.org/_files/ugd/4344b0_d73afdd0007c4ed6a0e7e2ffbd6c4eb8.pdf.

**249** See recommendation on improvement of training for new recruits & continuous education of existing employees in Chapter II: Recruitment, Education & Training at pg 120.

**250** William C Thompson et al., *Perceived strength of forensic scientists' reporting statements about source conclusions*, 17(2) Law, Probability and Risk (2018), pg 133. https://academic.oup.com/lpr/article/17/2/133/5032318.

## HOUSTON FORENSIC SCIENCE CENTER: CASE STUDY

*In the early 2000s, the Houston Police Department (HPD) Crime Laboratory came under scrutiny when a broadcasting station reported on the heavy pendency in the DNA/Biology division in the examination of sexual assault kits, with some cases pending for over two decades. It exposed the incorrect reporting on seven DNA/serology cases based on a review from two independent experts. Further, reports of crumbling infrastructure within the division, such as leaky roofs and contamination of biological samples were circulated. This led to a two-day independent audit of the DNA/Serology section of the laboratory.*[251] *It revealed major issues, including unqualified scientific staff, inadequate training programmes on DNA profiling, issues with the SOPs and substandard quality of casework.*[252] *The audit led to the immediate shutdown of the DNA/Serology section. In 2005, a broader investigation into the functioning of the entire HPD Crime Lab was ordered.*[253] *This year-long independent audit involved a review of over 3,500 cases processed across six divisions of the laboratory. Apart from the serious errors in the DNA/Serology section, the audit found fabrication of forensic reports through 'drylabbing'*[254] *in four cases in the collected substances division.*

*Following these revelations, the HPD Crime Lab initiated a series of widespread changes to move away from its troubled past and transform into one of the*

**251** Michael R Bromwich, *Final Report of the Independent Investigator for the Houston Police Department Crime Laboratory and Property Room* (2007) at pg 51 [Houston Crime Lab Audit Report]. http://www.hpdlabinvestigation.org/reports/070613report.pdf; Ralph Blumenthal, *Officials Ignored Houston Lab's Troubles, Report Finds*, New York Times (2005). https://www.nytimes.com/2005/07/01/us/officials-ignored-houston-labs-troubles-report-finds.html.

**252** Houston Crime Lab Audit Report, pg 55-56.

**253** Houston Crime Lab Audit Report, pg 1.

**254** Drylabbing refers to serious malpractice by a forensic examiner of preparing a false report without conducting the necessary examination or analysis.

*leading laboratories to successfully implement quality management in forensic science. In 2014, the laboratory separated from the police department and was revamped as the Houston Forensic Science Center (HFSC). It established a client service/case management division in 2015, to separate task-irrelevant data from case receipts and protect against cognitive bias during forensic examination. HFSC also implemented a blind proficiency testing programme in six divisions, wherein mock evidence samples were introduced in the laboratory's regular casework, without the knowledge of the forensic examiners.*[255] *This enabled an assessment of the analyst's competence, and the calculation of error rates with respect to the division and the testing methods and procedures in operation. The principles of transparency and quality management adopted by the HFSC have been successful in renewing confidence in its forensic services, thereby setting an example for other laboratories to implement similar measures.*

**255** Sandra Guerra Thompson et. al., *Solving Daubert's Dilemma for the Forensic Sciences Through Blind Testing*, 57 Houston Law Review Volume (2020), pg 617-670.

## Accreditation

Accreditation is a process by which an independent institution evaluates the FSL's conformance to set quality standards. It is a certification process that reviews the laboratory's systems and practices, including the validity of test methods, maintenance and calibration of instruments, staff training and proficiency and related documentation.[256] It is pertinent to note that an accreditation status does not imply that the laboratory's examination and functioning is error-free or that it complies with best practices in every case.[257] However, it serves as motivation and guidance for the laboratories to practice good quality management. Adherence to quality standards by a laboratory depends on the scope and rigour of the accreditation scheme.

Accrediting bodies follow norms developed by Standard Development Organisations while accrediting laboratories. These standards may be divided into three levels: level one includes general standards applicable to a wide range of testing laboratories, level two covers standards at the industry level specifically for forensic laboratories, and at level three are standards at the discipline-specific level.[258]

In India, NABL is the national accreditation body, which provides voluntary accreditation services to government and private laboratories based on ISO standards. Currently, there are ten FSLs[259]

**256** ISO 17025:2017 *General requirements for the competence of testing and calibration laboratories* are international standards which have been universally adopted by accrediting bodies to formulate accreditation norms for forensic laboratories.

**257** NAS Report, pg 195.

**258** Sean Doyle, pg 27-42.

**259** As per the NABL website, CBI-CFSL, CFSL Hyderabad, CFSL Shimla, SFSL Chennai, SFSL Gandhinagar, SFSL Shimla, RFSL Dharamshala, RFSL Mandi, RFSL Mangaluru and RFSL Mysuru are currently accredited.

accredited by NABL in accordance with ISO standard 17025:2017.[260] ISO is also developing standards specifically for forensic laboratories, which have been released partly.[261]

The NAS Report had recommended the establishment of standards for mandatory accreditation of forensic science laboratories.[262] While several jurisdictions have opted to make accreditation statutorily mandatory for forensic science laboratories,[263] there is currently no legislative or regulatory requirement in India which requires accreditation of FSLs.[264]

**260** NABL has released assessment forms (NABL 219) and a document review checklist (NABL 220) as per ISO 17025:2017. https://nabl-india.org/nabl/index.php?c=publicaccredationdoc&m=index&docType=both&per_page=50.

**261** ISO Technical Committee 272 has released standards on ISO 21043:2018 Parts 1 and 2 on forensic science and ISO 18385:2016 on minimising risk of DNA contamination. https://www.iso.org/committee/4395817.html.

**262** NAS Report, pg 19.

**263** In the UK, the Accreditation of Forensic Service Providers Regulations 2018 require law enforcement to use accredited forensic services in relation to DNA profiling and fingerprint analysis. https://www.legislation.gov.uk/uksi/2018/1276/made.

**264** The requirement for accreditation was proposed for government and private DNA laboratories in the DNA Profiling (Use & Technology) Bill, 2019. While this is an important measure, accreditation of only DNA divisions in FSLs across India, without considering the existence or operation of quality management systems in the rest of the laboratory, would pose several challenges.

# ERROR DETECTION & COURSE CORRECTION

*Quality management systems are crucial in detecting errors in casework and preventing miscarriages of justice. Unlike research studies where the ground truth is known, or clinical work which relies on feedback from the client/patient to arrive at a diagnosis, forensic work does not have inherent systems to detect errors. Therefore, measures for quality control and quality assurance gain particular significance, since without these systems, crucial errors may go undetected. Some instances of error detection in forensic laboratories in other jurisdictions have been outlined below:*

**Massachusetts drug laboratories, US:** *Between 2017-2018, the Supreme Judicial Court in Massachusetts dismissed over 21,000 and 16,000 drug convictions due to serious misconduct committed by forensic chemists Annie Dookhan and Sonja Farak, respectively.[265] Annie Dookhan worked at the Hinton State Drug Laboratory from 2003 till 2011. Based on a review of documentation relating to Gas chromatography–Mass spectrometry, control samples and other handwritten notes, Annie Dookhan was found guilty of drylabbing and falsifying results, violating the chain of custody and forging her initials on quality control documents.[266] Similarly, Sonja Farak, who worked at the Amherst State Laboratory Institute from 2004 to 2013, was found guilty of stealing methamphetamine drug standards and tampering with evidence samples.[267] Both laboratories were closed after this malfeasance was exposed.*

**265** Office of the Inspector General, *Summary of Methodology for the Investigation of the Drug Laboratory at William A Hinton State Laboratory Institute* 2002-2012 (2021), pg 1 [Summary of OIG Investigation into Hinton State Laboratory Institute]. https://www.mass.gov/doc/summary-of-the-methodology-for-the-investigation-of-the-drug-laboratory-at-the-william-a-hinton-state-laboratory-institute/download.

**266** Office of the Inspector General, *Report on Investigation of the Drug Laboratory at the William A Hinton State Laboratory Institute 2002-2012* (2014), pg 5. https://www.mass.gov/doc/investigation-of-the-drug-laboratory-at-the-william-a-hinton-state-laboratory-institute-2002-0/download.

**267** Summary of OIG Investigation into Hinton State Laboratory Institute, pg 13.

**Randox Testing Services, Manchester, UK:** *In 2017, Randox Testing Services (RTS), a private company accredited by the UK Accreditation Services which conducted forensic examinations of biological samples in criminal casework, detected and reported the manipulation of its quality control data.*[268] *This cast doubts over the accuracy of its examination in drug-driving cases and led to the review of over 10,500 samples. Due to this breach, police suspended all contracts with RTS and the convictions for 40 motorists were cleared.*[269]

**District of Columbia Department of Forensic Sciences, Washington DC, US:** *The Washington DC Crime Laboratory lost accreditation for all its divisions in 2021, following revelations that examiners in its Firearms Unit had falsely matched cartridge casings to a gun in a murder case, which was subsequently suppressed by the laboratory management. After the loss of its accreditation, a forensic consulting firm, SNA International was asked to identify the issues within the functioning of the laboratory and recommend steps towards regaining accreditation.*[270] *Based on a thorough investigation of the laboratory's procedures and documentation, the report found significant non-conformance with ISO 17025:2017 in the Latent Fingerprint and Firearms units and recommended a re-examination of all cases since the inception.*[271]

**268** Randox Testing Services, Update on the Manchester Incident (2018). https://www.randoxtestingservices.com/rts-update-on-the-manchester-incident/.

**269** BBC News, *Randox forensics inquiry: Forty drug-driving offences quashed* (2018). https://www.bbc.com/news/uk-england-manchester-46466710.

**270** *DC Department of Forensic Sciences Laboratory Assessment Report* (2021), pg 1. [DFS Assessment Report]. https://dfs.dc.gov/sites/default/files/dc/sites/dfs/publication/attachments/DFS%20Forensic%20Laboratory%20Assessment%20Report.pdf.

**271** DFS Assessment Report, pg 44, 53.

**Austin Police Department Forensic Science Division, US:** *Following a site inspection by the Texas Forensic Science Commission (TFSC), an investigation into the DNA section of the Austin Police Department's Forensic Science Division was conducted. It highlighted issues regarding standards followed during DNA mixture interpretation, inadequate validation studies, subjectivity in DNA mixture interpretation, contamination events and issues related to leadership and training.*[272] *Consequently, the DNA division was closed due to non-conformity with ISO standards. Thereafter, the University of Pennsylvania's Quattrone Center for the Fair Administration of Justice was requested to conduct a detailed audit of the functioning of the DNA division between 2010 to 2015, to identify the factors that contributed to these quality assurance issues. Based on a thorough documentary review of the DNA division's procedures, correspondence, audit reports, contamination logs and other documents related to the TFSC investigation, the audit report recommended the creation of a new DNA laboratory, independent of the police department.*[273]

**272** TFSC, *Final Audit Report For Austin Police Department Forensic Services Division DNA Section* (2016), pg 12-25. https://static.texastribune.org/media/documents/APD_Audit_Final_report_071116.pdf.

**273** Report of the Quattrone Center for the Fair Administration of Justice, *The Austin Police Department DNA Laboratory, 2010–2015: Looking Back To Move Forward*, pg 99. https://www.austintexas.gov/edims/pio/document.cfm?id=347884.

TRENDS

## TRENDS

27 of the 30 laboratories covered in the survey provided information relating to quality management procedures.[274] Of these, 24 laboratories[275] provided information regarding their use of WPMs. As shown in Graphic 30, 19 laboratories followed the model WPMs published by DFSS for at least some of their divisions, while 12 laboratories used manuals or reference materials such as textbooks published by external bodies. Only six laboratories had formulated their own WPMs for either all or some of their divisions.

**274** SFSL Lucknow, RFSL Agra and RFSL Berhampur did not provide any data on quality management procedures.

**275** SFSL Puducherry and RFSL Thrissur did not provide data on WPMs. SFSL Mangalagiri is excluded as it did not have any functional divisions during the assessment period. However, it has stated that it follows its own WPM and the DFSS manuals for 11 divisions.

**Graphic 30. WPMs used by FSLs in their functional divisions**[276]

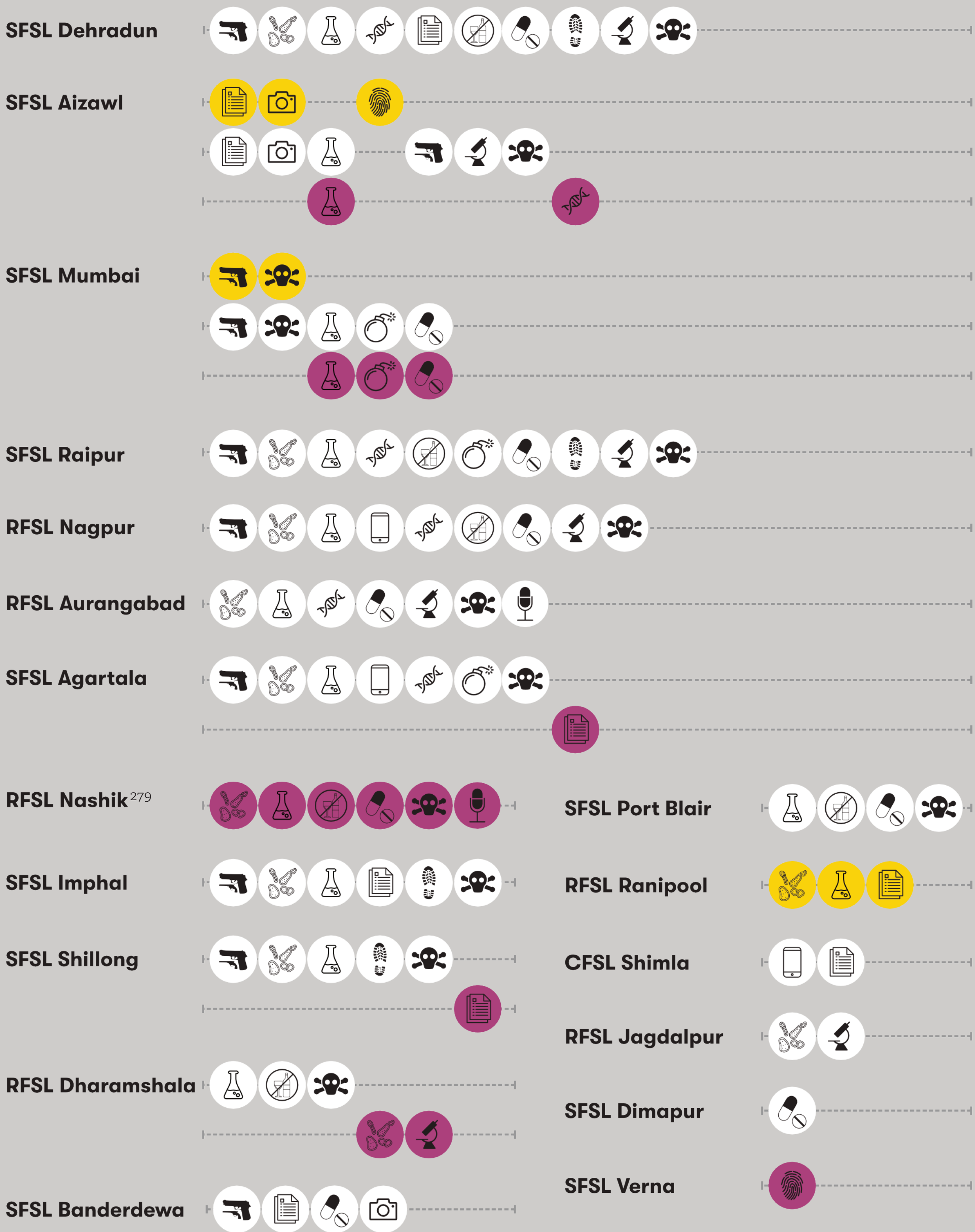
**Divisions using their own manual** | **Divisions using DFSS manual**

**Divisions using external manuals or reference materials**


**276** See Annexure II for the functional divisions in each laboratory at pg 309.

**277** RFSL Pune follows the manuals used by SFSL Mumbai.

**278** SFSL Bhubaneswar reported that they were in the process of drafting their own WPMs for all functional divisions.




**279** RFSL Nashik follows the manuals used by SFSL Mumbai.

21 out of 27 laboratories provided information regarding quality manuals.[280] Of these, only five[281] laboratories had formulated their own quality manuals while 16 laboratories[282] did not have a quality manual.

Only five out of the 30 laboratories[283] are accredited by NABL.[284] During the field visits five laboratories[285] mentioned that they had either applied for accreditation or were striving to upgrade their procedures to apply for it.

Only nine laboratories had participated in internal or external proficiency testing.[286] Of these, five laboratories were NABL-accredited laboratories for whom proficiency testing is mandatory. The remaining four laboratories participated in proficiency testing although they were

**280** SFSL Agartala, SFSL Shillong, SFSL Thiruvananthapuram, SFSL Verna, RFSL Berhampur, RFSL Dharamshala and RFSL Thrissur did not provide information on quality manuals.

**281** CBI-CFSL, CFSL Chandigarh, CFSL Shimla and SFSL Shimla have their own quality manuals. SFSL Mumbai has a quality manual for its Toxicology division. While its Ballistics, Chemistry and DNA Profiling divisions do not have quality manuals, its Physics and Excise divisions did not provide this information.

**282** SFSL Bhubaneswar reported that it was in the process of drafting its quality manual.

**283** Information about the accreditation status of SFSL Lucknow, RFSL Agra and RFSL Berhampur was sourced from the NABL website, as the data was not provided by them.

**284** CBI-CFSL, CFSL Chandigarh, CFSL Shimla, SFSL Shimla and RFSL Dharamshala. As of 2022, there are only ten NABL-accredited FSLs in India.

**285** SFSL Agartala, SFSL Bhubaneswar, SFSL Port Blair, SFSL Shillong and SFSL Verna. SFSL Aizawl and SFSL Raipur stated that they had started but could not complete the accreditation process.

**286** Only 21 out of 27 laboratories have provided information on proficiency testing. SFSL Agartala, SFSL Banderdewa, SFSL Mangalagiri, SFSL Puducherry, SFSL Thiruvananthapuram, SFSL Verna and RFSL Thrissur did not provide information regarding proficiency testing.

not accredited.[287] Besides CFSL Shimla,[288] the other laboratories did not conduct proficiency tests for each of their functional divisions. Twelve of the 27 laboratories had not participated in proficiency testing at all.

Only three laboratories calculate error rates.[289] Of these, CFSL Chandigarh compares results with the external proficiency test provider or nodal laboratory, SFSL Puducherry calculates false positive rates and SFSL Shimla uses a measurement of uncertainty for quantitative analysis. The remaining 17 laboratories do not calculate error rates.[290]

**287** The four non-accredited laboratories provided the following data: SFSL Aizawl participated in proficiency testing through an external proficiency test provider; SFSL Agartala conducts internal proficiency tests; RFSL Pune and SFSL Dehradun participated in interlaboratory proficiency tests, with SFSL Dehradun also conducting internal proficiency testing for its Narcotics division.

**288** CFSL Shimla conducted proficiency tests for both its functional divisions in all years, except in 2016-17 for Cyber Forensics.

**289** 20 out of 27 laboratories provided information regarding calculation of error rates. SFSL Imphal, SFSL Banderdewa, SFSL Mangalagiri, SFSL Thiruvananthapuram, SFSL Verna, RFSL Nashik and RFSL Thrissur did not provide data on error rates.

**290** CBI-CFSL reported zero error rates as its results were based on validated methods and subjected to technical and administrative reviews.

## CHALLENGES

### Lack of quality management systems

There is a lack of understanding about the meaning, components and significance of a quality management system among laboratories. As discussed earlier, quality management requires adherence to standards at the level of the laboratory, the forensic methods and the forensic examiners. To develop these systems, the laboratory must commit significant investment and resources to ensure compliance with quality control and quality assurance systems.

***"If the result is negative then the test is repeated, otherwise there is no review. Looking at negative results is stressed upon. Positive results are not looked at: we can check that by looking at the case history."***

- Assistant Director at an RFSL

However, without the basic facilities, including sufficient space and equipment and adequately trained scientific staff, many laboratories expressed an inability to focus on quality management while grappling with their day-to-day functioning. Some laboratory personnel believed that quality management was a requirement for accreditation alone, and not a part of the regular casework. Given the variance in views over the importance and role of quality management, this critical gap in understanding needs to be addressed.

### Lack of internal validation & WPMs

As described above, internal validation is crucial to test and demonstrate the reliable operation of forensic techniques within the particular setup of each division of a laboratory. Apart from some accredited laboratories, most laboratories do not currently conduct internal validation of testing methods. Some laboratories explained that since the techniques and instrumentation had undergone developmental validation, they did not conduct internal validation.[291] Others stated that internal validation was limited to new technology developed by the laboratory itself.

Further, as shown in Graphic 30, a majority of the laboratories did not have their own WPMs. They either followed DFSS manuals, or manuals and reference materials from other sources. These materials included standard textbooks, which cannot serve the purpose of a WPM. Further, several laboratories stated that they referred to multiple manuals and reference materials within the same division, which raises doubts regarding the standard procedure followed within the laboratory and the basis on which deviations are made.

This depicts a fundamental lack of understanding of the necessary role of WPMs in regulating and standardising casework within each division. Further, procedures and standards set in the WPMs should be based on internal validation studies, which are not conducted. Laboratories also do not have mechanisms for periodic reviews and updates of the existing WPMs.

### Lack of proficiency testing

Most laboratories do not conduct or participate in any proficiency testing measures. A common belief was that considering that the laboratories were not accredited, they were not required to conduct

**291** The UK FSR guidance, *Validation*, Issue 2 (2020) at pg 13-17 explains that the need for validation of forensic methods is independent of the accreditation process. It demonstrates whether the method is fit for purpose and reliable, the evidence for which would be required by court. It also explains that even seemingly established methods may need more experimental work to show that they meet the requirements of a specific laboratory, if the existing (developmental) validation study does not cover all requirements. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/920449/201_-_FSR-G-201_Validation_Guidance_Issue_2.pdf.

proficiency testing. Therefore, very few non-accredited laboratories have participated in any proficiency tests. While some laboratories conduct internal and interlaboratory proficiency testing, such tests are not blind and cannot provide an accurate sense of the examiner's competence in regular casework.

Considering the variance in the recruitment process, concerns with forensic science education and inadequate training in FSLs, the absence of proficiency testing to regularly test the competence of all scientific staff is significant.[292]

### Lack of guidance & resources for accreditation

While many laboratories agreed that accreditation is important to instil confidence in the laboratory's examination and to ensure quality, they expressed the need for support and guidance to move towards accreditation. One of the main reasons cited for the lack of accreditation was the shortage of personnel to plan and work on the accreditation process, without impacting casework. Some laboratories also stated that unless significant changes were made to the existing infrastructure, including the possibility of building a new laboratory, their move towards accreditation would not be possible. Further, some laboratories shared that they had previously begun efforts towards accreditation which were later abandoned due to the exacting demands of the process.

***"There are no plans for accreditation. This building cannot be accredited. If there is a new building, then maybe we can think of it."***

- In-charge of an RFSL while discussing plans for accreditation

**292** See challenges on high variation in recruitment process, concerns with forensic science education and inadequate training programmes in laboratories in Chapter II: Recruitment, Education & Training at pg 108, 112 and 113 respectively.

Without moving towards building a robust quality management system, laboratories will struggle to meet the additional requirements that may come with the accreditation process. Further, training on quality management and accreditation standards must be provided to the laboratory administrators and staff.

## RECOMMENDATIONS

### DFSS consultations towards promoting quality management

To understand the perspectives of laboratories on quality management and the challenges faced by them in implementing it, DFSS in conjunction with NFSU[293] should organise consultations with FSL directors and senior scientific staff within laboratories. These consultations may be organised regionally and should be aimed at building a common understanding of the importance and components of quality management systems. Such consultations should involve a consideration of the quality management regimes in other jurisdictions, with case studies of different laboratories, the operational challenges faced by them and the measures taken to improve their functioning.

Such discussions will reveal specific hurdles faced by the laboratories in complying with quality control and quality assurance standards, and help identify the targeted interventions and support required from the DFSS or the proposed state DFSS[294] to facilitate the move towards quality management. NFSU, through its participation in these consultations, should incorporate the understanding of quality management into its curricula for forensic science courses.[295]

### Preparation of a Quality Management Action Plan

Based on these consultations, DFSS should design a staggered Action Plan for quality management. The plan should lay out the phased

**293** See recommendation on the creation of FSR in Chapter VIII: Overall Recommendations at pg 270.

**294** See section on recommendation for state DFSS in Chapter VIII: Overall Recommendations at pg 266.

**295** See Table 5 on recommendations relating to Recruitment, Education & Training in Chapter VIII: Overall Recommendations at pg 276.

implementation of the different aspects of quality management in every laboratory, starting from the most fundamental components. It should provide the minimum funds, resources, training and support necessary for laboratories to fulfil the requirements for each phase. The Action Plan should propose timelines for the completion of each phase, which should be defined for each state, in consultation with the proposed state DFSS and the laboratories. It should also ensure mechanisms for troubleshooting, such that any obstacles in the completion of any phase can be reported and addressed promptly.

This document would provide guidance to the laboratories and the state DFSS on moving towards quality management. As part of the implementation, laboratories should begin by building the internal capacity of their staff in understanding quality standards and the measures necessary for ensuring compliance.

### Development of WPMs

Laboratories must move towards time-bound preparation of their own WPMs, based on the existing technology available within the laboratory and supported by internal validation studies. DFSS and the proposed FSR should provide necessary guidance to the laboratories in designing internal validation studies.

For guidance on drafting WPMs, the model WPMs prepared by expert groups constituted by DFSS should be widely circulated amongst SFSLs and RFSLs. In the case of forensic disciplines for which model WPMs are unavailable, such WPMs should be prepared by DFSS or the proposed FSR. Further, the proposed state DFSS should ensure that laboratories within their jurisdictions periodically review and update their WPMs. This will ensure that the manuals are revised based on the changes in the techniques and instrumentation employed within the laboratory, or to reflect the necessary advancements in scientific research.

### Support for accreditation

The process of accreditation requires additional resources in terms of financial support, personnel and training. As laboratories make progress on the quality management action plan proposed above, they must strategise to move towards accreditation. The proposed state DFSS must ensure that laboratories have sufficient guidance throughout the accreditation process to understand the application procedure and its requirements. Consultations with accredited FSLs, the proposed FSR and NABL assessors may be organised towards providing such guidance.

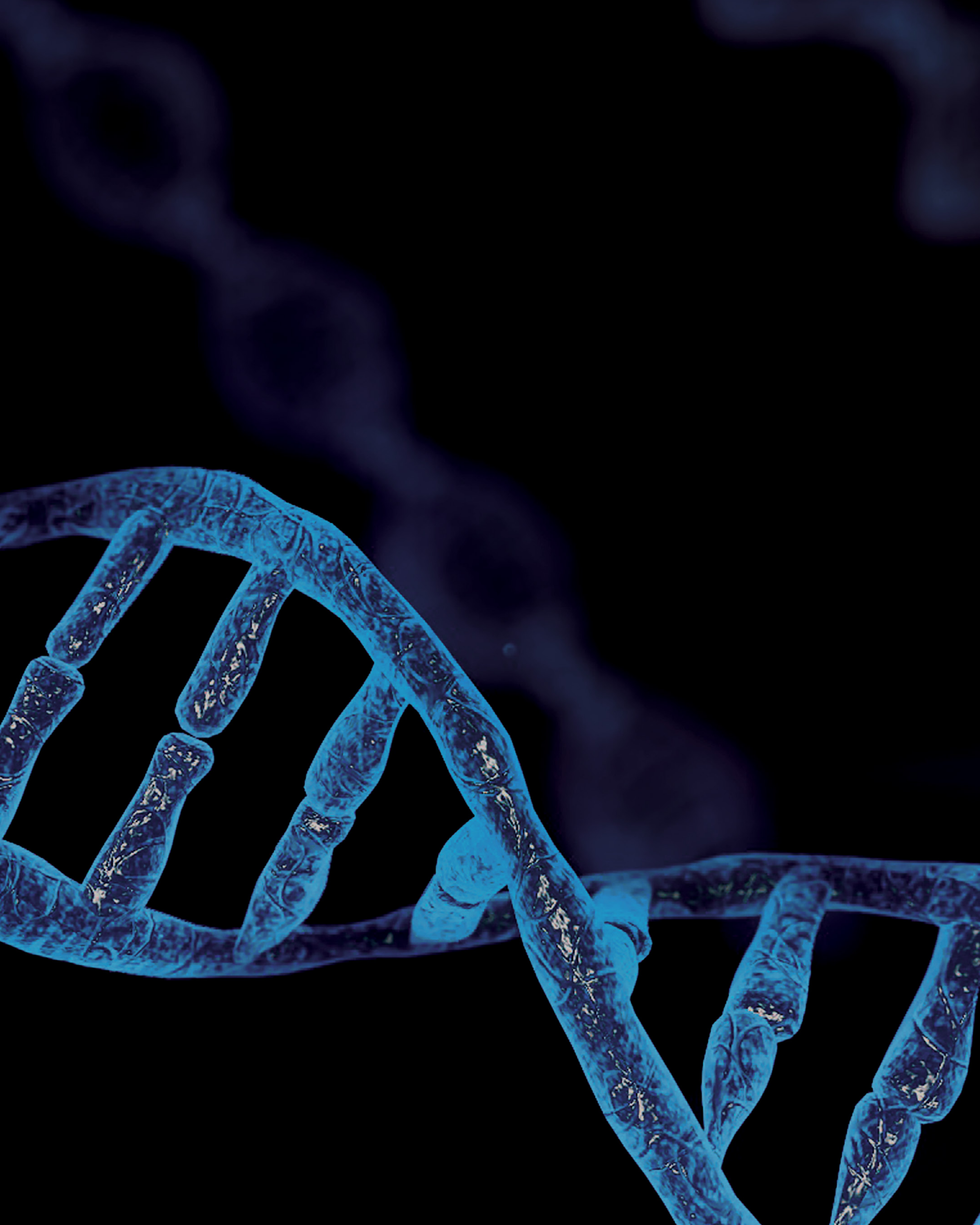
***"FSL is trying to start working on NABL accreditation for a year. However, we are unable to follow it up perfectly. Accreditation is important. The public should trust the FSL. In fact, the courts are also becoming conscious with respect to the FSL and its functioning."***

\- In-charge of an SFSL

Eventually, the push towards formalising quality management will only be successful when accreditation is mandated by legislation or regulation.[296] Several laboratories agreed that mandatory accreditation would improve the functioning of FSLs and ensure that they receive the necessary funds and resources for accreditation. However, such a statutory or regulatory mandate must be grounded in the current realities of the forensic system. It should provide flexibility in the implementation timeline, based on reported progress and challenges in building a quality management system.

**296** The NIJ Report at pg 66 makes a similar observation, that some forensic agencies may not feel that accreditation is the highest priority or a reasonable investment unless it is made mandatory or incentivised. Securing funding for accreditation can be challenging, and some agencies may not want to divert time and workforce efforts from casework.

# 6 FORENSIC DNA PROFILING IN INDIA



# INTRODUCTION

Forensic DNA profiling is a scientific technique which involves the analysis of DNA found in biological material and its comparison with reference DNA profiles, towards ascertaining the identity of the person or determining kinship.[297] It is one the most advanced forensic disciplines, whose roots lie in decades of research on life sciences and the later exploration of their forensic application.[298] Unlike the assumption underlying fingerprint analysis i.e. the fingerprints of every individual are unique, which does not have any scientific basis,[299] DNA profiling can provide a statistical basis for understanding the significance of a 'match' between two DNA profiles.

Following the advancements in DNA profiling technology and the legislative changes towards introducing DNA evidence in sexual violence cases,[300] the use of DNA profiling has significantly grown in India. Considering this trend and to explore the scientific review of protocols and practices in a particular division, Part B of the survey focussed on the DNA profiling divisions within the laboratories. Fifteen out of 29[301] laboratories, comprising two CFSLs, nine SFSLs and four RFSLs, had functional DNA profiling divisions.[302] As discussed in Chapter III on Case Management, DNA profiling is one of the divisions that has seen a continuous increase in

**297** See Annexure I: Primer on Forensic DNA Profiling at pg 287.

**298** NAS Report, pg 40-41.

**299** AAAS Report on Latent Fingerprint Examination, pg 23.

**300** See section on law on DNA profiling in India in Chapter VII: Law on Expert Evidence at pg 255.

**301** SFSL Mangalagiri is excluded as it was not functional during the assessment period and information regarding its divisions is unavailable.

**302** CBI-CFSL, CFSL Chandigarh, SFSL Agartala, SFSL Aizawl, SFSL Bhubaneswar, SFSL Dehradun, SFSL Lucknow, SFSL Mumbai, SFSL Raipur, SFSL Shimla, SFSL Thiruvananthapuram, RFSL Aurangabad, RFSL Nagpur, RFSL Nashik and RFSL Pune had functional DNA divisions. See Annexure II for a list of functional divisions in each FSL at pg 309.

the number of cases received across the assessment period.[303]

This chapter seeks to present a scientific review of DNA profiling practices, in order to provide a model for similar audits of other forensic disciplines. It highlights the issues underlying the scientific practice of DNA profiling in the FSLs, even as issues with the judicial treatment of DNA evidence are discussed in Chapter VII on Law on Expert Evidence.[304] To understand the technical aspects of forensic DNA profiling in this chapter, a primer on the basic concepts and common issues in forensic DNA profiling is available as Annexure I.

**303** See Graphic 16 on continuous increase in cases received by the Cyber Forensics & DNA Profiling divisions in Chapter III: Case Management at pg 135.

**304** See section on law on DNA profiling in India in Chapter VII: Law on Expert Evidence at pg 255.

TRENDS

## TRENDS

As explained in Chapter V on Quality Management, it is essential to ensure the validity and reliability of protocols and methods followed in every division.[305] The development of WPMs is an essential measure towards this, so that internally validated procedures are documented and consistently applied in casework. In an attempt to review the protocols and practices followed within DNA divisions in light of established scientific literature, this section briefly discusses the standards followed by the 15 laboratories with DNA divisions which participated in the survey.[306] This is not an exhaustive review of and may not represent the standards followed by DNA divisions in other laboratories.

### Methods of DNA profiling

As part of the survey, information regarding types of DNA profiling and the procedures and kits used during different stages of the DNA profiling process was necessary. This information was sought as there are various methods to examine different portions of an individual's DNA. The types of DNA profiling vary in their applications in forensic casework.[307] All 15 laboratories conduct Short Tandem Repeats (STR) and Y-STR DNA profiling. Apart from this, 11 laboratories conducted mini-STR examinations,[308] three laboratories had facilities for X-STR profiling,[309] and no laboratory was conducting mitochondrial DNA

305 See section on quality management in forensic methods in Chapter V: Quality Management at pg 194.

306 For an introduction to procedures during DNA profiling, see Annexure I: Primer on DNA Profiling at pg 287.

307 See section on the different types of DNA profiling in Annexure I: Primer on DNA Profiling at pg 291.

308 SFSL Agartala, SFSL Aizawl, SFSL Shimla, and SFSL Thiruvananthapuram do not conduct mini-STR examinations.

309 CFSL Chandigarh, SFSL Shimla and SFSL Thiruvananthapuram conduct X-STR analysis.

profiling during the survey.[310] Two laboratories reported that they had the capacity to conduct low-copy DNA typing.[311]

One of the major advancements in forensic DNA profiling has been the development of commercially available kits to effectively streamline the process. As per the information provided, two laboratories used only organic extraction methods for DNA extraction, while most laboratories used different kinds of extraction kits.[312] Similarly, for DNA quantitation, three laboratories exclusively followed the yield gel method, while other laboratories used real-time quantitative PCR analysis using quantification kits.[313] For the amplification and electrophoresis steps, laboratories used different kinds of kits which varied based on the method of DNA typing and the extent of DNA examined. Kits manufactured by ThermoFisher Scientific Applied Biosystems were the most widely used, followed by Promega and Qiagen. GeneMapper software by ThermoFisher Scientific Applied Biosystems was used by all laboratories for the interpretation of the DNA profiling data.[314] However, only RFSL Pune reported using a probabilistic genotyping software, STRmix for DNA mixture interpretation.[315]

**310** During the field visit, SFSL Shimla reported that they were planning to start mitochondrial DNA analysis.

**311** CFSL Chandigarh and RFSL Pune reported that they conduct low copy DNA typing.

**312** SFSL Agartala and SFSL Raipur use organic extraction methods in DNA profiling. As discussed by John Butler in *Advanced Topics in Forensic DNA Typing: Methodology*, Elsevier Inc (2011) at pg 32, the organic extraction method works well on biological samples with high quantities of DNA but is "time-consuming, involves the use of hazardous chemicals, and requires the sample to be transferred between multiple tubes, which increases the risk of error or contamination." [John Butler: Methodology]

**313** SFSL Agartala, SFSL Aizawl and SFSL Shimla use the yield gel method for DNA quantitation. As discussed by John Butler: Methodology at pg 52, yield gel methods have lower sensitivity and may consume more quantities of DNA. Additionally, such methods may give falsely high signals due to the presence of non-DNA materials left over after the extraction.

**314** SFSL Shimla also reported using software by GeneProof for DNA interpretation.

**315** SFSL Thiruvananthapuram did not provide information on use of software for mixture interpretation. NIST in its scientific foundation review on DNA Mixture

### WPMs for DNA profiling

Of the 15 laboratories with functional DNA divisions, only three laboratories had developed their own WPMs for DNA profiling.[316] As the standards and protocols set in a WPM should be based on internal validation studies, this raises the question of whether the reliability of DNA profiling procedures followed by the other 12 laboratories has been tested within their laboratory setups and conditions. This is also important as the DNA kits used during the different stages of the DNA profiling process specify standards that should be set based on validation studies conducted by the laboratory.[317]

### Standards for DNA profiling

Each laboratory was asked whether it had a set limit of detection (LoD) of DNA below which it does not conduct STR analysis. Setting the LoD is crucial to ensure that a sufficient quantity of DNA is available to reliably conduct the DNA examination.[318] Only seven[319] laboratories had a defined LoD, while the remaining eight laboratories did not have a fixed LoD.

Interpretation at pg 34-35 finds that probabilistic genotyping softwares are more effective in interpreting DNA mixtures as it covers a wider range of possible genotypes and provides an estimate of the statistical strength of the evidence [NIST Review of DNA Mixture Interpretation]. https://nvlpubs.nist.gov/nistpubs/ir/2021/NIST.IR.8351-draft.pdf.

**316** CBI-CFSL, CFSL Chandigarh and SFSL Shimla have formulated their own WPMs for DNA profiling. Information regarding WPMs is unavailable for SFSL Lucknow.

**317** Kits for the different steps in DNA profiling require validation of the different standards and protocols. As explained in John Butler: Methodology at pg 186, validation studies should be conducted to “demonstrate that DNA typing results can be consistently and accurately obtained in the specific laboratory environment.”

**318** See section on how a DNA profile is generated in Annexure I: Primer of Forensic DNA Profiling at pg 293.

**319** CFSL Chandigarh, SFSL Agartala, SFSL Bhubaneswar, SFSL Lucknow, SFSL Raipur, SFSL Thiruvananthapuram and RFSL Pune have defined an LoD.

The laboratories were also asked whether they had a set stochastic threshold (ST) for STR analysis. While interpreting the DNA profile, ST is the standard above which the DNA examiner considers that there has been no loss of DNA.[320] Laboratories must carefully fix their ST based on internal validation studies, as setting the ST level too low or too high has repercussions on the reliability of the DNA interpretation. If the ST level is too low, then instances where the loss of DNA may have occurred, may not be detected and considered for examination. Similarly, if the ST level is too high, then the examiner may have doubts about the reliability of the data.

Ten laboratories have a set ST, out of which eight provided their ST value.[321] Five laboratories had set their ST value as low as 50 Relative Fluorescence Units (RFU), with laboratory's value ranging from 50 RFU to as high as 3000 RFU.[322] Based on the current scientific literature, the ST level of 50 RFU is extremely low and requires examination of the internal validation data.[323] Five laboratories did not have a defined ST.[324]

## Statistical analysis

The process of DNA profiling examines the composition of DNA in specific locations or markers on the DNA, which are known to show high variations across individuals.[325] Hence, there is a possibility that the profiles of two unrelated individuals may match with each other

**320** John Butler, *Advanced Topics in Forensic DNA Typing: Interpretation*, Elsevier Inc (2015), pg 38, 93-94 [John Butler: Interpretation].

**321** CFSL Chandigarh and SFSL Thiruvananthapuram did not provide their ST value.

**322** SFSL Lucknow, SFSL Mumbai, SFSL Shimla and RFSL Aurangabad reported 50 RFU as their ST value while SFSL Bhubaneswar reported a range of 50 RFU - 3000 RFU as the ST value.

**323** John Butler: Interpretation, pg 93-95.

**324** SFSL Agartala, SFSL Aizawl, SFSL Dehradun, SFSL Raipur and RFSL Nagpur did not have a defined ST value.

**325** See section on the meaning of the match in Annexure I: Primer on DNA profiling at pg 298.

at one or all of the tested markers. To explain the possibility of an unrelated individual having the same profile, all DNA results must include a statistical analysis of the DNA match, based on the frequency of the observed DNA profile within the given population. Statistical calculations, such as a random match probability or a likelihood ratio, are conducted to explain the significance of the DNA match and determine its evidentiary value.[326] Therefore, a DNA examination is incomplete without statistical analysis in the case of a DNA match.[327]

Only four of the 15 laboratories conduct statistical analysis as part of DNA examinations.[328] Three out of the four laboratories reported that they conduct statistical analysis based on publicly available population data.[329]

## Quality control measures

One of the important aspects of quality control in DNA examinations is taking steps towards minimising contamination. Contamination refers to the unintentional introduction of foreign DNA into a DNA sample. It can happen either during the process of sample collection, its handling and transport to the laboratory, or within the laboratory, during processing and examination.[330] The possible sources of contamination

**326** John Butler: Interpretation, pg 213-95; SWGDAM, *Interpretation Guidelines for Autosomal STR Typing by Forensic DNA Testing Laboratories* (2021) emphasise at pg 36 that "with any relevant inclusion, statistical calculations are performed following proper interpretation on evidentiary DNA profile to provide an assessment of the significance of an inclusion."

**327** National Research Council, *The Evaluation of Forensic DNA Evidence* (1996) states at pg 192 that "it would not be scientifically justifiable to speak of a match as proof of identity in the absence of underlying data that permit some reasonable estimate of how rare the matching characteristics actually are." https://www.nap.edu/read/5141/chapter/1.

**328** CFSL Chandigarh, SFSL Agartala, SFSL Shimla and SFSL Thiruvananthapuram conduct statistical analysis.

**329** CFSL Chandigarh responded that statistical analysis is carried out on the basis of population studies conducted by the laboratory itself.

**330** UK FSR, *The Control and Avoidance of Contamination in Laboratory Activities* within the laboratory include contamination from the laboratory personnel, through the use of contaminated reagents, equipment or laboratory environment, and cross-contamination between samples.[331]

One of the important measures to minimise cross-contamination between samples is the separate processing of evidence DNA samples, before, during and after the process of amplification.[332] However, SFSL Dehradun and RFSL Aurangabad reported that they do not have separate working areas for processing DNA samples pre- and post-amplification. This raises concerns regarding contamination during DNA examinations and must be taken into account.

Another important measure for quality control is the technical review of casework, as discussed in Chapter V on Quality Management.[333] Such a review covers an evaluation of the notes, data and other laboratory records which form the basis of the forensic examination, to ensure the accuracy of the results and their consistency with the underlying documents.[334] Apart from SFSL Dehradun and SFSL Raipur, all other

*involving DNA Evidence Recovery Analysis* (2020), pg 5 [UK FSR Control & Avoidance of Contamination Guidelines]. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/914268/208_FSR_lab_anti_contam__V2.pdf.

**331** SWGDAM, *Contamination Prevention and Detection Guidelines for Forensic DNA Laboratories* (2017), pg 3 [SWGDAM Contamination Prevention Guidelines]. https://www.swgdam.org/_files/ugd/4344b0_c4d4dbba84f1400a98eaa2e48f2bf291.pdf.

**332** Amplification is the process of making copies of the DNA on specific markers which are being tested as part of forensic DNA profiling. Since the amplified DNA would have a higher concentration of DNA, there is a risk of cross-contamination in case such samples are handled with unamplified DNA. See SWGDAM Contamination Prevention Guidelines at pg 4.

**333** See section on components of quality management in forensic science in Chapter V: Quality Management at pg 193; challenge on absence of technical review in individual casework and recommendation on review of casework in Chapter III: Case Management at pg 150 and 160.

**334** SWGDAM Interpretation Guidelines, pg 3; FBI Laboratory, *Manual on DNA case files, reports and reviews* (2022), pg 7-8. https://fbilabqsd.fbi.gov/file-repository/

laboratories reported that all cases underwent a review before the final report was furnished. Three laboratories shared information regarding the review process, out of which CBI-CFSL and SFSL Bhubaneswar stated that their DNA reports are reviewed twice before finalisation while SFSL Aizawl stated that the cases undergo as many rounds of review 'as required'.

dna/casework/bio-500-00-dna-case-files-reports-and-reviews.pdf/view.

## CHALLENGES

### Absence of contamination control protocols

Given the susceptibility of DNA samples to contamination, it is crucial to follow strict protocols for minimising contamination. Contamination can occur either directly from the source of the contaminant DNA to the DNA sample or indirectly through secondary and tertiary transfer involving different surfaces.[335] The fieldwork indicates that there is an absence of sufficient contamination control guidelines within the laboratories, including the use of PPE kits, gowns and hair nets, protocols for changing protective gear during an examination, separate processing of evidence and reference samples and restriction of access to only authorised staff.[336]

As discussed in Chapter IV on Infrastructure, the shortage of space to delineate areas for the different parts of the scientific process, have separate workspaces for non-scientific tasks and have adequate storage facilities for examined and non-examined cases, pose a high risk of contamination within laboratories.[337] Another important measure for contamination detection that is currently absent is the maintenance of a staff elimination database, containing the DNA profiles of the laboratory personnel that are likely to come in contact with DNA samples. In case of suspected contamination events, such databases are crucial in ascertaining the source of contamination and taking corrective measures.[338]

**335** SWGDAM Contamination Prevention Guidelines, pg 3; see section on what DNA transfer is in Annexure I: Primer on DNA Profiling at pg 301.

**336** SWGDAM Contamination Prevention Guidelines, pg 6-10; SWGDAM, *Quality Assurance Standards for Forensic DNA Testing Laboratories* (2020) say at pg 21 that a laboratory should have secure, controlled access to evidence storage with a documented evidence control programme to ensure the integrity of the evidence. https://www.swgdam.org/_files/ugd/4344b0_d73afdd0007c4ed6a0e7e2ffbd6c4eb8.pdf. See challenge on lack of security in Chapter IV: Infrastructure at pg 184.

**337** See inset on shortage of space in Chapter IV: Infrastructure at pg 181.

**338** SWGDAM Contamination Prevention Guidelines, pg 18; FSR Control &

CHALLENGES

### Absence of internal validation for DNA profiling

From the standards for DNA profiling reported by laboratories, the lack of internal validation of procedures was evident. Without such validation studies, the thresholds and standards to be followed during the process and interpretation of DNA profiling cannot be determined. All the commercially available kits currently used by the laboratories also require internal validation to be conducted on different aspects of the profiling. Without these validation studies, the reliability of the DNA profiling as conducted within a laboratory cannot be confirmed.[339]

### Lack of protocols for DNA mixture interpretation

While the process of DNA profiling for single-source DNA samples and DNA mixtures is the same, the interpretation of DNA mixtures is known to be inherently more difficult and subjective.[340] The complexity of DNA mixtures may vary based on various factors, including the number of contributors, the quality of the sample and the amount of DNA available, as well as an overlap in certain portions of the DNA profiles.[341] Studies have also highlighted the subjectivity in DNA mixture interpretation and its susceptibility to confirmation bias, which can affect the probative value of DNA evidence.[342]

Avoidance of Contamination Guidelines, pg 37.

**339** SWGDAM, *Validation Guidelines for DNA Analysis Methods* (2016) at pg 9-11 discuss the different aspects of the DNA profiling process that should be tested in validation studies. https://www.swgdam.org/_files/ugd/4344b0_813b241e8944497e99b9c45b163b76bd.pdf.

**340** NIST Review of DNA Mixture Interpretation, pg 23-25.

**341** NIST Review of DNA Mixture Interpretation, pg 32.

**342** Itiel Dror & Greg Hampikian, *Subjectivity and bias in forensic DNA mixture interpretation*, 51(4) Science & Justice (2011), pg 204-208. In this study, 17 DNA examiners reviewed the laboratory casefile of a decided case involving gang-rape by three accused persons. The DNA examiners did not have the extraneous information (i.e. one of the accused persons had provided evidence against the others for a lesser sentence) which was available to the original DNA examiners that conducted the examination. The original examiners concluded that the DNA of the two remaining accused was found

Considering that a majority of criminal cases concerning serious offences involve evidence samples of DNA mixtures, that laboratories must follow valid and reliable protocols for DNA mixture interpretation. Some laboratories acknowledged the inherent challenges in the interpretation of DNA mixtures. Despite that, there is an absence of validated protocols for DNA mixture interpretation within laboratories, which raises doubts about the accuracy and consistency of mixture analyses. There is also a critical gap in the guidelines and best practices to be followed by laboratories while interpreting DNA mixtures. Further, laboratories currently do not use probabilistic genotyping software to interpret DNA mixtures. Instead, they follow binary methods of interpretation which do not cover all possibilities.[343]

### Absence of statistical analysis

A majority of the laboratories do not conduct statistical analysis as part of their DNA casework. One of the reasons cited by laboratories to explain this was the absence of a clear requirement to conduct statistical analysis as per the laboratory's protocols or by the courts.[344] Further, the scientific staff working in the DNA divisions does not have the requisite knowledge and training on conducting such statistical evaluation. Some laboratories also cited the lack of population genetics data for different population subsets to explain their inability to conduct statistical analysis.

in the vaginal sample collected from the victim. However, out of the 17 DNA examiners in the study, only one concurred with the conclusion of the original examiners, while 12 concluded that the suspects were excluded and four found that the results were inconclusive. These findings show the subjectivity in DNA mixture interpretation and its susceptibility to bias.

**343** The binary method of DNA mixture interpretation covers only two possibilities i.e. whether the suspected contributor's DNA is present in the DNA sample or not. However, probabilistic genotyping methods consider more possibilities of the potential DNA profiles in the unknown mixture towards determining whether the suspected contributor's DNA is present and, if so, the strength of support for it based on data. See NIST Review of DNA Mixture Interpretation at pg 154.

**344** See section on law on DNA profiling in India in Chapter VII: Law on Expert Evidence at pg 255.

RECOMMENDATIONS

## RECOMMENDATIONS

### Scientific audit of DNA divisions

Considering the disparity with established scientific and quality assurance standards, a detailed scientific audit of the functional DNA profiling divisions across all FSLs should be conducted as a first step. This audit should be planned and conducted by DFSS in collaboration with NFSU and the proposed FSR, and should involve independent scientific experts in the area of DNA profiling.[345]

This scientific audit will reveal the issues with the technical practice of DNA profiling, and the areas for upgradation within the DNA divisions. It will also assist in making targeted interventions in the laboratories to build capacity of their scientific personnel. Thereafter, each FSL should develop a plan to address the aspects of their DNA profiling practice identified during the audit, which has either not been validated or require further validation. The proposed state DFSS should monitor the progress on these validation studies.

In light of the judicial and legislative push towards the use of DNA evidence and the increasing caseload for DNA divisions, the need to expand DNA profiling capabilities across states is growing. However, it is important to ensure the validity and reliability of the existing practice of DNA profiling in order to provide the right direction for such an expansion.

### Developing practices for contamination control

To ensure the integrity of DNA samples and preserve the evidentiary value of DNA analyses, DFSS along with the proposed FSR should develop anti-contamination guidelines for DNA divisions. Laboratories should

**345** See Table 3 on overall recommendations in Chapter VIII: Overall Recommendations at pg 274.

accordingly revise their WPMs to ensure the adoption of these protocols. These guidelines should focus on measures to prevent contamination as well as detect it, in order to avoid incorrect interpretation and analysis. These guidelines should be developed after a comprehensive study of the existing protocols, best practices and guidelines followed in other jurisdictions.[346] Some important aspects that should be considered while preparing these guidelines are the design and infrastructure of DNA divisions, handling and movement of samples, procedure during DNA profiling and the use of controls, use of protective clothing, preparation of a staff elimination database, routine cleaning and maintenance of reagents and consumables.

### Ensuring statistical analysis in forensic DNA profiling

The lack of statistical analysis is a major gap in the practice of forensic DNA profiling in India. For the scientific and legal legitimacy of forensic DNA results submitted to courts, a statistical evaluation of DNA results should be conducted. Towards this, it is important for the proposed state DFSS and NFSU to provide adequate training to the current scientific staff in all DNA divisions on understanding different statistical models and their application to genetics.

***Courts currently do not ask for statistical evaluation, but in the future this question will be raised as lawyers become more educated about the science. Without statistics, a report is not acceptable. Unlike other countries, we lack population data.***

Joint Director at an SFSL

346 For instance, the SWGDAM Contamination Prevention Guidelines and UK FSR Control & Avoidance of Contamination Guidelines provide crucial guidance on contamination minimisation measures.

Further, an expert group on genetics should be constituted to scientifically review existing research on population genetics studies conducted on Indian sub-groups and South Asian populations. Based on this analysis, indices for allelic frequencies should be prepared, which should be validated by the expert group for both binary and probabilistic genotyping models. This data should be disseminated to all FSLs for use in statistical analyses. Resources should also be allocated for government-funded research projects by premier scientific research organisations or institutions to conduct population genetic studies in collaboration with NFSU. This would ensure a more representative dataset of population frequencies covering various Indian sub-groups, which may be used by FSLs for conducting statistical analysis.

# 7 LAW ON EXPERT EVIDENCE

This chapter discusses the law of expert evidence in India and its interaction with the forensic science landscape. It analyses the scope of existing legal enquiry on expert evidence and explores its link with the state of the administration and functioning of FSLs, as discussed in the previous chapters. It identifies the existing gaps in the judicial standards and legal practice relating to expert evidence, which impact the consideration of only valid and reliable forensic evidence. Lastly, the chapter traces the operation of the current legal standards on expert evidence within the law on DNA profiling in India and explores its impact on forensic practice.

## INTERSECTION OF LAW & SCIENCE

The NAS Report describes science and law as having an "uneasy alliance."[347] While the law considers normative principles on how society should function when resolving disputes, science, the report points out, focuses on understanding what the universe is, rather than how it should be.[348] Despite these fundamental differences in the pursuit of 'truth', science can offer crucial inputs on questions of fact within a legal enquiry. In this process, the law relies on the accuracy and precision of scientific findings to inform its judgement. This explains the need for forensic science to be practised in a valid and reliable manner, as well as for the law to test these aspects before forming its conclusions.

Given the finality prescribed within the legal process, the empirical basis for the forensic discipline, its inherent limitations and the potential for error must be considered by law. To test forensic evidence, the law must embrace the principles of scientific enquiry and develop clear legal standards for the examination of expert scientific evidence. Considering the perpetual revision within science, the law must adapt and should not be bound by judicial precedent in determining questions of the

**347** NAS Report, pg 86.

**348** The NAS Report at pg 86 quotes from *Developments in the law—confronting the new challenges of scientific evidence*, 108 Harvard Law Review (1995), pg 1481, 1484.

admissibility and weight of forensic evidence. The focus should be on assessing the reliability of forensic evidence and ensuring that the law develops in correspondence with scientific advancements, rather than on maintaining consistency in the law.

Emerging research, reviewing the assumptions and scientific foundations of different forensic disciplines, points to the need to continuously update the manner in which forensic evidence is appreciated. Scientific reviews have highlighted the limitations in disciplines that are based on analytical testing in laboratories as well as pattern-matching disciplines based on the observational skills and interpretation of experts.[349] This research has even resulted in the foundational validity of some disciplines being doubted or disproved.[350] Although this research may emerge from premier institutions and bodies in other jurisdictions, the nature of scientific truth is such that it transcends jurisdictional boundaries. Therefore, the Indian forensic and legal systems should also evolve based on such scientific developments.

**349** NAS Report, pg 6-8.

**350** The NIST *Draft Report of Bitemark Analysis: A NIST Scientific Foundation Review* (2022) finds that the assumptions underlying bitemark analysis are not supported by any empirical data [NIST Review of Bitemark Analysis]. https://nvlpubs.nist.gov/nistpubs/ir/2022/NIST.IR.8352-draft.pdf. Similarly, the PCAST Report at pg 121 discusses that there is insufficient research on microscopic hair analysis to determine its accuracy, with a 2002 FBI study showing a false positive error rate of 11%. With respect to brain mapping, narco-analysis and polygraph, Jinee Lokaneeta in *The Truth Machines: Policing, Violence, and Scientific Interrogations in India*, Orient BlackSwan (2020) discusses the lack of scientific evidence underlying these disciplines. She cites the report of the Nagaraja Committee convened by the MHA, which concluded that brain mapping techniques have a "suboptimal scientific basis" to be used as evidence. The book also documents the unreliable and unlawful practices that sustain the practice of these disciplines in India.

***Lawyers should know the limitations of science. 100% perfect science does not exist.***

- Director of an SFSL

Finally, the movement towards the use of valid and reliable forensic science requires a cultural shift within the legal practice relating to expert scientific evidence. The appreciation of forensic evidence tests the abilities of judges and lawyers, who may often lack the expertise to comprehend and assess such evidence. Therefore, legal professionals need to develop a working understanding of the principles underlying different forensic disciplines and their limitations. Without embracing a scientific method of enquiry while evaluating forensic evidence, the evolution of the legal framework in line with scientific truth would be impossible.

## UNDERSTANDING THE LAW OF EXPERT EVIDENCE IN INDIA

During a trial, a report by an FSL on the examination of forensic evidence may be submitted by the police as part of the final report or chargesheet filed upon completion of its investigation or after the commencement of the trial. Section 45 of the Indian Evidence Act, 1872 (IEA) guides the court's examination of expert evidence in any criminal or civil proceeding.[351] This section elaborates on the ingredients of Section 45 IEA and the limitations of the provision.

### Who is an expert?

Like in other common law jurisdictions, there is a general rule against opinion evidence in the evidence law framework in India. However, expert evidence is one of the most notable and important exceptions to this rule. Section 45 IEA allows for the reliance on the opinions of experts in a diverse range of specialised areas, in which the court would not have the necessary knowledge or skills. In such a situation, the section envisages that the expert's opinion may assist the court in answering the questions of fact before it and in arriving at its conclusion. While the text of Section 45 IEA only considers 'special skills' as the criterion for determining an expert, the judicial interpretation of the section has expanded it to include necessary knowledge, qualifications and experience. In its landmark decision on expert evidence in India, in *State of Himachal Pradesh v. Jai Lal*,[352] the Supreme Court held that for a person

**351** Section 45 IEA states: "Opinions of experts –– When the Court has to form an opinion upon a point of foreign law or of science, or art, or as to identity of handwriting, or finger impressions, the opinions upon that point of persons specially skilled in such foreign law, science or art, or in questions as to identity of handwriting or finger impressions are relevant facts. Such persons are called experts."

**352** Criminal Appeal No. 530 of 1997, Supreme Court, dated 13.09.1999 [*Jai Lal*]. In this case, the Supreme Court was examining the evidence presented by the prosecution expert, a District Horticulture Officer, on his opinion on the fruit-bearing capacity of apple orchards afflicted by a disease. The accused persons were charged with corruption and criminal conspiracy for inflating the quantities of apples borne by such orchards.

to qualify as an expert in the subject at hand, it must be shown that "he has made a special study of the subject or acquired special experience therein or in other words he is skilled and has adequate knowledge of the subject".[353]

Considering the technical and varied nature of forensic science, a forensic examiner who conducts an examination and prepares a report must be qualified and skilled in that specific discipline. Further, given the various kinds of methods and techniques that may be used within a division and the variation in their complexities, it is important to consider whether the expert has the necessary experience in that type of examination.

However, variations in recruitment qualifications, inadequate training programmes in laboratories and the unregulated nature of forensic science education raise concerns about the level of expertise of forensic examiners.[354] The rotation of scientific staff between different divisions, irrespective of their qualifications or professional experience, also gives rise to concerns regarding compliance with the requirements under Section 45 IEA. Despite these issues, courts often do not consider the qualifications of forensic examiners from FSLs. In contrast to the rigorous enquiry into the qualifications of the expert conducted in *Jai Lal*, the reports by scientific officers covered within Section 293 CrPC are admitted as evidence without their deposition, leading to the loss of an opportunity to examine the forensic examiner's expertise.[355]

The Court found that the prosecution expert did not show "any scientific study or research in assessing the productivity of apple trees in Himachal Pradesh" that he had conducted. While the prosecution expert was an officer of the government horticulture department, that was not held to be sufficient to make him an expert in the present case.

**353** *Jai Lal*, para 13, 17.

**354** See challenges on high variance in the recruitment process, concerns with forensic science education & profession and inadequate training in the laboratories in Chapter II: Recruitment, Education & Training at pg 108, 112 and 113.

**355** See section on procedural law on examination of experts at pg 253.

### What are the requirements of expert scientific evidence?

With relation to expert scientific evidence, the Supreme Court in *Jai Lal* has held that expert opinion should provide the "necessary scientific criteria for testing the accuracy of the conclusions so as to enable the judge to form his independent judgement." It further held that the "scientific opinion evidence, if intelligible, convincing and tested", is an important factor for consideration.[356] In *Ramesh Chandra Agrawal v. Regency Hospital Pvt. Ltd.*, the Court held that expert scientific opinion should be in "a recognised field of expertise" and must be based on "reliable principles."[357] Subsequently, in *Machindra v. Sajjan Galfa Rankhamb*, the Court restated that the expert's opinion should be "demonstrative" and supported by "convincing reasons". It held that an expert's opinion has no value if it is "slipshod, inadequate or cryptic and information on similarities or dissimilarities is not available in the report of an expert."[358]

Despite emphasising the importance of the intelligible, convincing and reliable nature of expert scientific opinions, these decisions do not create a cogent framework to determine what constitutes 'science' under Section 45 IEA or how such evidence should be examined by trial courts. In the absence of specific criteria, questions regarding the admissibility of forensic evidence are determined based on relevance.[359] This legal indeterminacy may lead a judge to determine

**356** *Jai Lal*, para 18.

**357** Civil Appeal No. 5991 of 2002, Supreme Court, dated 11.09.2009, para 16 [*Ramesh Chandra*]. In this case, the court was considering a medical negligence claim, where the aggrieved patient argued that denial of the relevant medical records had affected his ability to effectively argue his claim before the National Consumer Disputes Redressal Commission.

**358** Criminal Appeal No. 1794 of 2013, Supreme Court, dated 19.04.2017, para 16. In this case, the court was considering the report and testimony of a post-mortem doctor, which did not state the cause of the injuries seen on the deceased. Based on this, the court held that the prosecution had failed to link the alleged weapons to the offence.

**359** Section 136 IEA allows the judge to determine the admissibility of evidence based on relevance.

questions regarding the strength of the expert opinion in a case, based on their own perception of the validity and reliability of the particular forensic discipline. Such a position ignores advancements in science and risks reliance on outdated and unreliable forensic methods. In practice, courts often satisfy the requirement of considering whether the forensic evidence before them constitutes 'science' by placing unguided reliance on scientific textbooks and literature, without any meaningful fact-finding on the current state of the scientific research on it.[360] The lack of clear legal standards also gives rise to arbitrariness in decision-making, with different courts adopting different approaches to examining forensic evidence.[361]

***If lawyers will come prepared to court, forensic scientists would also come prepared. Quality would improve as everyone - society, police, judiciary - wants to know the truth. This can happen only by fine-tuning the process.***

- Director of an SFSL

**360** In *Mukesh & Anr. v. State (NCT of Delhi) & Ors,* Criminal Appeal Nos. 607-608 of 2017, Supreme Court, dated 05.05.2017 [*Mukesh & Anr.*], the Supreme Court at para 237-241 cited literature on bitemark analysis to conclude that it allows for the identification of persons through comparison with suspected such injuries. However, the scientific research on bitemark analysis unequivocally points to the lack of a scientific foundation for such analysis, as there is no evidence of the uniqueness of human dentition. Further, dental patterns are not accurately transferred to human skin consistently nor can they be accurately analysed to include or exclude a person as the source of a bitemark. See NAS Report, pg 176; PCAST Report, pg 87; NIST Review of Bitemark Analysis.

**361** This varied approach may be seen from the opposing views adopted by courts while examining the same kind of forensic evidence. For instance, with respect to forensic DNA profiling, the Supreme Court in *Santosh Kumar Singh v. State through CBI,* Criminal Appeal No. 87 of 2007, Supreme Court, dated 06.10.2010 held at para 71 that DNA profiling was an "exact science". This has subsequently led other courts, such as the High Court of Madhya Pradesh in *In Reference v. Vinod alias Rahul Chouhtha,* Criminal Reference No. 1 of 2018, High Court of Madhya Pradesh, dated 08.08.2018, to accept the

In light of this, clear standards must be developed by courts to examine expert scientific evidence. There is a need for clarity on the factors for examining the foundational validity of 'science' or 'scientific techniques' as well as the standards for determining whether it has been reliably applied in a particular case (i.e. validity as applied).[362] Based on these standards, the Supreme Court should develop practice directions for trial courts to provide guidance on the application of these standards.

### What materials should be provided along with expert evidence?

In *Jai Lal*, the Supreme Court held that the credibility of the expert depends on the "reasons stated in support of his conclusions and the data and materials furnished which form the basis of his conclusions".[363] The Court has consistently held that the "materials and reasons"[364] or "the underlying basis"[365] for the expert opinion should be provided to enable a judge to arrive at an independent opinion. However, as described above, since the standards for examining expert scientific evidence remain unclear, there is a lack of clarity on the scope of the 'data and materials' that should be provided along with the forensic report.

Due to scant engagement on questions of whether a forensic technique is foundationally valid or if it has been reliably applied by the examiner, there is little direction on the documentation that must be

DNA report without independently examining it and point out the failure of the defence to summon the DNA analysts under Section 293 CrPC. In contrast, the Supreme Court in *Rahul and Ors. v. State (NCT of Delhi)*, Criminal Appeal No. 611 of 2022, Supreme Court, dated 07.11.2022 [*Rahul & Ors.*] while dismissing the DNA evidence, emphasized at para 32 the lack of "examination of the underlying basis of the findings in the DNA reports" and "whether the techniques were reliably applied by the expert" by the trial court and the High Court.

**362** See Chapter 4 in the PCAST Report at pg 44 to understand the scientific standards of 'foundational validity' and 'validity as applied' for examining forensic methods.

**363** *Jai Lal*, para 18.

**364** *Pattu Rajan v. State of Tamil Nadu*, Criminal Appeal Nos. 680-681 of 2009, Supreme Court, dated 29.03.2019, para 51.

**365** *Rahul & Ors*, para 32.

submitted along with forensic reports relating to different disciplines. This lack of clarity also creates a divergence in practice across laboratories on the report format, details of the examination and the supporting documentation provided with the reports. This prevents the judge from independently assessing the findings of the report and impacts the right of the other party to the proceeding to meaningfully examine and challenge the forensic evidence. As part of the practice directions for the examination of expert scientific evidence, the Supreme Court should specify the materials that should be provided as part of the forensic reports.[366]

### When should the scientific validity of expert evidence be examined?

In India, the evidentiary stages of determining the admission of evidence and the assessment of its probative value are not clearly defined. Parties can object to the admissibility of any document as it is being submitted before the court. However, in practice, the arguments on the admissibility of evidence are heard by the court at the stage of arguments after both sides have led their evidence. Therefore, the court is aware of the entire body of evidence led on both sides, while determining the question on admissibility. Given the nature of forensic evidence and the probative value that it may hold, the determination of its admissibility at the stage of final arguments may suffer from the effects of confirmation and contextual bias. This approach is in contrast to jury-based systems,

**366** Supreme Court of Victoria, Practice Note No. 2, *Expert Evidence in Criminal Trials* (2014). http://netk.net.au/Forensic/Forensic13.pdf. This note was prepared by a Forensic Evidence Working Group comprising judges, forensic scientists and legal professionals to guide the submission of expert evidence in criminal trials within Victoria, Australia. As stated in the Note, the 'overriding duty' of an expert is to impartially assist the court in providing an objective and unbiased opinion. The Note also identifies the contents that must be included in every expert report, including details of the examinations and tests conducted; the materials, observed facts and assumptions underlying the report and any supporting literature for them; any limitations or uncertainty of the techniques used which impacts its reliability; and any recognised disagreement in the field known to the expert. The Note also provides guidance on access to documents by the other party upon their request.

where the jury plays the role of the fact-finder. In such systems, the admissibility of evidence is decided by the judge in the absence of the jury, and only that evidence is placed before the jury which meets the admissibility requirements.

Therefore, a rigorous enquiry into the strength of forensic evidence is affected due to the absence of a clear stage for examining the admissibility of expert evidence. As part of the practice directions for the examination of expert scientific evidence, the Supreme Court should also specify the stage for determining the admissibility of such evidence.

# ROLE OF COURTS IN FORENSIC SCIENCE ADMINISTRATION

*The Supreme Court and various High Courts often pass directions on matters relating to case pendency, recruitment, equipment and infrastructure within FSLs. Such directions are given either in individual cases where issues relating to the functioning of a particular FSL are raised or as part of public interest litigation (PIL) or suo motu proceedings initiated by the courts themselves.*

*These interventions ought to be understood against the backdrop of the expansive nature of judicial powers. With the advent of PIL in the late 1970s, the role of constitutional courts and their powers has been reimagined. Through PIL, the courts have attempted to fill the vacuum in governance, which has led to a series of landmark decisions in the realm of constitutional law and human rights. However, it has also led to the dilution of the separation of powers and the breakdown of judicial processes.*[367] *This rings true in the context of forensic science too. While the judicial push to seek accountability from the executive about the state of affairs in FSLs is crucial, courts are not positioned to address the deeper structural issues underlying the forensic science system. Courts have widely differed in their approach to fact-finding on the issues within FSLs. Consequently, the directions passed to the respective FSLs and state governments also vary, resulting in a patchwork of judicial policymaking which is unable to drive sustainable change. Some examples of court interventions are discussed below:*

**Supreme Court:** *While taking cognizance of the rising number of sexual offences against children or issues relating to undertrial prisoners, the Supreme Court has considered issues regarding the forensic science system and passed directions to seek status reports on the availability of laboratories in each district for conducting forensic DNA profiling and odontology and the availability of*

**367** Anuj Bhuwania, *Courting the People: Public Interest Litigation in Post-Emergency India*, Cambridge University Press (2017), pg 2.

*SOPs,*[368] *ensure that forensic reports in child sexual violence cases are received without delay*[369] *and seek data on the vacancies across SFSLs and RFSLs in every state, failing which costs would be imposed.*[370]

**Assam**: *Triggered by newspaper reports on the poor state of affairs of forensic laboratories in Assam, the Gauhati High Court appointed a committee in 2016 to review various aspects of the functioning of SFSL Guwahati and RFSL Jorhat and make recommendations to the state government. It affirmed all the recommendations made by the committee and mandated their adoption by the FSLs within six months, with directions to the reconstituted State Forensic Science Development Board to monitor progress.*[371]

**Delhi**: *Following the infamous 2012 December gang rape case in Delhi, the High Court of Delhi initiated a suo motu petition to implement measures aimed at improving women's safety and ensuring effective investigations in cases involving sexual offences. In this ten-year-long ongoing proceeding, the High Court oversaw the establishment of RFSL Chanakyapuri, practices for handling and storage of evidence samples in police evidence rooms, mechanisms for monitoring pendency of cases, procurement of equipment and creation and filling of posts in SFSL Delhi and RFSL Chanakyapuri.*[372]

**Himachal Pradesh**: *The High Court of Himachal Pradesh appointed an amicus curiae to submit a report after an inspection of SFSL Shimla, RFSL Dharamshala and RFSL Mandi. It sought information from the state on pending cases in the FSLs, the number of vacant posts and methods of*

**368** In *Re: Assessment of the Criminal Justice System in Response to Sexual Offences*, SMW (Crl.) No. 4 of 2019, Supreme Court, order dated 18.12.2019.

**369** In *Re: Alarming Rise in the Number of Reported Child Rape Incidents*, SMW (Crl.) No. 1 of 2019, Supreme Court, order dated 25.07.2019.

**370** In *Re: Speedy Trial of Undertrial Prisoners*, WP(s) (Civil) No(s). 749 of 2018, Supreme Court, order dated 29.11.2018.

**371** *XXX v. In Re: The State of Assam and Anr*, PIL No. 35 of 2016, Gauhati High Court, order dated 26.03.2018.

**372** *Court on its Own Motion v. Union of India*, WP No. 7927 of 2012, High Court of Delhi.

*recruitment, details of machines that were lying out of order and the need for additional equipment. Subsequently, the court directed the state Public Service Commission and Staff Selection Commission to prioritise recruitment to the vacant FSL posts in a time-bound manner and the state to procure the required equipment.*[373]

**Jammu & Kashmir**: *In line with the directions of the Supreme Court in Thana Singh v. Central Bureau of Narcotics,*[374] *the Jammu & Kashmir High Court ordered the state to explore the possibility of establishing more FSLs, keeping in mind the rising rate of drug-related cases.*[375]

**Karnataka**: *The High Court of Karnataka issued a series of directions with separate timelines for each of the following aspects, including filling existing vacancies, operationalizing new divisions and more RFSLs, establishing an R&D wing within the SFSL to recommend the creation of new divisions and ensure the development of WPMs and training of personnel, and creating a District Scientific Aid, with scene-of-crime officers in each district. Based on the recommendation of the Karnataka State Legal Services Authority, the court also prescribed a one-month timeline for the submission of reports across divisions, extendable by two months considering the pendency of cases.*[376]

**Kerala**: *While hearing a bail application in a murder case, the High Court of Kerala took notice of the delay by the FSL in submitting its forensic report, due to which the trial could not be completed. It issued notice to the director of the FSL and ordered the state to build the capacity of its forensic system to ensure that the forensic report in every case is filed within three weeks of sample collection.*[377]

**373** *Neha Scott v. State of Himachal Pradesh*, CWP No. 2880 of 2017, High Court of Himachal Pradesh, orders dated 02.03.2022, 09.05.2022 and 03.08.2022.

**374** Criminal Appeal No. 1640 of 2010, Supreme Court, dated 23.01.2013.

**375** *Court on its Own Motion v. State of J&K*, WP PIL No. 5 of 2013, Jammu & Kashmir High Court, order dated 09.07.2014.

**376** *High Court of Karnataka v. State of Karnataka*, WP No. 2739 of 2021, High Court of Karnataka, order dated 13.08.2021.

**377** *Aneeshkutty v. State of Kerala*, Bail Appl. No. 2722 of 2022, High Court of Kerala.

**Manipur**: *As part of a PIL seeking measures to tackle incidents of sexual violence, the High Court of Manipur issued directions regarding the functioning of SFSL Imphal. These included addressing the underutilization of central funding under the Nirbhaya Fund due to bureaucratic delays, repair and procurement of equipment, upgrading the physical infrastructure within the laboratory and filling vacant posts.* [378]

**Odisha**: *In a case involving the rape of a minor, the accused disputed the paternity of the child. While hearing the bail application, the High Court took notice of the delay in submitting the DNA report and sought data on the number of DNA cases received by the SFSL within a month, time taken for such testing, number of personnel engaged for this job and measures for reducing the turnaround time. Based on the suggestions of the SFSL Director, the court ordered the state government to fill the vacancies within the laboratory.*[379]

**Punjab & Haryana**: *The Punjab & Haryana High Court ordered the time-bound establishment of four RFSLs each within the states of Punjab and Haryana. The High Court ordered two laboratories to be established within six months, while the remaining two were to be established within 12 months.*[380]

**Rajasthan**: *The Rajasthan High Court initiated proceedings that have been ongoing for six years, to address the forensic needs within the state, by monitoring the establishment of RFSLs in Bikaner, Ajmer and Bharatpur, mechanisms for addressing the vacancies across FSLs and pendency of casework and directing the procurement of equipment.*[381]

**378** *RK Joysana v. Union of India*, PIL No. 14 of 2017, High Court of Manipur.

**379** *Ganeswar Behera v. State of Odisha and Anr.*, Bail Appl. No. 7569 of 2020, Orissa High Court, order dated 09.08.2021.

**380** *Court on its Own Motion v. State of Punjab and Ors.*, CWP No. 5385 of 2014, Punjab & Haryana High Court, order dated 08.07.2014.

**381** *Suo Motu v. State of Rajasthan and Ors.*, DB CWP No. 3341 of 2014, Rajasthan High Court.

## Procedural law on the examination of experts

Section 293 CrPC allows the submission of a report by a government scientific expert as evidence, without requiring their examination as a witness as part of the trial or proceeding. This exemption from deposing before the court is limited to certain designations of scientific experts employed by the government.[382] The section also allows the government scientific expert to depute another officer to depose before the court, in case they are unable to attend personally.[383] While the section provides discretion to courts to summon and examine such experts, in practice, this is dependent upon an application by the defence explaining why the particular government expert ought to be summoned.

Considering the need to ensure the use of valid and reliable forensic evidence, it is important to reconsider the legality of Section 293 CrPC. Under Section 45 IEA, despite the specialised nature of expert opinion, courts have held they should independently review its accuracy and reliability.[384] Without the benefit of oral examination of the expert, crucial aspects relating to the admissibility of the forensic evidence, such as the foundational validity of the technique, qualifications and experience of the expert in that particular testing method, and whether the process of examination was reliably conducted, cannot be properly scrutinised. Further, it creates an artificial distinction between forensic examiners within the same discipline in the requirement to testify before the court.

This section also inhibits the adversarial process of truth-seeking, which is the underlying basis for all criminal proceedings.[385] As discussed in

**382** See the trend describing the preference among FSLs of having these reporting officers sign all forensic reports in Chapter II: Recruitment, Education & Training at pg 99.

**383** Section 293(3) CrPC.

**384** *Jai Lal*, para 18-19; *Ramesh Chandra*, para 22.

**385** *Melendez-Diaz v. Massachusetts,* 557 US 305 (2009). In this case, the petitioner was convicted for distributing and trafficking cocaine based on the prosecution's evidence of drug analysis reports which were presented at trial, without the drug analyst being

Chapter II on Recruitment, Education & Training, Section 293 CrPC also prompts laboratories to ensure that the designated experts covered under it i.e. reporting officers sign the forensic reports submitted to courts, to avail the exemption. While this practice may be justified by the practical considerations of limiting the time spent away from casework within a laboratory, given the high case intake or difficulties in travelling for court appearances,[386] it impacts the meaningful examination of forensic evidence, which, in turn, ensures the right to a fair trial guaranteed by Article 21 of the Constitution.

presented as a witness. Recognising that forensic evidence was not immune from error or manipulation, the court held that the right of cross-examining an expert is important in order to examine their competence and whether they reliably applied the forensic technique.

**386** See challenge on crime scene & court visits in Chapter III: Case Management at pg 152.

## LAW ON DNA PROFILING IN INDIA

DNA evidence has been relied on in civil and criminal disputes in India since 1991. As discussed in the introductory chapter on the Forensic Science Landscape in India, the 2005 amendment to the CrPC modified Section 53 on the medical examination of accused persons and added Sections 53A and 164A to cover the medical examination of the accused and victim respectively in cases of rape.[387] In order to expand the use of DNA profiling, especially in cases relating to rape, the amendment specified that biological samples collected from accused persons and victims should be sent for DNA examination.

Following these amendments, the significance of DNA profiling has grown considerably. In *Krishan Kumar Malik v. State of Haryana*, the Supreme Court held that after the insertion of Section 53A, it has become 'necessary' for the prosecution to conduct a DNA test in cases relating to rape.[388] A similar reasoning was subsequently adopted in *Rajendra Pralhadrao Wasnik v. State of Maharashtra*,[389] where the court noted that because of Sections 53A and 164A, the absence of DNA evidence in rape cases would lead to "an adverse consequence" for the prosecution's case.

### Factors while examining DNA evidence

*Packaging & chain of custody of items*

Given the possibility of contamination, degradation and manipulation, courts have emphasized the need to ensure the proper packaging and maintenance of the chain of custody of biological samples.[390] Such

**387** See section on legal framework in Forensic Science Landscape in India at pg 43.

**388** Criminal Appeal No. 1252 of 2011, Supreme Court, dated 04.07.2011, para 44.

**389** Review Petitions (Crl.) Nos. 306-307 in Criminal Appeals Nos. 145-46 of 2011, Supreme Court, dated 12.12.2018, para 54.

**390** *Pidathala Satyam Babu v. State of Andhra Pradesh,* Criminal Appeal No. 1518 of 2010, High Court of Andhra Pradesh, dated 31.03.2017, para 90-96. The court disregarded the DNA evidence as there was a discrepancy in the packaging of the vaginal samples and the examiner did not remember the manner in which they were sealed. Therefore, the samples are usually collected either from the crime scene directly, or during the medical examination of the accused or victim or the post-mortem examination of a deceased person. Like other evidence, these samples are often kept in police evidence rooms (malkhanas) before being sent to the FSLs for examination.

Courts have held that such samples should be collected, handled and transported to the FSLs, without any delay, under proper seal, to avoid any tampering or contamination during transit.[391] Further, chain-of-custody documentation, including records relating to the collection of evidence from the crime scene or hospital, police evidence room records and records of forwards to the FSLs, should be properly maintained.[392] To ensure compliance, police officers, medical practitioners and officers and forensic pathologists should be trained in the legal and scientific standards for handling such evidence. Further, government medical hospitals and police evidence rooms should be adequately equipped to ensure the proper handling of evidence.

*Adherence to quality standards in DNA profiling*

The Supreme Court has consistently maintained the need to ensure compliance with quality control and quality assurance standards while evaluating DNA evidence.[393] Yet, the Court has not identified any specific

possibility of manipulation could not be ruled out.

**391** DFSS, *Standard Operating Procedure for Crime Scene Investigation* (2022), Guideline 10: Packing of physical evidence/exhibits [DFSS Crime Scene SOP 2022]. http://dfs.nic.in/pdfs/crime%20scene%20manual%20full_organized.pdf; DFSS Crime Scene Biological Sample Guidelines For IOs, Guideline 9: Preservation, packaging and forwarding of biological evidences.

**392** *Rahul & Ors.*, para 30, 32. One of the issues with the DNA evidence was the possibility of tampering of samples, as they were stored in the police evidence room for 14 days after their collection, before being received by the FSL for examination.

**393** *Pantangi Balarama Venkata Ganesh v. State of Andhra Pradesh*, Criminal Appeal No. 174 of 2004, Supreme Court, dated 23.07.2009, para 41; *Dharam Deo Yadav v. State of Uttar Pradesh*, Criminal Appeal No. 369 of 2006, Supreme Court, dated 11.04.2014, para 36; *Anil v. State of Maharashtra*, Criminal Appeal Nos. 1419-20 of 2012, Supreme Court, dated 20.02.2014, para 18 [*Anil*]; *Mukesh & Anr.*, para 228.

quality standards or the consequences of non-compliance with them on the DNA evidence. This lack of clarity leads to divergence in the application of standards across cases and inhibits proper examination of DNA evidence. While some courts have reiterated the importance of DNA evidence generally or the qualification of the expert to explain their reliance on the DNA report,[394] others have rejected such evidence because they did not examine the underlying basis of the report towards determining if the DNA profiling was conducted reliably.[395]

This indeterminacy is further exacerbated by a lack of clarity on the documents that should be submitted along with DNA reports. To evaluate compliance with quality standards, documents related to the chain of custody of samples, worksheets, bench notes and equipment logs reflecting the procedure followed at each step of DNA profiling, electropherograms (EPGs) and electronic raw data for all samples, controls and allelic ladder should be reviewed.[396] However, Indian case law relating to DNA analysis does not clarify the documents that should be submitted along with the DNA report.

*Statistical analysis*

As explained in Chapter VI on Forensic DNA Profiling in India, in case

**394** *Anil*, para 18-19.

**395** *Rahul & Ors.*, para 32. Another issue considered by the Supreme Court in dismissing the DNA evidence was that neither the trial court nor the High Court had examined the underlying basis of the DNA report or whether the techniques were reliably applied by the expert.

**396** See section on information and documents to be supplied with a DNA report in Annexure I: Primer on Forensic DNA Profiling at pg 305. *Bokolo v. S* [2013] ZASCA 115 (2013) noted at para 18-19 that the weight of the DNA evidence depends on the chain of custody of the evidence, proper functioning of the equipment and machines to produce EPGs, acceptability of the interpretation of the EPGs, probability of the match and other evidence in the case [*Bokolo*]; *State v. Schwartz*, 447 N.W.2d 422 (1989) at pg 427 affirmed the right of the defence to access all data, methodology and actual results of DNA profiling, including population data for calculating statistical analysis; *People v. Gills*, 52 Misc.3d 903 (2016) at pg 908-909 held that since the electronic raw data is subject to interpretation by both the software program and the analyst, it should be produced before the court.

the genotypes detected in the evidence and reference sample match on all tested loci, statistical analysis should be conducted to explain the significance of the match, without which the DNA report would be incomplete. Despite its essential nature, DNA profiling divisions either do not conduct statistical analysis or report them as part of their reports.[397]

An important reason for the widespread lack of statistical evaluation is the absence of clear legal standards requiring such analysis. While in a few cases, courts have held that statistical analysis should be conducted,[398] there is no clarity on the consequences of its absence on the admissibility or probative value of the DNA report.[399] Courts across jurisdictions have held that DNA reports would be inadmissible without proper statistical evaluation, ordering the reversal of convictions or retrials if such

**397** See trend on the lack of statistical analysis in Chapter VI: Forensic DNA Profiling in India at pg 226.

**398** *Premjibhai Bachubhai Khasiya v. State of Gujarat,* Criminal Appeal No. 36 of 2008, Gujarat High Court, dated 16.01.2009, para 24-28. In a case involving rape which was sought to be proved through the paternity of the foetus, the Gujarat High Court noted the absence of statistical analysis of the results and held that a positive DNA report cannot be the sole basis for conviction; *Manoj and Ors. v. State of Madhya Pradesh,* Criminal Appeal Nos. 248-250 of 2015, Supreme Court, dated 20.05.2022, para 146. The Supreme Court noted the absence of statistical analysis and the manner in which the samples were seized, which made them susceptible to contamination, to hold that the DNA report did not have a high probative value. This was affirmed in *Rahul & Ors*. at para 31.

**399** Law Commission of India, *185th Report on Review of the Indian Evidence Act, 1872* (2003), Part IIIA, pg 285-286. While discussing DNA evidence under Section 45 IEA, the commission noted that a DNA match does not mean that the identity has been conclusively proved. Rather, the expert will be able to derive a 'random occurrence ratio' from a database of DNA samples. https://cdnbbsr.s3waas.gov.in/s3ca0daec69b5adc880fb464895726dbdf/uploads/2022/08/2022081076-1.pdf.

reports had been wrongly admitted.[400] In order to accurately weigh the significance of DNA evidence and drive change in laboratory practices, Indian courts should emphasize the need for statistical analysis as a requirement for the admissibility of DNA reports.

**400** *State v. Cauthron*, 120 Wn.2d 879 (1993) at pg 906-909 held that DNA results cannot be admitted without valid probability statistics; *Brim v. State*, 695 So.2d 268 (1997) held that a DNA match would be meaningless without qualitative or quantitative estimates demonstrating the significance of the match and remanded the matter to trial for determination of whether the method for statistical analysis was generally accepted within the scientific community; *R v. Doheny and Adams*, [1997] Cr. App. R. 369 at pg 374-375 held that the scientist should adduce evidence of the DNA comparisons along with the random occurrence ratio and methodology of how the calculations were conducted; The court in *Bokolo* emphasised at para 20-22 that without statistical analysis, a 'match' has little to no probative value, and acquitted the defendant due to the lack of clear evidence on record as to the probability of occurrence of the match.

# 8 OVERALL RECOMMENDATIONS

This chapter draws from thematic recommendations in the Report to propose a regulatory framework for forensic science in India.[401] This overarching structure is aimed at strengthening the foundations of forensic science education, profession and industry, through collaboration and cooperation between existing central and state administrators, autonomous educational and research institutions and proposed statutory bodies.

In proposing these actionable recommendations, we draw from the trends observed across FSLs and the narratives of forensic scientists, towards improving the existing administration and identifying the gaps in governance that should be filled. We have also considered the best practices adopted by other jurisdictions to address similar issues within their forensic science systems. We propose the promulgation of a Forensic Science Regulation Act (FSR Act), under which two new statutory bodies i.e. the Forensic Science Regulator (FSR) and Forensic Council of India (FCOI) should be established. However, until the establishment of these bodies, the roles and responsibilities envisioned for them should be fulfilled by the existing actors within the current forensic science administration.

For ease of reference, all recommendations proposed in the Report have been summarised thematically in seven graphics at the end of this chapter.

**401** See section on current forensic science system in India and Graphic 1 on its organisation in Forensic Science Landscape in India at pg 39 and 41.

## EXISTING BODIES IN FORENSIC ADMINISTRATION

### Directorate of Forensic Science Services

As previously described, DFSS presently oversees the forensic science system in India. According to its Charter, DFSS is responsible for capacity building at the central level and providing technical and financial support to state laboratories.[402] Its wide mandate includes promoting R&D in forensic science, promoting knowledge transfer between national and international forensic institutions and universities, promoting quality management in forensic testing by arranging technical and financial support for the development of forensic standards and uniform SOPs, and formulating plans for capacity-building in forensics.

In pursuance of these objectives, DFSS has taken several initiatives, including the constitution of expert groups to develop guidelines for the collection of biological materials,[403] model WPMs related to different disciplines,[404] a model quality manual,[405] a standard list of equipment for forensic laboratories[406] and guidelines for the calibration of equipment and testing methods.[407] Further, DFSS in conjunction with NFSU organises the all-India Forensic Aptitude and Caliber Test (FACT) as a benchmark to assess the knowledge and skills of forensic science

402 DFSS Charter.

403 DFSS Crime Scene SOP 2022; DFSS Crime Scene Biological Sample Guidelines for IOs; DFSS Medical Examination Guidelines for MOs.

404 The model WPMs prepared by different expert groups for Toxicology, Narcotics, Explosives, Chemistry, DNA Profiling, Biology, Cyber Forensics and Voice Identification are available on the DFSS website. http://dfs.nic.in/downloads.html.

405 DFSS Quality Manual 2021.

406 DFSS Standard Equipment List 2020.

407 DFSS, *Recommended Procedures for Calibration of Test and Measuring Equipment used in Forensic Science Laboratories* (2022). http://dfs.nic.in/pdfs/In%20House%20calibration_Merged-1.pdf.

professionals[408] and designs schemes to promote research in forensics,[409] including the establishment of the Forensic Hackathon.[410] While these measures are meant to improve forensic practice, steps should be taken towards their wide dissemination within the network of FSLs across India and to ensure compliance, in order to drive effective change.

To fulfil the present needs of the forensic science system, DFSS should be expanded to include two separate wings on administration and human resources.[411] The Administration wing would assist laboratories in matters relating to budget and expenditure, infrastructure, procurement of equipment and quality management. The Human Resources wing would cover aspects relating to recruitment, training and proficiency of personnel, continuous forensic education, employee welfare and career progression. Towards establishing these wings, the staffing of DFSS should be increased to include personnel with knowledge and experience in laboratory management, quality assurance, statistics and data analysis.

**408** NFSU, FACT 2022 Exam Registration. https://www.nfsu.ac.in/fact

**409** DFSS, *Extramural/Intramural Research Scheme Book: Financial Assistance to the R&D Projects in Thrust Areas of Forensic Science to Building Capability in Forensic Services*. http://dfs.nic.in/pdfs/EMR_Scheme_Book_DFSS%20R.pdf.

**410** NFSU, Forensic Hackathon 2023 Brochure. https://www.nfsu.ac.in/hackathon

**411** A similar recommendation was made in the Perspective Plan at pg 31, where DFSS would be remodelled as DIFOSER to include three portfolios i.e., Administration & Human Resources, Service & Quality and Training & Research.

DFSS must create a framework for conducting periodic needs assessment surveys of FSLs in India (Table 3).[412] Such surveys must gather information from all divisions within each FSL related to budget and forecast, personnel, training, infrastructure, equipment and quality management within laboratories. The trends and challenges highlighted in such surveys can enable guided interventions to address the issues within each state or laboratory and ensure effective policymaking on forensics.

### State Directorate of Forensic Science Services

As described in Chapter I on Budget & Expenditure,[413] a majority of the SFSLs and RFSLs covered within the survey were under the administrative and financial control of the police department. Consequently, they experienced more cumbersome procedures for approvals, and some even experienced interference with budgetary decisions and casework, leading to doubts over the integrity of their forensic evidence. To ensure impartiality and transparency in forensic work, SFSLs and RFSLs should be independent of state police departments and under a separate State Directorate of Forensic Science Service (SDFSS) within the respective

**412** In the US, a similar provision for needs assessment survey exists in the Justice for All Reauthorisation Act, 2016, where the Department of Justice has been charged with conducting a needs assessment survey of the forensic science community and submitting its report to the US Congress. This survey is conducted by the NIJ and covers areas relating to workload, backlog, personnel, equipment and additional equipment needs of public crime laboratories and medical examiner and coroner offices. https://www.ojp.gov/pdffiles1/nij/253626.pdf. Another survey of public forensic laboratories in the US is conducted by the Bureau of Justice Statistics (BJS), the statistical agency of the Department of Justice. BJS undertakes the Census of Publicly Funded Forensic Crime Laboratories that collects data on staff, budgets, and workloads within publicly funded crime laboratories. https://bjs.ojp.gov/data-collection/census-publicly-funded-forensic-crime-laboratories.

**413** See challenge on lack of independence for laboratories under the police department and recommendation on separating FSLs from police administration in Chapter I: Budget & Expenditure at pg 81 and 87.

home department, headed by a high-ranking scientific officer.[414] The state DFSS should be modelled on the central DFSS and perform similar administrative and human resource functions at the state level. This will reduce the bureaucratic delays with different administrative approvals, provide better financial and technical support to FSLs and enable better coordination between the state laboratories and the central DFSS. Further, at the state level, the state DFSS would monitor compliance with the standards and policies prepared by the central DFSS or the proposed FSR.

Additionally, effective administration of an FSL and adherence to quality management necessitates a strong grasp of the scientific and technical aspects of forensic work undertaken across different divisions. Therefore, laboratory directors or officers-in-charge should only be forensic scientists and not IPS or IAS officers, who may hold multiple portfolios.

### National Forensic Science University (NFSU)

As described in Forensic Science Landscape in India,[415] the Parliament through the National Forensic Sciences University Act, 2020 rechristened GFSU and LNJN NICFS as the National Forensic Science University (NFSU) and deemed it as an Institute of National Importance. Currently, there are six other campuses of NFSU under operation, with plans for further expansion. The University has a wide mandate under Sections 6

**414** Currently, some states such as Himachal Pradesh (https://himachal.nic.in/index.php?lang=1&dpt_id=174) and Rajasthan (https://home.rajasthan.gov.in/content/homeportal/en/stateforensicsciencelaboratorydepartment.html#) have separate directorates for forensic science under the home department, while Maharashtra has a directorate headed by a Director General (IPS) (https://dfsl.maharashtra.gov.in/en).

**415** See section on forensic science education in Forensic Science Landscape in India at pg 42.

and 7 of the Act, which outline the objects and the powers and functions of the University. [416]

Beyond developing capabilities for research, education and training in forensic science, NFSU is tasked with assisting the central and state governments in policymaking, establishing databases for forensic information, accreditation of FSLs and creating SOPs for forensic work and specifications for the forensic equipment and kits to be used across laboratories. As part of its wide mandate, NFSU should assume greater responsibilities relating to surveying the needs of FSLs across India (Table 3), recruitment, education and training (Table 5) and the development of different kinds of standards and policies (Table 6, 7 and 8).

**416** National Forensic Sciences University Act, 2020.https://beta.nfsu.ac.in/Uploads/NFSU%20Act%202020.pdf

## PROPOSED LEGISLATION ON FORENSIC SCIENCE REGULATION IN INDIA

As stated above, the Indian forensic system is in dire need of a robust and effective regulatory system. Although DFSS has a wide mandate, it only has administrative and financial command over the CFSLs and does not exercise any direct control over the SFSLs or RFSLs, which carry out the bulk of forensic examinations in India. Further, in the absence of any legislative authority, DFSS cannot exercise any monitoring powers to enforce compliance with quality standards by laboratories. Therefore, a statutory regulator is necessary to develop and ensure adherence to a code of conduct for forensic laboratories and practitioners.

For instance, the UK enacted the Forensic Science Regulator Act, 2021,[417] after acknowledging that without statutory powers, the FSR cannot ensure that the "science being used in the criminal justice system is being carried out to the required standard."[418] This Act provides powers to the FSR to prepare a code of conduct applicable to private and government forensic bodies and practitioners. The FSR has powers to monitor compliance with the code of conduct,[419] investigate cases of possible violations and prohibit the operator from conducting any forensic science activity until

**417** UK Forensic Science Regulator Act, 2021. https://www.legislation.gov.uk/ukpga/2021/14/introduction.

**418** UK House of Lords, Science and Technology Select Committee, *Forensic science and the criminal justice system: A blueprint for change*, 3rd Report of Session 2017-19, pg 7. This report was prepared based on an inquiry into the forensic science regulatory framework and market in the UK. The inquiry also considered evidence on the scientific evidence base for different forensic techniques and the current state of research within forensics. https://publications.parliament.uk/pa/ld201719/ldselect/ldsctech/333/333.pdf.

**419** A comprehensive draft Code of Conduct was published for public consultation in August 2022. This included the standards of practice applicable to all forensic laboratories and practitioners, definition of forensic science activities covered under the code and discipline-specific rules to be followed. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1096677/Consultation_Response_Guidance_Document_0.5.pdf.

necessary steps are taken. Further, the code of conduct is admissible as evidence in civil and criminal proceedings, and courts can consider any non-compliance as part of such proceedings.

A similar legislation establishing a statutory FSR, with the powers to develop and enforce a code of conduct applicable to all FSLs, should be enacted in India. While a DNA Regulatory Board to monitor all private and government DNA laboratories was proposed as part of the DNA Technology (Use & Application) Regulation Bill, 2019, a fragmented structure for overseeing different forensic disciplines would not be compatible with the existing set-up of FSLs in India. Further, there is no regulatory structure currently for universities and institutions offering forensic education programmes or a professional body for forensic practitioners. Therefore, a Forensic Science Regulation Act (FSR Act) must be enacted, with the aim of establishing a regulatory system for FSLs, forensic education and forensic science practitioners.[420] Under the FSR Act, two separate bodies i.e. a Forensic Science Regulator (FSR) and a Forensic Council of India (FCOI) shall be established for the supervision of different aspects of the forensic science system in India.

### Forensic Science Regulator (FSR)

*Vision:* The FSR shall be the forensic standard-setting and monitoring body for forensic science in India. It shall ensure compliance with the forensic code of conduct for public and private forensic science laboratories and examiners.

*Structure & Composition:* An FSR should be established at the national level, with branches in each state. The FSR shall comprise experienced scientists and independent forensic practitioners with backgrounds

**420** A similar recommendation was made in the Perspective Plan at pg 458: "The Forensic Act proposed here intends to regulate practice of different disciplines, lay down standards for education and training, accredit forensic institutions, prescribe code of conduct for practitioners as well as maintain a registry of certified forensic practitioners."

in different disciplines of forensic science, with representatives from different stakeholder groups i.e. the police, judiciary, prosecution and legal aid bodies.

*Powers & Responsibilities:* Following a process of open consultation, the FSR shall formulate a code of conduct applicable to government-run and private forensic science laboratories or units in India. It shall have the powers to guide laboratories on technical aspects, ensure adherence to the code of conduct, investigate any non-compliance and restrict any laboratory from processing casework until the issues have been resolved to its satisfaction (Table 3). Further, courts shall have the power to take cognizance of any non-conformity with the code and appropriately decide on the admissibility of such evidence.

The FSR shall also establish discipline-specific Scientific Working Groups (SWGs). These SWGs shall be bodies comprising scientists and forensic experts from their respective fields, academia, and legal practitioners. They shall publish best practices and guidelines as per international standards for different aspects of forensic services, with regular meetings for reviewing the same. These documents shall provide guidance to each laboratory in developing and updating its own protocols and WPMs. They shall also assist with the preparation of revised work norms for different disciplines (Table 5).

The FSR, through its state branches, shall oversee mandatory compliance with the FSR's code of conduct by laboratories within each state. Regular scientific audits must be conducted to review compliance with the various standards created by the FSR, provide technical guidance wherever necessary and assist the central or the proposed state DFSS in making targeted resource interventions (Table 3).

## Forensic Council of India (FCOI)

*Vision:* Similar to the Bar Council of India (BCOI)[421] and the National Medical Commission (NMC),[422] FCOI shall regulate forensic science education and forensic practitioners in India.

*Structure & Composition:* Similar to the decentralised structure of BCOI and NMC, FCOI should also be set up at the national level with state branches. The councils should include experts across all forensic disciplines, the Vice Chancellor of NFSU, the Chief Forensic Scientist, the head of the proposed FSR, representatives from the proposed state DFSS, retired judges and eminent legal practitioners.

*Powers & Responsibilities:* In consultation with NFSU, FCOI shall also lay down standards for forensic education in India. Based on these standards, FCOI shall evaluate and approve forensic science courses and institutions. For setting standards for forensic science education, the models adopted by the Forensic Science Education Programs Accreditation Commission (FEPAC)[423] in the United States and the Chartered Society of Forensic Science[424] in the United Kingdom for accreditation of undergraduate and postgraduate forensic science courses may be considered.

**421** Under the Advocates Act, 1961, the Bar Council of India along with State Bar Councils was established to regulate the legal practice and legal education in India. http://www.barcouncilofindia.org/wp-content/uploads/2010/05/Advocates-Act1961.pdf.

**422** Replacing the Medical Council of India, the National Medical Commission Act, 2019 established the National Medical Commission, which along with the State Medical Councils regulates medical institutions, medical practitioners and medical education across the country. https://www.nmc.org.in/nmc-act/

**423** American Academy of Forensic Sciences, FEPAC Accreditation Standards (2021). https://www.aafs.org/sites/default/files/media/documents/2021%200924%20FEPAC%20Standards_0.pdf.

**424** The Chartered Society of Forensic Science, Educational Quality Standards. https://www.csofs.org/quality-standards/educational-standards/.

These standards include requirements for practical knowledge regarding different disciplines and the infrastructural capabilities required within the institution. Similar to the registration of medical colleges with the NMC,[425] the establishment of forensic science institutions or programmes at the undergraduate, postgraduate and diploma level shall require approval from FCOI. This would ensure adherence to FCOI standards for curriculum, teaching methods, and availability of adequate infrastructure and equipment to ensure experiential learning. Regular assessment of the educational programmes should be conducted to ensure compliance with FCOI standards (Table 5).

Further, in collaboration with NFSU, FCOI shall conduct examinations to licence and certify forensic science practitioners in specific disciplines, which shall be a mandatory requirement for their recruitment in an FSL (Table 5).[426] FCOI shall explore methods to assess both theoretical knowledge and practical skills as part of this certification. Therefore, based on their specialisation, only certified forensic practitioners shall be engaged either through direct recruitment or on a contractual basis to work within the respective divisions. A registry of licensed forensic practitioners shall be maintained by the state councils and centrally by FCOI (Table 5). Such certification requirements may be formalised for crime scene examiners as well.

FCOI shall also establish standards for professional conduct and the ethics to be observed by forensic science practitioners. It shall have powers to investigate any complaint and accordingly revoke certification after following due process requirements.

**425** Section 28 (1) of the NMC Act, 2019 mandates that "no person shall establish a new medical college or start any postgraduate course" without obtaining permission from the Medical Assessment and Rating Board.

**426** The NAS Report concluded at pg 215 that "certification of forensic science professionals should be mandatory" and recommended that "certification requirements should include, at a minimum, written examinations, supervised practice, proficiency testing, continuing education, recertification procedures, adherence to a code of ethics, and effective disciplinary procedures."

# OVERALL RECOMMENDATIONS

The recommendations made in this Report have been thematically represented in Table 3 to 9. While some of the recommendations may be executed by a single institution, many require various existing and proposed bodies to work collaboratively towards fulfilling that aim.

**Table 3. Overall Recommendations**

| Recommendation | Body | | | | | | |
|---|---|---|---|---|---|---|---|
| | FSL | DFSS | State DFSS | NFSU | FSR | FCOI | Other |
| Conceptualise regular needs assessment surveys of FSLs through consultations with relevant experts towards identifying:<br>1. Budgetary needs for fund allocation for different heads and guiding financial policy processes in every FSL<br>2. Number of scientific and non-scientific personnel required based on trends related to case receipts and regional crime rates<br>3. Infrastructural needs including additional space, laboratory design and planning, equipment and mobile units | | ✓ | | ✓ | ✓ | | |
| Conduct regular needs assessment surveys of FSLs, identify challenges and potential solutions, and ensure necessary action | | ✓ | ✓ | | | | |
| Make laboratory-wise annual statistics on case intake, examination and pendency in each division publicly available | | ✓ | ✓ | | | | |
| Conduct periodic scientific audits of all FSLs to assess compliance with the FSR's code of conduct, scientific protocols and quality standards | | ✓ | | ✓ | ✓ | | |
| Regularly monitor compliance and identify gaps that require targeted interventions, including internal validation of all techniques, preparation/update of WPMs, and steps towards quality assurance and quality control | | | ✓ | | ✓ | | |

## Table 4. Recommendations related to Budget & Expenditure

| Recommendation | Body | | | | | | |
|---|---|---|---|---|---|---|---|
| | FSL | DFSS | State DFSS | NFSU | FSR | FCOI | Other |
| Hold consultations with state governments for separation of FSLs from police administration | | ✓ | | | | | |
| Ensure consistent and timely disbursal of central and state funds across FSLs at the beginning of each financial year, with earmarked funds for specific budget heads in SFSLs and RFSLs | | ✓ | ✓ | | | | |
| Improve financial powers of FSL directors, especially in RFSLs, by appointment as DDOs; improve coordination with the SFSL to ensure that the needs of the RFSL are reflected in the funds disbursed | | ✓ | ✓ | | | | |
| Financially train senior FSL administration and staff FSLs with financial management personnel for data analysis of forecast, fund receipts and expenditure to assist in better financial planning | | ✓ | ✓ | | | | |

## Table 5. Recommendations related to Recruitment, Education & Training

| Recommendation | Body | | | | | | |
|---|---|---|---|---|---|---|---|
| | FSL | DFSS | State DFSS | NFSU | FSR | FCOI | Other |
| Prepare a National Forensic Recruitment Strategy after consultations with FSLs, concerned officers in state home and police departments, and SPSCs/SSCs; streamline the recruitment process across states by standardising posts, eligibility criteria and recruitment methods for scientific and non-scientific staff at FSLs (including financial management and analysis personnel, case receiving personnel and case data analysts) and CSOs for police | | ✓ | | ✓ | | ✓ | |
| Standardise posts across FSLs and restructure human resources within states in line with the National Forensic Recruitment Strategy | ✓ | | ✓ | | | | |
| Prepare work norms through consultation with SWGs, FSL directors and relevant authorities, based on technological developments, caseload trends and qualifications of personnel | | ✓ | ✓ | | ✓ | | |
| Ensure improvement in working conditions, provision of medical insurance, psychological support and other employee benefits including parity in pay with other government services | ✓ | ✓ | ✓ | | | | |
| Implement Flexible Complementing Scheme in all SFSLs and RFSLs | | ✓ | ✓ | | | | |
| Certify forensic science practitioners through qualifying examinations and maintain a registry of certified forensic science professionals | | | | ✓ | ✓ | ✓ | |
| Conduct a survey of forensic science degree and diploma courses offered by government and private institutions on their curriculum, faculty, infrastructure and employment prospects | | ✓ | | ✓ | | ✓ | |

| Recommendation | Body | | | | | | |
|---|---|---|---|---|---|---|---|
| | FSL | DFSS | State DFSS | NFS U | FSR | FCOI | Other |
| Formulate standards for forensic science programmes at the undergraduate, postgraduate and diploma level, including standards for curriculum, teaching methods, infrastructure and laboratory equipment, to ensure experiential learning | | | | ✓ | | ✓ | |
| Approve forensic science courses and institutions based on such standards | | | | | | ✓ | |
| Conduct technical capacity reviews of existing scientific staff in FSLs and organise discipline-specific practical training programmes for building the technical capacity of forensic examiners, focussing on scientific and legal developments, report drafting and court testimony | | | | ✓ | | | |
| Establish minimum standards for training new recruits for every division within an FSL and audit the training programmes for new recruits in every FSL | | | | ✓ | ✓ | | |
| Establish minimum standards for continuous forensic education (CFE) of scientific staff and curate regular online and offline CFE programmes | | | | ✓ | | ✓ | |
| Prepare curricula for training other stakeholders, facilitate organisation of training programmes and audit them | | | | ✓ | | | Judicial Academies, Police Academies, Bar Councils, Legal Aid Bodies, Prosecution Departments and Law Universities |
| Facilitate research on forensic science through collaboration between domestic and foreign scientific organisations, forensic science universities and students, and scientific staff at FSLs | | | | ✓ | | | Premier Scientific Research Institutions and Forensic Science Universities |

## Table 6. Recommendations related to Case Management

| Recommendation | Body | | | | | | |
|---|---|---|---|---|---|---|---|
| | FSL | DFSS | State DFSS | NFSU | FSR | FCOI | Other |
| Develop standard protocols for case receipt | | ✓ | | | ✓ | | |
| Staff FSLs with personnel trained in case receipt, evaluating chain of custody, context management procedures to remove task-irrelevant information | | ✓ | ✓ | | | | |
| Enforce mandatory technical and administrative review of casework as part of a quality manual and ensure standardised reporting | ✓ | | ✓ | | ✓ | | |
| Develop standard formats for reporting findings and opinions, identifying laboratory documentation to be submitted, and delivering expert testimony in court | | ✓ | | | ✓ | | |
| Develop a digitised and secure case management system like the Laboratory Information Management System (LIMS) | | ✓ | | ✓ | ✓ | | |
| Staff FSLs with personnel trained in case data input and analysis, including a statistician, for computing caseload trends and improving internal management | | ✓ | ✓ | | | | |
| *Improving crime scene management*<br><br>Create and disseminate standardised protocols based on best practices for the collection, handling, storage and transport of all types of forensic evidence | | ✓ | ✓ | | ✓ | | |
| Adequately supply the police and investigative agencies with the necessary protective gear, equipment and kits for evidence collection | | | | | | | Central and State Police Departments |

| Recommendation | Body | | | | | | |
|---|---|---|---|---|---|---|---|
| | FSL | DFSS | State DFSS | NFSU | FSR | FCOI | Other |
| Hold consultations with police officials, forensic scientists and legal practitioners on training requirements for police officials; develop practical training programmes for investigative agencies on evidence collection and crime scene management, and ensure their inclusion in all police academies' curricula | | | ✓ | ✓ | ✓ | | Central and State Police Departments |
| Improve planning and coordination between FSLs and police departments to build an annual training calendar, and audit existing programmes | | | ✓ | ✓ | ✓ | | Central and State Police Departments |
| Ensure recruitment of crime scene officers (CSOs) with a background in forensic science in every police district based on the National Forensic Recruitment Strategy | | | ✓ | ✓ | | | Central and State Police Departments |
| *Improving practice of forensic medicine*<br><br>Conduct a survey of forensic medicine practice in India | | | | | | | MHA and MoHFW |
| Develop standard guidelines/ protocols for post-mortem examination and medical examination in cases other than sexual assault | | | | | ✓ | | MoHFW |
| Design mandatory training programmes based on best practices to train new recruits, existing medical practitioners and support staff in forensic medicine departments, and inject resources to achieve these standards | | | | | ✓ | | MoHFW and State Health Departments |
| Create a code of professionals ethics for the practice of forensic medicine | | | | | | | National Medical Commission, State Medical Councils and Ethics & Medical Registration Board |

## Table 7. Recommendations related to Infrastructure

| Recommendation | Body | | | | | | |
|---|---|---|---|---|---|---|---|
| | FSL | DFSS | State DFSS | NFS U | FSR | FCOI | Other |
| Create minimum infrastructural standards for planning, design and expansion of FSLs, including measures for anti-contamination, health & safety, waste disposal and workflow management | | ✓ | | | ✓ | | NABL |
| Monitor adoption of health & safety protocols by each FSL based on the minimum infrastructural guidelines and regularly audit FSLs for compliance | | ✓ | ✓ | | ✓ | | |
| Standardise equipment across FSLs and centralise equipment procurement | | ✓ | | | ✓ | | |
| Ensure consistent disbursal of central funds at the beginning of each financial year across FSLs, earmarked for purchase of equipment | | ✓ | ✓ | | | | |

## Table 8. Recommendations related to Quality Management

| Recommendation | Body | | | | | | |
|---|---|---|---|---|---|---|---|
| | FSL | DFSS | State DFSS | NFS U | FSR | FCOI | Other |
| Promote a common understanding of quality management through regional consultations with FSL staff, understand hurdles and identify targeted interventions to ensure compliance with quality management | | ✓ | ✓ | ✓ | ✓ | | |
| Prepare a phased Action Plan for FSLs towards quality management, with minimum requirements for each phase, guidance for planning ahead and troubleshooting mechanisms; the timelines may be tailored based on discussions with each FSL and SDFSS | ✓ | ✓ | ✓ | | | | |
| Guide FSLs in preparation of WPMs for each division in FSLs after internal validation, by preparing and disseminating division-wise model WPMs | | ✓ | | | ✓ | | |
| Monitor FSLs to ensure time-bound preparation of WPMs and regular updates to them | ✓ | | ✓ | | | | |
| Provide support and guidance to each FSL for the accreditation process | | ✓ | ✓ | | ✓ | | NABL |
| Incorporate principles of quality management in the curricula for forensic science degree courses | | | | ✓ | | ✓ | |

## Table 9. Recommendations related to Forensic DNA Profiling in India

| Recommendation | Body | | | | | | |
|---|---|---|---|---|---|---|---|
| | FSL | DFSS | State DFSS | NFS U | FSR | FCOI | Other |
| Ensure preparation of WPM for DNA profiling divisions based on internal validation studies | ✓ | | ✓ | | ✓ | | |
| Prepare anti-contamination guidelines for DNA divisions based on best practices and update WPMs to incorporate them | ✓ | ✓ | | | ✓ | | |
| Provide training on statistical analysis to scientific staff at FSLs | ✓ | | ✓ | ✓ | | | |
| Establish an expert group on genetics to evaluate current population genetics studies and prepare allelic frequency indices for dissemination; initiate research projects by premier organisations to conduct population genetics studies | | ✓ | | ✓ | | | Premier Scientific Research Organisations in Biology |

# CONCLUSION

This survey has revealed the diverse realities of forensic science in India. There exists a wide variance in the number of divisions, funding, vacancies, infrastructure and technical practices across FSLs. Consequently, the quality of forensic services and the challenges faced by laboratories greatly differ across regions and states. Despite these variations, there were also similarities in the narratives of FSLs on the lack of consistent funding, cumbersome procedures for budget approvals and procurement, struggles with case management, and inadequate infrastructure. A majority of the state laboratories in the survey were found to be under the administrative and financial control of police departments, raising concerns regarding delays in approvals and interference with casework. Scientific staff across several laboratories struggled with increased workload due to inadequate staffing. They shared their dissatisfaction with the lack of parity in pay with other government services as well as with issues regarding their promotion. Shortage of space, absence of adequate health and safety measures and non-compliance with contamination minimisation procedures were concerns seen in many laboratories.

These interrelated issues have been discussed in prior surveys on the state of forensic science in India. Despite that, they have continued to persist either because the recommendations made by these reports have not been acted upon or have failed to address the underlying causes. Further, the issues within forensic science have been primarily approached as administrative problems rather than the lack of quality management within laboratories. Matters relating to personnel hiring and training, equipment, laboratory design and infrastructure are often decided without considering the requirements within laboratories to ensure adherence to the standards of quality control and quality assurance.

Therefore, the touchstone of quality should guide the allocation of current resources and the minimum threshold of functionality below which forensic science services cannot operate. Adherence to a quality management regime would also promote standardisation and ensure accuracy and reliability of forensic examinations. This may potentially cause short-term disruptions within the forensic science system. However, such a fundamental shift in perspective is necessary to find a sustainable solution to the challenges facing our forensic laboratories.

While the push towards just and fair investigations and prosecutions through the expansion of forensic services is vital, we must first ensure the accuracy and reliability of the forensic science being practised within FSLs. To achieve this, a strong Forensic Science Regulator (FSR) with a defined statutory mandate is necessary. The regulator must monitor and support laboratory functioning at the state and central levels. Through independent Scientific Working Groups established by the FSR, scientific standards and best practices should be developed for all forensic divisions across FSLs. Further, SFSLs and RFSLs must be separated from the police departments in their respective states and administered independently to ensure impartiality and secure greater financial independence.

Courts must also enforce a commitment to quality through clear legal standards for the examination of expert scientific evidence. Without a rigorous judicial examination of the reliability of forensic techniques or the manner in which they are applied by the examiner, the administration of forensic laboratories will not be guided by principles of scientific validity. To enable such critical enquiry of forensic evidence, it is crucial to train judges, prosecutors and lawyers on the scientific basis of different forensic disciplines and their inherent limitations. These developments within the scientific and legal practice will ensure the efficiency and reliability of outcomes of criminal proceedings and directly benefit victims and accused persons alike.

This Report is a first step towards understanding the reality within our laboratories and evaluating the Indian forensic science system from the perspective of quality management. We hope that it triggers new conversations on forensic science and leads to consistent research into the functioning of FSLs. Such data from laboratories and the narratives of forensic scientists should be harnessed to create more insights for legislators, policymakers and courts about the needs of the forensic science system. Built on such empirical rigour, our forensic laboratories will fulfil their commitment to producing valid and reliable science within the criminal justice system and guarantee fairness and justice for all.

# ANNEXURE I: PRIMER ON FORENSIC DNA PROFILING

## Scope of the Primer

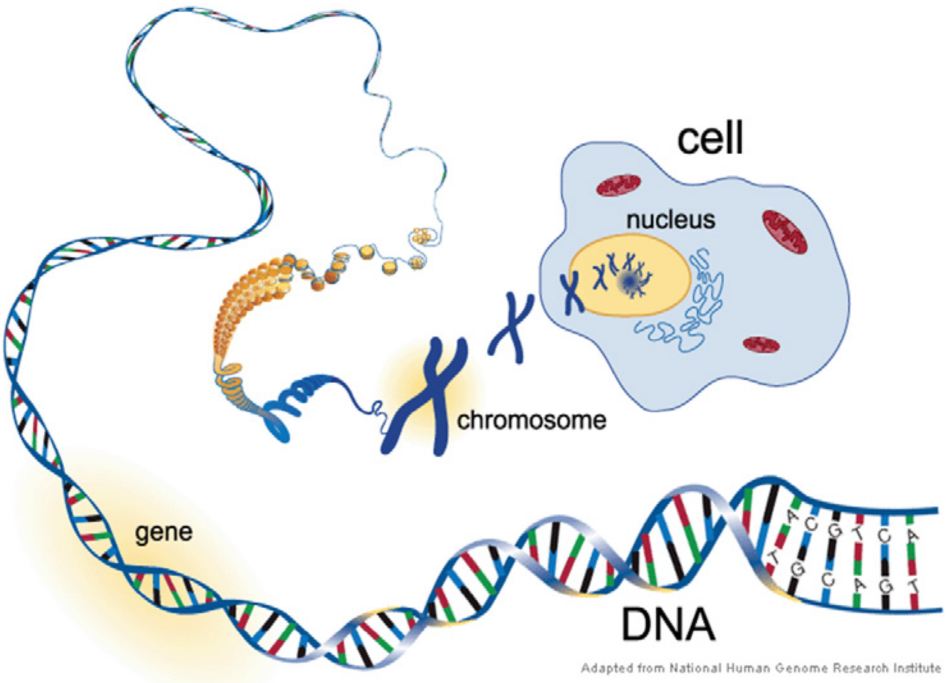
This primer provides an introduction to the scientific concepts underlying forensic DNA profiling and its evidentiary value in criminal proceedings. It explains the inherent limitations of the techniques involved in forensic DNA profiling and highlights the complications that may arise during the interpretation of DNA.

It covers 13 questions regarding DNA evidence, including the commonly used sources of DNA in criminal investigations, collection and packaging of biological materials, the process of DNA profiling, the meaning of a DNA and uniqueness of a DNA profile, interpretation of DNA mixtures, complications in DNA profiling, measures for quality control and use of DNA as evidence. This primer aims to bridge the gap between these scientific concepts and their relevance for legal analysis.

### 1. What are the sources of DNA?

DNA is a molecule that is present inside the nucleus of each cell in the human body (Image 1). It is a double-stranded structure composed of four nucleotide bases [Adenine (A), Thymine (T), Guanine (G) and Cytosine (C)] attached to a sugar-phosphate backbone. The same DNA sequence is present in every cell of the body (apart from mature red blood cells); therefore, DNA can be sourced from any biological material. This includes saliva, semen, vaginal fluids, blood, body tissues, teeth, hair and bones.

**Image 1: Overview of the human cell structure**
(Source: Adapted from the National Human Genome Research Institute)




The quantity of DNA contained within a biological material varies. Blood and saliva are richer sources of DNA as compared to teeth and hair roots, which are DNA deficient. DNA may be left behind on objects during physical contact, which is commonly referred to as touch DNA or trace DNA. Touch DNA contains very low amounts of DNA and is not an ideal source for DNA profiling.

### 2. How should DNA samples be collected and packaged?

The method for the collection, packaging, storage and transportation of a DNA sample differs based on the source of the biological material and the conditions in which it is found, to ensure that the quality and quantity of DNA is preserved. The common practice for packaging of biological fluids such as blood and semen involves their collection on cotton gauze pieces and air drying the gauze before packing it into a paper packet or envelope. In case a liquid blood sample is collected, it must be refrigerated at 4°C and must be transported in a thermocol box with an ice pack. For stains found on clothes and fabrics, they must be air dried at room temperature and packed in a paper packet, envelope or cotton bag. Objects such as weapons, bricks or utensils are also air-dried and packaged in shipping boxes or cardboard boxes sealed with evidence tape. Each of the items is packaged separately to prevent cross-contamination between samples.

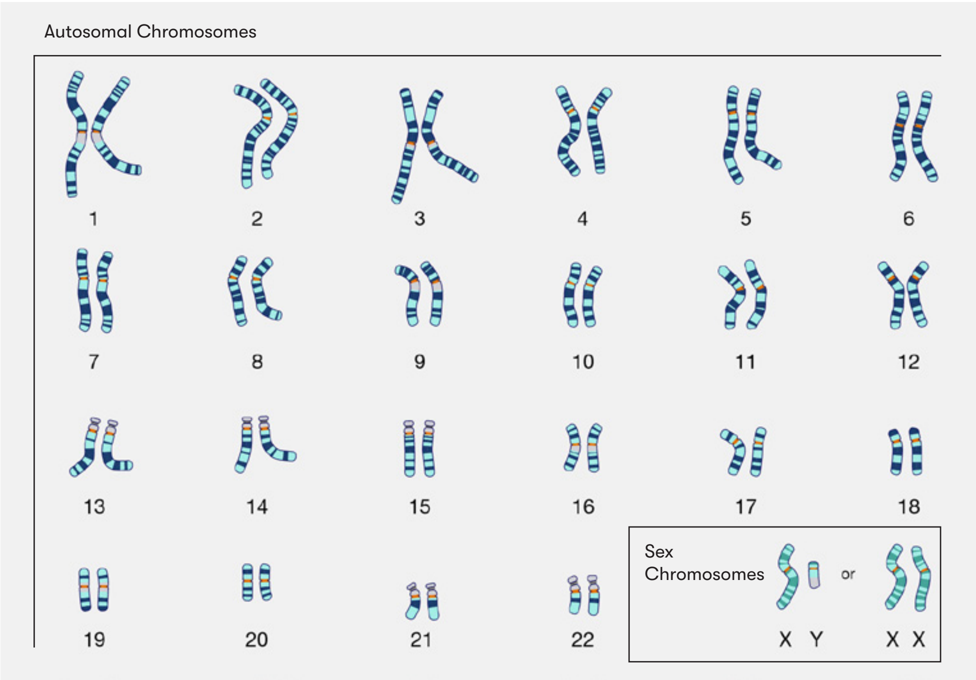
It is necessary to label each of the exhibits with the FIR number, date, section number, name of the investigating officer (IO), police station, district and state. The exhibit should then be signed by the IO and sealed appropriately. The DFSS guidelines for IOs and medical practitioners are important resources highlighting the best practices for the collection, packaging, storage and transportation of biological samples.[427]

**3. What is the underlying basis of forensic DNA profiling?**

In humans, the nucleus of every cell consists of 23 pairs of chromosomes which are made up of DNA and proteins. In each pair of chromosomes, every individual inherits one chromosome from the biological father and the other from the biological mother. As shown in Image 2, out of the 23 pairs of chromosomes, the first 22 pairs are called autosomal chromosomes and the 23rd pair is the sex chromosomes.

**427** DFSS, *Guidelines for collection, storage and transportation of crime scene biological samples for investigating officers* (2018). http://dfs.nic.in/pdfs/IO%20-Forensic%20evidence-Guidelines%20for%20%20IO.pdf; DFSS, *Guidelines for forensic medical examination in sexual assault cases* (2018). http://dfs.nic.in/pdfs/MO-Forensic%20examiniation-%20Guidelines%20%20for%20MO.pdf.

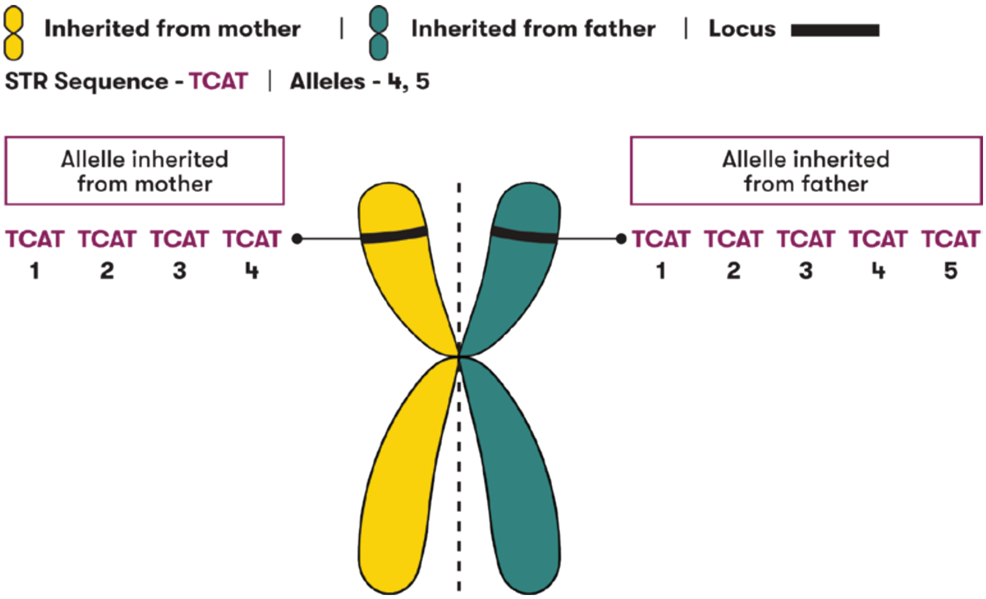
**Image 2: Pairs of chromosomes within a human cell**
(Source: National Human Genome Research Institute https://www.genome.gov/sites/default/files/media/images/tg/Karyotype.jpg)




Of the DNA in all human beings, 99.9% is identical. In forensic DNA profiling, a few locations in the remaining 0.1% of DNA are chosen to create a person's DNA profile. These specific locations on which the DNA is examined are called loci (singular locus). These loci have repetitive sequences of DNA called Short Tandem Repeats or STRs. While every individual has the same sequence or STR on a locus, the number of times that it repeats itself may vary across individuals. This variation in the number of repetitions is referred to as alleles.

As shown in Image 3, the alleles of the same STR at a specific locus on each chromosome within a pair are examined. Therefore, at a given locus, an individual has two alleles, one inherited from the father and the other inherited from the mother. In Image 3, TCAT is the STR sequence at the specific locus under examination on each chromosome. The STR sequence inherited from the mother shows four repetitions i.e. allele 4, while the sequence inherited from the father at the same locus shows five repetitions i.e. allele 5. Therefore, the DNA profile of the individual at that particular locus is 4, 5. The pair of alleles at a particular locus is referred to as a genotype and the combination of the genotype across all the tested loci is called the DNA profile.

**Image 3: Structure of a chromosome showing the alleles at a locus**




### 4. What are the different types of DNA profiling?

Different types of DNA profiling can be used in forensic casework. Based on the casework requirements, and the type and condition of the biological sample, the type of DNA profiling may be chosen.

- *STR DNA Profiling:* In forensic casework, this is the most common type of DNA profiling method. It involves identifying the alleles in the selected STR loci of the autosomal as well as the sex chromosome.
- *Y-STR Profiling:* It is a profile of the selected loci found only on the Y-sex chromosome in males. The Y-STR profile is the same

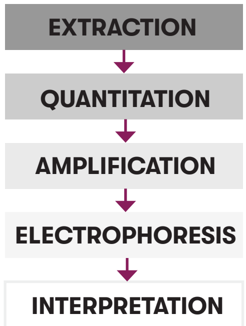
amongst males of the same lineage unless there are mutations. Hence, Y-STR profiling is useful in cases involving male perpetrators.

- ***X-STR Profiling:*** Males possess one X chromosome while females possess two X chromosomes. Therefore, in cases of kinship testing such as when the father-daughter relationship is in question, X-STR profiling can be adopted. It may also be used in case of missing persons.
- ***Mini-STR Profiling:*** DNA recovered from crime scene samples is commonly observed to be degraded due to several external factors. Profiling a degraded DNA using the commonly used method renders an incomplete DNA profile as the STR sequences are broken down (by degradation), leading to a complete loss of information. In such cases, mini-STR profiling is employed, wherein the STR sequence is shortened such that only the most variable portion is considered, and valuable information is retained.
- ***Mitochondrial DNA Profiling:*** In human cells, most of the DNA is found in the nucleus and is referred to as nuclear DNA. However, a small portion of the DNA is also found in structures known as mitochondria within the cell (singular mitochondrion), referred to as the mitochondrial DNA or mtDNA. It is passed from the mother to the child i.e. all relatives on the maternal side will share the same mtDNA, provided there are no mutations. In the case of samples that may not contain sufficient amounts of nuclear DNA (such as hair strands without root ends) or in the case of degraded samples, mitochondrial DNA analysis is useful. Mitochondrial DNA is also used for maternal identification.
- ***Low Copy DNA Typing:*** This method of DNA profiling is carried out when the DNA in the sample is in minimal amounts, such as samples of touch DNA. In such cases, the usual method of STR profiling may lead to an unreliable interpretation. Therefore, the STR DNA profiling process is modified in the different stages to compensate for the low level of DNA and to enhance the sensitivity of the testing.

## 5. How is a DNA profile generated?

As shown in Image 4, forensic DNA profiling involves five steps which are involved in all types of DNA profiling. Specific kits are used for each step of the process.

**Image 4: Steps involved in forensic DNA profiling**




*Extraction:* During the extraction step, the DNA is separated from cellular materials (i.e. other parts of the cells) and non-cellular materials (i.e. cotton swabs on which the DNA is present). The presence of such components in the subsequent stages of DNA analysis can reduce the ability to correctly analyse DNA, making it crucial to recover high quality and quantity of DNA from the samples.

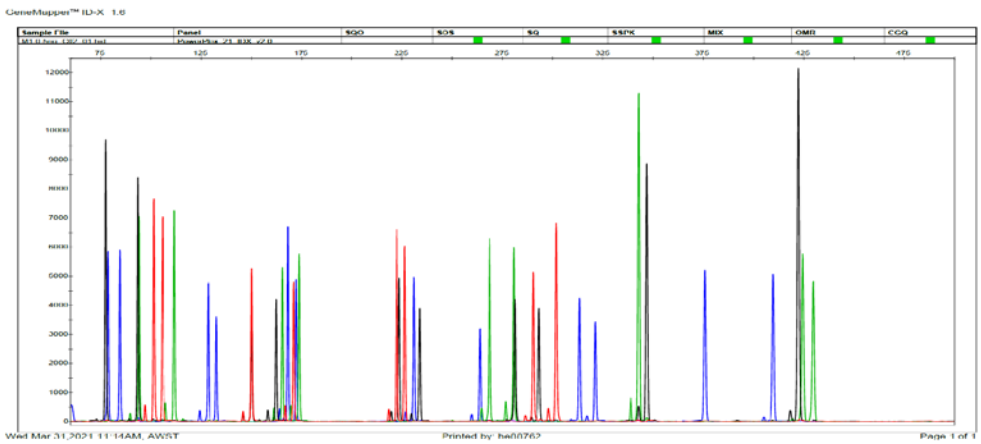
*Quantitation:* Once the DNA is separated from other components, the amount of available DNA is measured to ensure that an optimal quantity of DNA is available for the next stages of DNA analysis. Too much or too little DNA can lead to poor quality of DNA profiles which, in turn, can result in errors during interpretation.

*Amplification:* Amplification involves making millions of copies of the DNA fragments on the specific loci which are under examination in DNA profiling. Copies of these fragments are made in order to allow for the examination of the alleles found on those loci. The DNA fragments are marked with different coloured dyes which aid in detection and analysis during the next phases.

*Electrophoresis:* The amplified DNA is inserted into a thin tube (i.e. capillary) through which an electric current is passed from the negative to the positive end. While the sample moves through the tube, a laser light is shone which causes the different coloured DNA fragments to illuminate. The light signal reflected off the different coloured fragments is then captured by a sensitive camera. Smaller DNA fragments move through the tube faster than the larger fragments. The results of the electrophoresis step are provided as electronic raw data which depicts the DNA captured through the electrophoresis process as peaks.

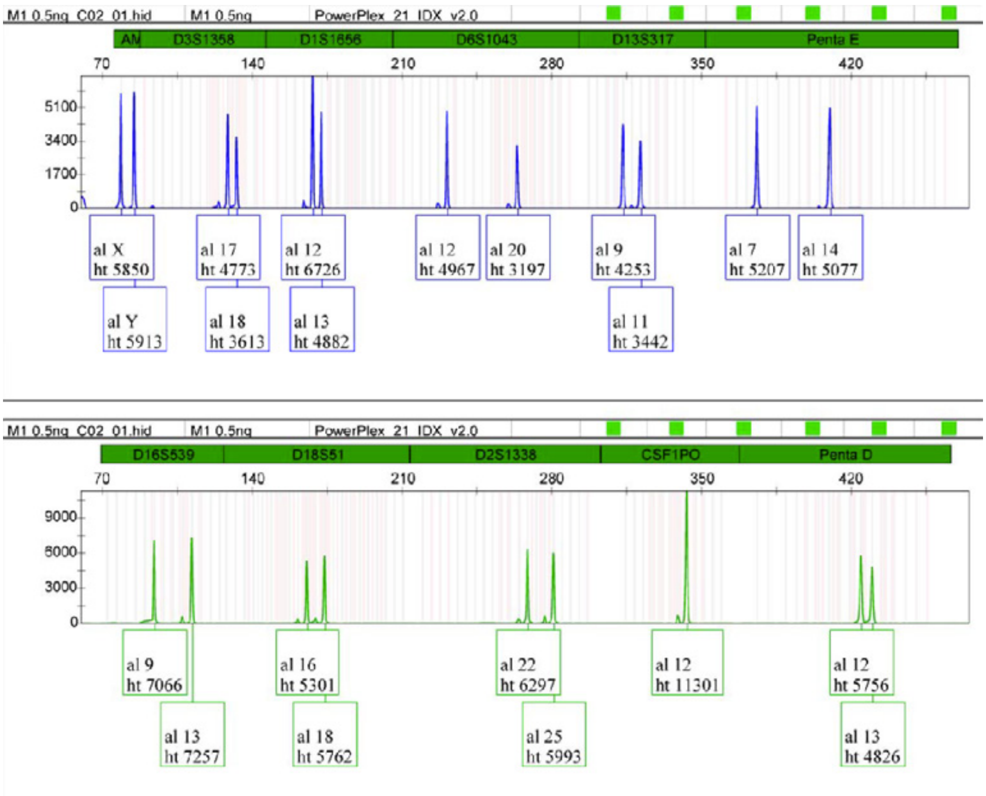
*Interpretation:* The electronic raw data (Image 5) collected during the electrophoresis process is captured in a separate computer, where it is analysed using software.

**Image 5: Electronic Raw Data**
(Source: Project 39A course on Decoding Forensics for Legal Professionals https://www.futurelearn.com/courses/decoding-forensics)



The software removes the noise generated during the electrophoresis process, interprets the electronic raw data based on the settings inputted by the DNA examiner and plots it on a graph known as an electropherogram (EPG), shown in Image 6. The alleles found in the DNA fragments are seen as peaks on the EPG. In an EPG, the height of the peak (shown on the vertical y-axis) represents the amount of DNA of that particular allele which is measured in Relative Fluorescence Units (RFU), while the horizontal position of the peak on the x-axis determines the size of the fragment, which is measured in base pairs (bp) (shown on the horizontal x-axis). Based on the size of the fragment, the allele on the locus is determined.

**Image 6: EPG showing 2 out of 4 panels of a 21 loci DNA profile**
(Source: Project 39A course on Decoding Forensics for Legal Professionals https://www.futurelearn.com/courses/decoding-forensics)



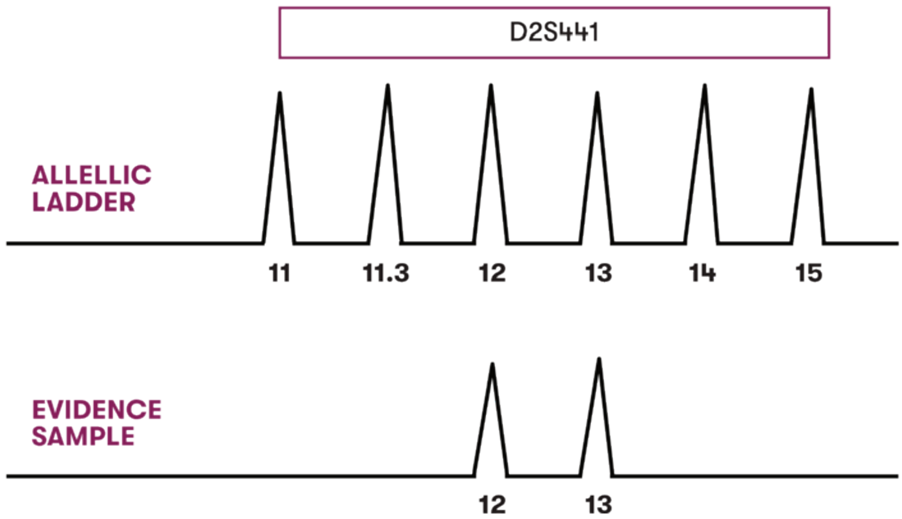

Some of the important standards inputted by the laboratory into the software are the limit of detection (LOD), analytical threshold (AT) and stochastic threshold (ST). The LOD is used to distinguish analytical signals detected during electrophoresis from the electrical noise that is generated during this process. Depending on how the LOD is set, a signal above the LOD has a high chance of not being noise.[428] The analytical threshold is the RFU value on the y-axis above which the peak can be quantified and reliably distinguished from noise. The stochastic threshold is the RFU value above which the peak is considered to be reliable with no loss of DNA data or any random changes.

During the process of DNA profiling, due to technical anomalies that can occur during the process of DNA profiling, non-allelic peaks known as artefacts may be visible on the EPGs. Artefacts can mimic true allelic peaks and impact the overall interpretation of the DNA profile. During interpretation, a DNA examiner must analyse whether or not the peaks seen on the EPG are alleles or artefacts.

To determine the allele designation i.e. allele number, the software also uses the results of the internal size standard and allelic ladder, which run along with the samples during every electrophoresis run. It calculates the size of the DNA fragments in base pairs using the internal size standard (i.e. DNA fragments of known length). Further, an allelic ladder, which is a chemically produced mixture consisting of all known alleles present at each locus, is used as a scale to determine which allele is present. In Image 7, the allele peak in the evidence sample is identified as 12, 13 at locus D2S441 in comparison with the allele peaks in the allelic ladder.

**428** John Butler, *Advanced Topics in Forensic DNA Typing: Interpretation*, Elsevier Inc (2015), pg 33 [John Butler: Interpretation].

**Image 7: DNA interpretation using allelic ladder by the software**

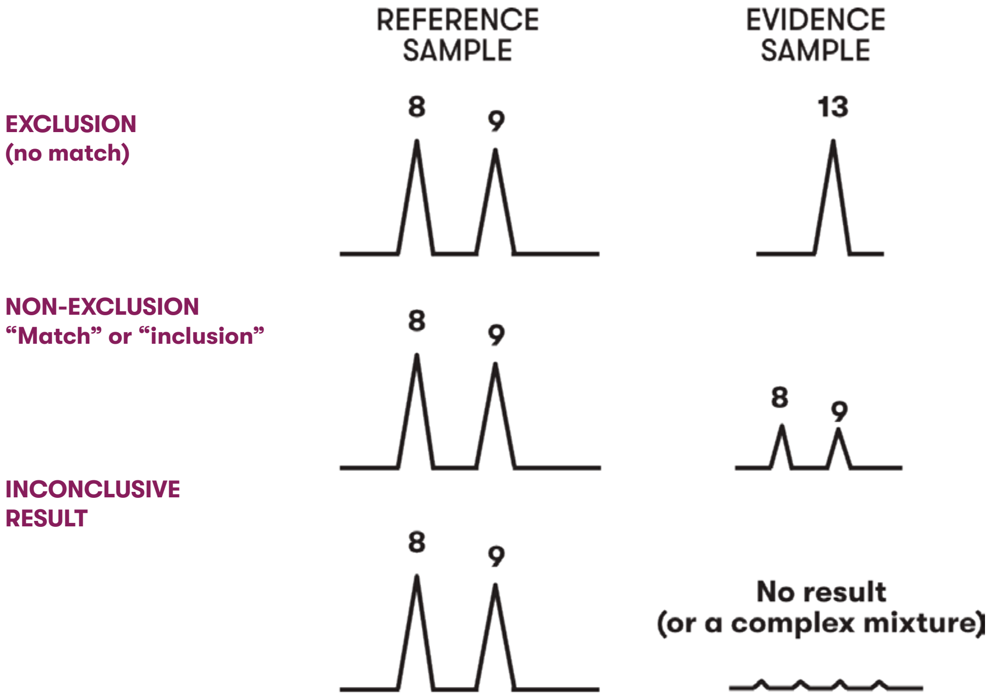



Once the allelic peaks are identified, the allele pair or genotypes on each locus in DNA samples is determined. These allele pairs are determined based on peak height ratios.

### 6. What are the possible outcomes of a DNA examination?

In DNA profiling, after separately generating the DNA profiles in the evidence sample [i.e. sample containing DNA of the unknown contributor(s)] and the reference sample (i.e. DNA sample collected from a known contributor), the DNA profiles are compared on all tested loci. As shown in Image 8, there are three possible outcomes for DNA profiling i.e. exclusion (i.e. DNA profiles differ on at least one tested loci), inclusion (i.e. DNA profiles match on all tested loci), and inconclusive (i.e. DNA profile cannot be determined).

**Image 8: Possible outcomes of a DNA examination**
[Adapted from John Butler, Advanced Topics in Forensic DNA Typing: Interpretation (2015)]




## 7. What is the meaning of a DNA 'match'?

In case of an inclusion or match, it does not mean it is conclusive evidence that the DNA in the evidence sample belongs to the known contributor whose reference DNA profile was generated. Since DNA profiling only tests specific loci on the DNA on which two unrelated individuals may coincidentally have the same profile, the DNA result must be statistically analysed. Such statistical evaluation explains the probability of an unrelated individual in a given population having the same DNA profile. This may be expressed as a random match probability (RMP), which calculates the probability of an unrelated individual in a given population having the same DNA profile to estimate its rarity. Another statistical method used for explaining the results is the likelihood ratio (LR), which compares the probability of the prosecution hypothesis (inclusion) with the defence hypothesis (exclusion) to determine the likelihood of finding the match if the defendant was the source of the DNA versus another person being the source. These are calculated by considering the frequency of the alleles within the given population, as included in population genetic studies. Since forensic DNA profiling is probabilistic in nature, the evidentiary value of the DNA evidence cannot be determined without a random match probability or a likelihood ratio. Therefore, a DNA report would be incomplete without statistical evaluation of the match.

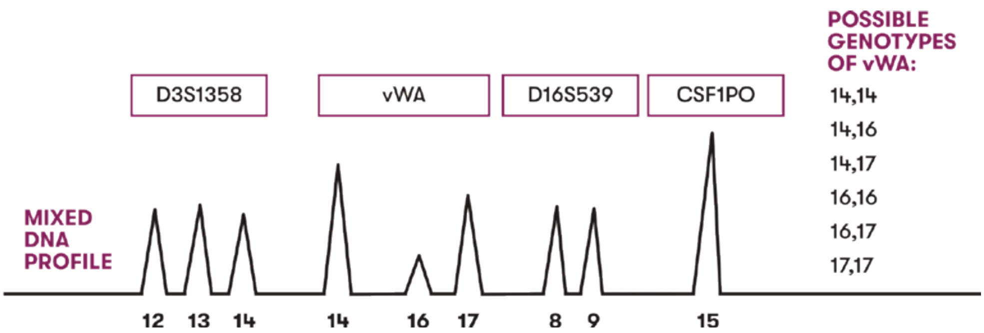
Statistical analysis should also be conducted in cases concerning parentage and reverse parentage. Parentage analysis is used to determine the biological parents of an individual. Paternity testing is commonly conducted when the identity of the biological father is in question. Reverse parentage is carried out when the sample from an unidentified person or bodily remains is compared to the reference samples of the biological parents to establish its identity. Statistical calculations, like the paternity index, compare the probability of an individual being the true biological father to the probability of a random individual being the true biological father.

Further, since forensic DNA profiling examines only those loci which show high variations in the STR sequences, two unrelated individuals may have the same DNA profile at one or all the loci that are examined. Therefore, a DNA profile cannot be considered unique to an individual. Currently, commonly used forensic DNA kits examine between 16 to 24 loci, which means the DNA profile generated from the kit gives the genotypes observed on 16 to 24 loci. With the development of DNA kits which test more loci, higher levels of individualisation and accuracy can be achieved.

**8. What are DNA mixtures and how are they interpreted?**
Evidence samples recovered from a crime scene do not always yield a clean single source profile. If the evidence sample consists of more than two alleles on a locus, it signifies the possibility of a DNA mixture by

two or more contributors. Peak height ratios are essential for mixture interpretation to check which alleles form the genotype at a particular locus. It is important to remember that DNA mixtures cannot be interpreted just by identifying the presence of individual alleles; it is essential to identify the possible genotypes (allele pairs) based on peak height ratios. For example, in Image 9, the six possible genotypes for the mixture at locus vWA are given below.

**Image 9: Mixed DNA Profile**




However, based on a peak height analysis, the likely genotypes at vWA may be a mixture of (14, 16) and (14, 17). Therefore, if the reference profile of the suspect on this locus was (16,17), then they would be excluded as a source for this DNA mixture. It is also important to note that the difficulty in interpretation may vary across the loci. For instance, considering the similar peak heights, it may be more difficult to analyse the possible genotypes on D3S1358.

Mixture interpretation may be conducted using binary methods or probabilistic genotyping. Binary methods follow fixed thresholds in interpreting data and work under the assumption of whether a specific genotype is present or absent.[429] Probabilistic genotyping software (PGS) utilises more data than binary methods of interpretation to make decisions regarding the possible genotypes and calculate the probability

429 John Butler: Interpretation, pg 39.

of potential genotype combinations at each locus.[430]

**9. What is DNA transfer?**

A person's DNA is capable of being transferred from one location or object to another easily, by direct contact. Studies illustrate that the DNA of an individual can be obtained from a location or object that the individual has never been in contact with before and determining how and when their DNA was deposited there can be extremely difficult.[431] DNA can find its way through touching, sneezing or simply due to the shedding of skin. It can therefore be present prior to the commission of the crime or can also be deposited by another individual. Transference of DNA can occur in three ways, namely:

- *Primary/direct transfer*: In this type of transfer, there is a direct deposit of biological material from the source onto the surface, object, or person. It can occur through direct touch or through non-contact activities such as speaking, coughing, and sneezing. With respect to the quantity of DNA, touching an item regularly may lead to the deposit of more DNA as opposed to a single contact.
- *Secondary transfer*: This type of transfer occurs when the DNA on an object is deposited through an intermediate. For instance, the transfer of sperm cells from one piece of clothing to another

430 John Butler: Interpretation, pg 40, 174.

431 Katie Worth, *Framed for Murder by His Own DNA*, The Marshall Project (2018). The article describes the case of Lukis Anderson, who was charged for murder as his DNA was found under the deceased's nails although they had never come in contact. It was later discovered that Anderson's DNA was transferred onto the victim through the paramedics who had attended to Anderson earlier on the day of the incident, and thereafter attended the crime scene where they used the same pulse oximeter on the deceased. https://www.themarshallproject.org/2018/04/19/framed-for-murder-by-his-own-dna.

when they are washed together.[432] Even without prior physical contact, DNA from an individual can be observed on an object; for example, as touching a knife after shaking hands with another person resulting in DNA deposition of the second individual onto the knife.[433]

- *Tertiary transfer*: Here, DNA can be transferred through two or more intermediaries.

  The transfer of DNA can complicate criminal investigations as the sample recovered from the crime scene can potentially have DNA deposited from other foreign or background sources.[434]

432 Sarah Noel et al., *DNA transfer during laundering may yield complete genetic profiles*, 23 Forensic Science International: Genetics (2016), pg 240-247. In this study, clean pairs of underwear were washed with bedsheets containing varying numbers of ejaculates in a machine to understand the transfer of the sperm DNA. It was observed that sperm cells were transferred during the wash and the source of the sperm was identified through interpretable DNA. https://www.researchgate.net/publication/302919247_DNA_transfer_during_laundering_may_yield_complete_genetic_profiles.

433 Georgina E Meakin et al., *The deposition and persistence of indirectly transferred DNA on regularly used knives*, 5 Forensic Science International: Genetics Supplement Series (2015), e498-e500. This study investigated the deposition and persistence of secondary transferred DNA on regularly used items. Volunteers shook hands with another person (handshaker) before touching their regularly used knives. It was observed that the handshaker's DNA was recovered from the knife even after a week. https://www.fsigeneticssup.com/article/S1875-1768(15)30043-3/fulltext.

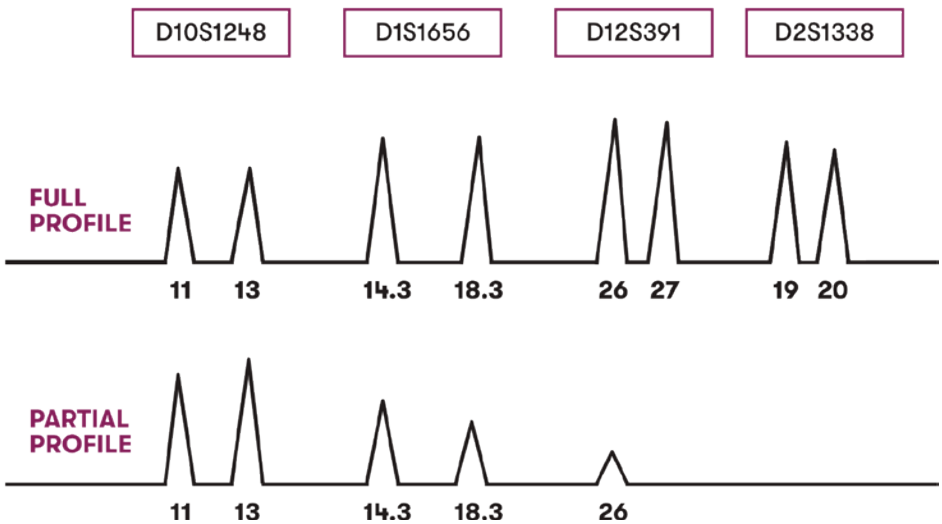
434 Mariya Goray & Roland AH van Oorchot, *The complexities of a DNA transfer during a social setting*, 17 Legal Medicine (2015), pg 82-91. The study examined multiple direct and indirect transfer of DNA in experimental settings wherein three individuals were seated around a table having a drink and interacted for 20 minutes. It was observed that in many experiments, the last participant or the only participant to come in contact with the object was the major depositor. However, there were some settings when the last person to touch the surface was not the main contributor. Further, unknown DNA profiles were also found on a number of items and surfaces which shows the possibility of multiple transfer. https://www.sciencedirect.com/science/article/abs/pii/S1344622314001576?via%3Dihub.

**10. What are the major complications during DNA profiling?**

There can be several complications within the process and interpretation of DNA profiles during casework, which can lead to errors in interpretation.

- *Partial profile* - While in an ideal situation, enough DNA would be available to generate a complete profile across all the tested loci, it is possible that a DNA sample is either degraded due to environmental factors or is recovered in such miniscule amounts that a full DNA profile cannot be generated. The partial profile can be observed at the locus D12S391 and D2S1338 in Image 10, wherein either some or all allele peaks are missing. With an incomplete profile, there are higher chances of a coincidental match with an unrelated individual, which may lead to erroneous results.

**Image 10: Full and partial DNA profile**




- *Subjectivity & bias* - DNA interpretation relies on analysis by the examiner based on the protocols set by the laboratory as well as their knowledge, and skills. Therefore, this may lead to subjectivity in the examination, where the interpretation of different examiners on the same set of DNA data may vary. Further, like in other forensic disciplines, the different sources of cognitive bias may impact the interpretation by the examiner. For instance, interpreting a reference profile before the evidence profile may lead the analyst to expect the same alleles to be found in the evidence sample, which, in turn may lead to confirmation bias. Further, the examiner may receive irrelevant information regarding the case, for instance, circumstances of the offence or other evidence in the case, which can lead to contextual bias during the interpretation process.

**11. What measures can be taken to minimise contamination within a laboratory?**

One of the common problems encountered within a laboratory during DNA profiling is the contamination of samples. As forensic techniques have improved, their sensitivity to detect miniscule amounts of DNA has increased as well. While this has been beneficial, it has also increased the chances of contaminant DNA being detected. Therefore, it is important to adhere strictly to anti-contamination measures to minimise the risk of contamination. Some of the important measures to prevent and detect contamination are:

- The analysts must wear appropriate personal protective equipment (PPE) to prevent their DNA from contaminating the samples in the casework.
- Amplified and non-amplified DNA samples should be processed in separate areas as amplified DNA fragments have a high concentration of DNA and hence can easily contaminate other samples.
- Reference and evidence samples should also be processed separately throughout the DNA profiling process, in order to avoid cross-contamination.
- Positive and negative controls must be run along with the DNA samples to ensure that the process has run correctly and to ensure that cross-contamination has not occurred.
- Laboratories must maintain a staff elimination database

consisting of the DNA profiles of all the staff within the laboratory. On detection of contamination, the database will help in eliminating them as a possible source of contamination.

- All workspaces, equipment and structures in the laboratory must be regularly cleaned to reduce the risk of contamination.

### 12. What information and documents must be supplied along with the DNA report?

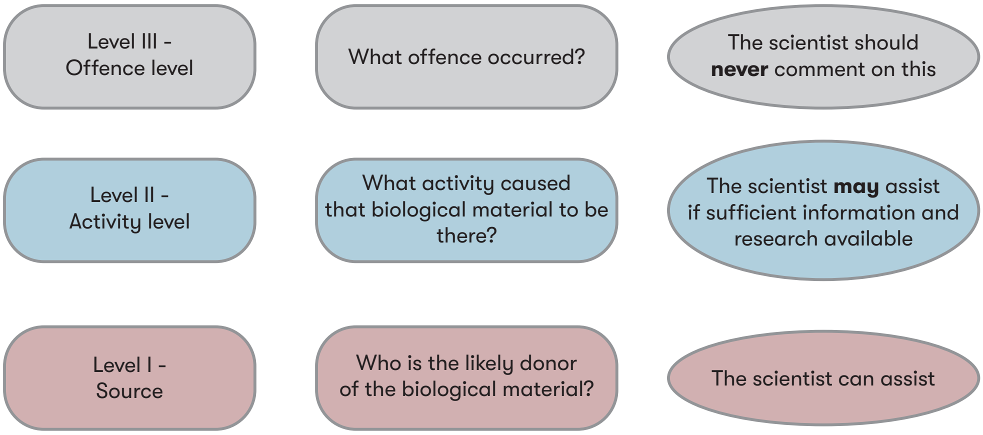
In order to allow the court to conduct an independent examination of the DNA evidence, the following information and documents must be supplied along with a DNA report:

- Chain-of-custody documents relating to all samples sent for DNA analysis.
- Worksheets and bench notes stating the type of serological examination undertaken for each exhibit and the source of biological material detected, such as blood or semen.
- Description of the methodology used, including worksheets and bench notes maintained during all stages of the process of DNA profiling.
- Details regarding the kits used during the process of DNA profiling and the working procedure manual (WPM) followed.
- EPGs of the exhibits, allelic ladder and the control samples which were interpreted as part of the DNA examination.
- Statistical analysis of the DNA profiling results.

### 13. Does the presence of DNA establish guilt?

There is a general misconception that finding a person's DNA may itself be enough to establish guilt. For the purposes of a legal inquiry, it is important to understand the inference that can be drawn from the presence of an individual's DNA in a particular case. For this, a framework called the Hierarchy of Propositions was developed by R Cook et al. in their paper titled *A hierarchy of propositions: deciding which level to address in casework*, published in Science & Justice (1998). As shown in Image 11, this framework examines the different levels of propositions and whether a scientist can comment on them.

**Image 11: Hierarchy of Propositions**
(Source: Project 39A course on Decoding Forensics for Legal Professionals https://www.futurelearn.com/courses/decoding-forensics)




- *Source level* - This level questions the source of the evidence i.e. whether the source of the DNA was blood, semen or saliva, or who was the contributor of the DNA. The forensic scientist can furnish an answer at this level.
- *Activity level* - At this level, the question being asked is what activity occurred for the biological material to be deposited. For instance, how was the suspect's blood found at the crime scene or on the murder weapon? Such questions cannot always be answered through DNA evidence. Scientists might rely on additional information, prior experience or published research in order to attempt to answer questions at this level. Further, this may involve assumptions on part of the scientist which should be clearly stated in their report.
- *Offence level* - This level questions the offence related to the evidence. The court makes the decision at this level to determine if an offence was committed and whether it was committed by the defendant. DNA evidence cannot answer questions at this level and therefore, a scientist should never comment on them.

The mere presence of DNA cannot be considered to establish guilt, as DNA evidence only provides information at the source level. It does not explain how the DNA was deposited there or when it was deposited, which consequently, cannot explain if the source of the DNA committed the offence or not.

Further, the weight attached to DNA evidence varies based on the circumstances of the case. For instance, the presence of a person's DNA on a knife in their own house where the co-inhabitant was found murdered may be low in probative value, as it cannot be ascertained when and how the DNA was deposited on the knife. However, finding a suspect's DNA in a vaginal sample in a rape case would have more probative value. Furthermore, the weight of the DNA evidence is also affected by other circumstances, such as the possibility of contamination and transference. Therefore, DNA evidence may be considered as corroborative evidence but should not be the sole basis of conviction.

# ANNEXURE II: LIST OF FUNCTIONAL DIVISIONS IN EACH FSL

| Laboratory | No. of Functional Divisions | Divisions |
|---|---|---|
| **CBI-CFSL** | **15** | Ballistics, Biology, Chemistry, Cyber Forensics, DNA Profiling, Document, Explosives, Fingerprint, Narcotics, Photography, Physics, Polygraph, Serology, Toxicology, Voice Identification |
| **CFSL Chandigarh** | **8** | Ballistics, Biology, Chemistry, DNA Profiling, Documents, Explosives, Physics, Toxicology |
| **CFSL Shimla** | **2** | Cyber Forensics, Documents |
| **RFSL Agra** | **9** | Ballistics, Biology, Chemistry, Cyber Forensics, Document, Explosives, Physics, Serology, Toxicology |
| **RFSL Aurangabad** | **8** | Biology, Chemistry, DNA Profiling, Excise, Narcotics, Serology, Toxicology, Voice Identification |
| **RFSL Berhampur** | **5** | Ballistics, Biology, Chemistry, Physics, Serology |
| **RFSL Dharamshala** | **6** | Biology, Chemistry, Documents, Excise, Serology, Toxicology |
| **RFSL Jagdalpur** | **2** | Biology, Serology |
| **RFSL Nagpur** | **10** | Ballistics, Biology, Chemistry, Cyber Forensics, DNA Profiling, Excise, Narcotics, Serology, Toxicology, Voice Identification |
| **RFSL Nashik** | **7** | Biology, Chemistry, DNA Profiling, Excise, Narcotics, Toxicology, Voice Identification |
| **RFSL Pune** | **8** | Biology, Chemistry, Cyber Forensics, DNA Profiling, Excise, Serology, Toxicology, Voice Identification |
| **RFSL Ranipool** | **3** | Biology, Chemistry, Documents |
| **RFSL Thrissur** | **5** | Biology, Chemistry, Cyber Forensics, Documents, Polygraph |
| **SFSL Agartala** | **9** | Ballistics, Biology, Chemistry, Cyber Forensics, DNA Profiling, Documents, Explosives, Narcotics, Toxicology |

| Laboratory | No. of Functional Divisions | Divisions |
|---|---|---|
| **SFSL Aizawl** | 8 | Ballistics, Chemistry, DNA Profiling, Documents, Fingerprint, Photography, Serology, Toxicology |
| **SFSL Banderdewa** | 4 | Ballistics, Documents, Narcotics, Photography |
| **SFSL Bhubaneswar** | 9 | Ballistics, Biology, Chemistry, Cyber Forensics, DNA Profiling, Physics, Polygraph, Serology, Toxicology |
| **SFSL Dehradun** | 10 | Ballistics, Biology, Chemistry, DNA Profiling, Documents, Excise, Narcotics, Physics, Serology, Toxicology |
| **SFSL Dimapur** | 3 | Fingerprint, Narcotics, Photography |
| **SFSL Imphal** | 6 | Ballistics, Biology, Documents, Narcotics, Physics, Toxicology |
| **SFSL Lucknow** | 12 | Ballistics, Biology, Chemistry, Cyber Forensics, DNA Profiling, Document, Narco-analysis, Physics, Polygraph, Serology, Toxicology, Voice Identification |
| **SFSL Mumbai** | 8 | Ballistics, Chemistry, DNA Profiling, Excise, Explosives, Narcotics, Physics, Toxicology |
| **SFSL Port Blair** | 4 | Chemistry, Excise, Narcotics, Toxicology |
| **SFSL Puducherry** | 2 | Biology, Serology |
| **SFSL Raipur** | 10 | Ballistics, Biology, Chemistry, DNA Profiling, Excise, Explosives, Narcotics, Physics, Serology, Toxicology |
| **SFSL Shillong** | 8 | Ballistics, Biology, Chemistry, Documents, Narcotics, Physics, Serology, Toxicology |
| **SFSL Shimla** | 14 | Ballistics, Biology, Chemistry, Cyber Forensics, DNA Profiling, Document, Excise, Explosives, Fingerprint, Narcotics, Photography, Physics, Serology, Toxicology |
| **SFSL Thiruvananthapuram** | 10 | Ballistics, Biology, Chemistry, Cyber Forensics, DNA Profiling, Documents, Explosives, Physics, Serology, Voice Identification |
| **SFSL Verna** | 2 | Biology, Fingerprint |

# ANNEXURE III: YEAR-WISE ANALYSIS OF CASEWORK

**Table 10. Year-wise cases received across divisions**[435]

| Division | 2013 | 2014 | 2015 | 2016 | 2017 | Grand Total |
|---|---|---|---|---|---|---|
| Ballistics | 4,984.8 | 5,029.2 | 4,671.3 | 4,614.5 | 4,404.3 | **23,704.1** |
| Biology | 24,019.5 | 26,034 | 32,215.5 | 27,674.5 | 28,715 | **1,38,658.5** |
| Chemistry | 14,911 | 15,107 | 18,677.7 | 16,419.3 | 14,146.3 | **79,261.3** |
| Cyber Forensics | 645 | 691 | 972 | 1,787 | 2,296 | **6,391** |
| DNA Profiling | 3,677 | 4,521 | 6,328 | 8,262 | 9,254 | **32,042** |
| Document | 2,424 | 3,060 | 2,589 | 2,523 | 2,721 | **13,317** |
| Excise | 65,814 | 69,261.7 | 66,775.7 | 70,496.7 | 92,662.7 | **3,65,010.8** |
| Explosives | 2,271.8 | 3,383.2 | 2,640 | 2,032.2 | 2,064.3 | **12,391.5** |
| Fingerprint | 646 | 620 | 577 | 663 | 675 | **3,181** |
| Narco-analysis | | 1 | 10 | 17 | 17 | **45** |
| Narcotics | 2,964 | 3,897.3 | 3,733 | 3,302.7 | 4,004.7 | **17,901.7** |
| Photography | 970 | 1,010 | 1,076 | 1,026 | 1,063 | **5,145** |
| Physics | 2,323.8 | 2,365.2 | 2,352.3 | 2,438.5 | 2,481.8 | **11,961.6** |
| Polygraph | 265 | 356 | 462 | 472 | 428 | **1,983** |
| Serology | 19,696.5 | 20,853 | 18,168.5 | 15,338.5 | 11,193 | **85,249.5** |
| Toxicology | 29,688 | 29,341 | 29,315 | 29,278.7 | 27,317.3 | **1,44,940** |
| Voice Identification | 247.5 | 229.5 | 764 | 989.5 | 988.5 | **3,219** |
| **Grand Total** | **1,75,548** | **1,85,760** | **1,91,327** | **1,87,335** | **2,04,432** | **9,44,402** |

435 As some laboratories provided case numbers for multiple divisions in one dataset, the data for cases received was equally divided among the individual divisions.

## Table 11. Year-wise cases examined across divisions[436]

| Division | 2013 | 2014 | 2015 | 2016 | 2017 | Grand Total |
|---|---|---|---|---|---|---|
| Ballistics | 4,497 | 5,098.5 | 4,312 | 4,248.3 | 4,440.3 | **22,596.1** |
| Biology | 26,260.5 | 29,626 | 27,178.5 | 30,022.5 | 25,114.5 | **1,38,202** |
| Chemistry | 14,916.3 | 15,655.3 | 20,233 | 16,622 | 13,496.3 | **80,922.9** |
| Cyber Forensics | 472 | 452 | 725 | 1,105 | 1,548 | **4,302** |
| DNA Profiling | 2,949 | 4,440 | 4,983 | 4,797 | 5,425 | **22,594** |
| Document | 2,830 | 2,214 | 2,530 | 2,557 | 2,275 | **12,406** |
| Excise | 90,041.3 | 69,945.7 | 65,970.7 | 72,715 | 87,509.7 | **3,86,182.4** |
| Explosives | 2,403.3 | 3,127.8 | 3,012.7 | 2,477.3 | 1,932.7 | **12,953.8** |
| Fingerprint | 203 | 261 | 278 | 368 | 294 | **1,404** |
| Narco-analysis | | 1 | 9 | 20 | 6 | **36** |
| Narcotics | 3,079 | 3,728.7 | 3,972.3 | 3,460 | 3,823.7 | **18,063.7** |
| Photography | 983 | 1,001 | 1,035 | 1,040 | 1,061 | **5,120** |
| Physics | 2,209 | 2,490 | 2,307.5 | 2,466.3 | 2,210.8 | **11,683.6** |
| Polygraph | 214 | 278 | 406 | 390 | 372 | **1660** |
| Serology | 17,454.5 | 20,644 | 15,597.5 | 14,090.5 | 10,183.5 | **77,970** |
| Toxicology | 38,542 | 42,750 | 28,627.3 | 31,043 | 28,140 | **1,69,102.3** |
| Voice Identification | 236 | 206 | 653.5 | 823 | 978.5 | **2,897** |
| **Grand Total** | **2,07,290** | **2,01,919** | **1,81,831** | **1,88,245** | **1,88,811** | **9,68,096** |

436 As some laboratories provided case numbers for multiple divisions in one dataset, the data for cases examined was equally divided among the individual divisions.

## Table 12. Year-wise cases pending across divisions[437]

| Division | 2013 | 2014 | 2015 | 2016 | 2017 | Grand Total |
|---|---|---|---|---|---|---|
| Ballistics | 4,450.2 | 4,615.8 | 4,681.8 | 4,924.7 | 5,082.3 | **23,754.8** |
| Biology | 17,890 | 15,062.5 | 14,240.5 | 14,780 | 14,381 | **76,354** |
| Chemistry | 7,322 | 6,315.3 | 3,841.3 | 3,390.3 | 3,872 | **24,740.9** |
| Cyber Forensics | 803 | 1,100 | 1,364 | 1,621 | 2,219 | **7,107** |
| DNA Profiling | 2,618 | 2,590 | 3,873 | 6,753 | 9,475 | **25,309** |
| Document | 2,845 | 955 | 1,324 | 976 | 830 | **6,930** |
| Excise | 10,346.7 | 5,987.3 | 6,444 | 3,638 | 2,818 | **29,234** |
| Explosives | 87.2 | 646.5 | 899.2 | 533 | 136.3 | **2,302.2** |
| Fingerprint | 36 | 13 | 46 | 47 | 66 | **208** |
| Narco-analysis | | 0 | 1 | 1 | 11 | **13** |
| Narcotics | 310.3 | 538 | 729.3 | 648.3 | 717 | **2,942.9** |
| Photography | 30 | 40 | 80 | 66 | 67 | **283** |
| Physics | 798.7 | 696.8 | 662.8 | 648.7 | 830.3 | **3,637.3** |
| Polygraph | 3 | 25 | 88 | 52 | 66 | **234** |
| Serology | 10,077 | 11,176.5 | 9,095.5 | 9,454 | 9,929 | **49,732** |
| Toxicology | 39,956 | 29,042.7 | 13,195 | 13,206 | 14,409 | **1,09,808.7** |
| Voice Identification | 82 | 96.5 | 156.5 | 316 | 432 | **1,083** |
| **Grand Total** | **97,655** | **78,901** | **60,722** | **61,055** | **65,341** | **3,63,674** |

437 As some laboratories provided case numbers for multiple divisions in one dataset, the data for cases pending was equally divided among the individual divisions.

## Table 13. Year-wise examination & pendency rate across divisions

**ER = Examination rate** **PR = Pendency rate**

| Laboratory | 2013 | | 2014 | | 2015 | | 2016 | | 2017 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | ER | PR | ER | PR | ER | PR | ER | PR | ER | PR |
| Ballistics | 90.2% | 89.3% | 101.4% | 91.8% | 92.3% | 100.2% | 92.1% | 106.7% | 100.8% | 115.4% |
| Biology | 109.3% | 74.5% | 113.8% | 57.9% | 84.4% | 44.2% | 108.5% | 53.4% | 87.5% | 50.1% |
| Chemistry | 100.0% | 49.1% | 103.6% | 41.8% | 108.3% | 20.6% | 101.2% | 20.6% | 95.4% | 27.4% |
| Cyber Forensics | 73.2% | 124.5% | 65.4% | 159.2% | 74.6% | 140.3% | 61.8% | 90.7% | 67.4% | 96.6% |
| DNA Profiling | 80.2% | 71.2% | 98.2% | 57.3% | 78.7% | 61.2% | 58.1% | 81.7% | 58.6% | 102.4% |
| Document | 116.7% | 117.4% | 72.4% | 31.2% | 97.7% | 51.1% | 101.3% | 38.7% | 83.6% | 30.5% |
| Excise | 136.8% | 15.7% | 101.0% | 8.6% | 98.8% | 9.7% | 103.1% | 5.2% | 94.4% | 3.0% |
| Explosives | 105.8% | 3.8% | 92.5% | 19.1% | 114.1% | 34.1% | 121.9% | 26.2% | 93.6% | 6.6% |
| Fingerprint | 31.4% | 5.6% | 42.1% | 2.1% | 48.2% | 8.0% | 55.5% | 7.1% | 43.6% | 9.8% |
| Narco-analysis | | | 100.0% | 0.0% | 90.0% | 10.0% | 117.6% | 5.9% | 35.3% | 64.7% |
| Narcotics | 103.9% | 10.5% | 95.7% | 13.8% | 106.4% | 19.5% | 104.8% | 19.6% | 95.5% | 17.9% |
| Photography | 101.3% | 3.1% | 99.1% | 4.0% | 96.2% | 7.4% | 101.4% | 6.4% | 99.8% | 6.3% |
| Physics | 95.1% | 34.4% | 105.3% | 29.5% | 98.1% | 28.2% | 101.1% | 26.6% | 89.1% | 33.5% |
| Polygraph | 80.8% | 1.1% | 78.1% | 7.0% | 87.9% | 19.0% | 82.6% | 11.0% | 86.9% | 15.4% |
| Serology | 88.6% | 51.2% | 99.0% | 53.6% | 85.8% | 50.1% | 91.9% | 61.6% | 91.0% | 88.7% |
| Toxicology | 129.8% | 134.6% | 145.7% | 99.0% | 97.7% | 45.0% | 106.0% | 45.1% | 103.0% | 52.7% |
| Voice Identification | 95.4% | 33.1% | 89.8% | 42.0% | 85.5% | 20.5% | 83.2% | 31.9% | 99.0% | 43.7% |

## Table 14. Year-wise cases received across laboratories

| Laboratory | 2013 | 2014 | 2015 | 2016 | 2017 | Grand Total |
|---|---|---|---|---|---|---|
| CBI-CFSL | 3,155 | 2,972 | 3,015 | 2,780 | 2,559 | **14,481** |
| CFSL Chandigarh | 2,159 | 2,960 | 2,536 | 2,244 | 2,123 | **12,022** |
| CFSL Shimla | 338 | 139 | 321 | 233 | 515 | **1,546** |
| RFSL Agra | 8,565 | 9,175 | 9,550 | 10,409 | 9,491 | **47,190** |
| RFSL Aurangabad | 21,338 | 26,412 | 24,939 | 21,707 | 21,918 | **1,16,314** |
| RFSL Berhampur | 2,971 | 1,963 | 1,332 | 1,321 | 1,403 | **8,990** |
| RFSL Dharamshala | 1,473 | 1,760 | 1,950 | 2,372 | 2,731 | **10,286** |
| RFSL Jagdalpur | 382 | 414 | 751 | 1,143 | 851 | **3,541** |
| RFSL Nagpur | 40,846 | 35,814 | 37,155 | 40,064 | 49,787 | **2,03,666** |
| RFSL Nashik | 13,018 | 13,958 | 14,184 | 15,280 | 20,700 | **77,140** |
| RFSL Pune | 24,837 | 27,366 | 30,543 | 25,079 | 26,208 | **1,34,033** |
| RFSL Ranipool | 347 | 226 | 250 | 383 | 386 | **1,592** |
| RFSL Thrissur | 640 | 840 | 821 | 1,130 | 1,087 | **4,518** |
| SFSL Agartala | 690 | 936 | 1,024 | 994 | 964 | **4,608** |
| SFSL Aizawl | 1,221 | 1,095 | 1,042 | 811 | 686 | **4,855** |
| SFSL Banderdewa | 98 | 122 | 148 | 179 | 195 | **742** |
| SFSL Bhubaneswar | 6,604 | 7,135 | 8,892 | 6,031 | 7,255 | **35,917** |
| SFSL Dehradun | 1,232 | 1,251 | 1,384 | 1,672 | 1,920 | **7,459** |
| SFSL Dimapur | 41 | 45 | 32 | 48 | 76 | **242** |
| SFSL Imphal | 499 | 538 | 465 | 434 | 680 | **2,616** |
| SFSL Lucknow | 12,116 | 11,077 | 12,856 | 11,565 | 10,713 | **58,327** |
| SFSL Mumbai | 19,804 | 24,380 | 20,792 | 20,292 | 22,797 | **1,08,065** |
| SFSL Port Blair | 301 | 212 | 103 | 149 | 199 | **964** |
| SFSL Puducherry | | | 28 | 53 | 53 | **134** |
| SFSL Raipur | 5,500 | 6,131 | 8,396 | 10,692 | 7,638 | **38,357** |
| SFSL Shillong | 622 | 631 | 548 | 552 | 504 | **2,857** |
| SFSL Shimla | 4,101 | 5,106 | 5,460 | 6,056 | 6,682 | **27,405** |
| SFSL Thiruvananthapuram | 2,297 | 2,756 | 2,580 | 3,385 | 3,944 | **14,962** |
| SFSL Verna | 353 | 346 | 230 | 277 | 367 | **1,573** |
| Grand Total | **1,75,548** | **1,85,760** | **1,91,327** | **1,87,335** | **2,04,432** | **9,44,402** |

## Table 15. Year-wise cases examined across laboratories

| Laboratory | 2013 | 2014 | 2015 | 2016 | 2017 | Grand Total |
|---|---|---|---|---|---|---|
| CBI-CFSL | 2,765 | 2,871 | 2,874 | 2,901 | 2,491 | **13,902** |
| CFSL Chandigarh | 2,573 | 2,055 | 3,077 | 2,848 | 2,120 | **12,673** |
| CFSL Shimla | 326 | 153 | 250 | 306 | 343 | **1,378** |
| RFSL Agra | 7,575 | 9,145 | 9,471 | 9,842 | 8,402 | **44,435** |
| RFSL Aurangabad | 35,884 | 24,951 | 19,324 | 19,382 | 20,323 | **1,19,864** |
| RFSL Berhampur | 1,414 | 1,965 | 3,695 | 1,441 | 1,025 | **9,540** |
| RFSL Dharamshala | 1,712 | 1,778 | 2,116 | 2,570 | 2,896 | **11,072** |
| RFSL Jagdalpur | 360 | 433 | 567 | 1,325 | 781 | **3,466** |
| RFSL Nagpur | 48,264 | 47,160 | 35,206 | 41,024 | 44,108 | **2,15,762** |
| RFSL Nashik | 21,051 | 19,593 | 14,021 | 17,218 | 19,377 | **91,260** |
| RFSL Pune | 28,580 | 31,119 | 25,662 | 24,907 | 22,882 | **1,33,150** |
| RFSL Ranipool | 339 | 221 | 233 | 371 | 358 | **1,522** |
| RFSL Thrissur | | | | | | |
| SFSL Agartala | 689 | 795 | 1,017 | 961 | 1,137 | **4,599** |
| SFSL Aizawl | 1,151 | 1,153 | 1,058 | 828 | 696 | **4,886** |
| SFSL Banderdewa | 98 | 122 | 148 | 179 | 195 | **742** |
| SFSL Bhubaneswar | 6,818 | 7,215 | 10,257 | 9,482 | 10,113 | **43,885** |
| SFSL Dehradun | 1,217 | 1,198 | 1,148 | 1,658 | 2,016 | **7,237** |
| SFSL Dimapur | 41 | 45 | 32 | 48 | 76 | **242** |
| SFSL Imphal | 284 | 365 | 282 | 240 | 516 | **1,687** |
| SFSL Lucknow | 9,229 | 10,136 | 12,568 | 10,603 | 9,583 | **52,119** |
| SFSL Mumbai | 23,343 | 25,838 | 21,842 | 17,861 | 21,671 | **1,10,555** |
| SFSL Port Blair | 312 | 187 | 73 | 175 | 176 | **923** |
| SFSL Puducherry | | | | | | |
| SFSL Raipur | 7,064 | 6,368 | 9,428 | 13,487 | 7,401 | **43,748** |
| SFSL Shillong | 362 | 467 | 606 | 536 | 391 | **2,362** |
| SFSL Shimla | 4,110 | 4,754 | 5,153 | 5,654 | 5,985 | **25,656** |
| SFSL Thiruvananthapuram | 1,729 | 1,827 | 1,718 | 2,378 | 3,717 | **11,369** |
| SFSL Verna | | 5 | 5 | 20 | 32 | **62** |
| **Grand Total** | **2,07,290** | **2,01,919** | **1,81,831** | **1,88,245** | **1,88,811** | **9,68,096** |

## Table 16. Year-wise cases pending across laboratories

| Laboratory | 2013 | 2014 | 2015 | 2016 | 2017 | Grand Total |
|---|---|---|---|---|---|---|
| CBI-CFSL | 971 | 1,087 | 1,389 | 1,203 | 1,242 | **5,892** |
| CFSL Chandigarh | 3,078 | 1,200 | 2,036 | 1,355 | 643 | **8,312** |
| CFSL Shimla | 88 | 11 | 18 | 20 | 32 | **169** |
| RFSL Agra | 6,659 | 6,689 | 6,768 | 7,335 | 8,424 | **35,875** |
| RFSL Aurangabad | 6,726 | 2,648 | 2,666 | 5,649 | 9,039 | **26,728** |
| RFSL Berhampur | 5,066 | 4,534 | 2,171 | 2,051 | 1,250 | **15,072** |
| RFSL Dharamshala | 56 | 24 | 59 | 43 | 48 | **230** |
| RFSL Jagdalpur | 22 | 3 | 187 | 5 | 75 | **292** |
| RFSL Nagpur | 21,913 | 15,476 | 4,848 | 6,845 | 5,647 | **54,729** |
| RFSL Nashik | 4,258 | 674 | 2,501 | 572 | 2,040 | **10,045** |
| RFSL Pune | 6,566 | 6,209 | 2,593 | 7,708 | 6,550 | **29,626** |
| RFSL Ranipool | 8 | 5 | 16 | 10 | 26 | **65** |
| RFSL Thrissur | 155 | 188 | 299 | 700 | 912 | **2,254** |
| SFSL Agartala | 34 | 174 | 180 | 209 | 36 | **633** |
| SFSL Aizawl | 59 | 130 | 70 | 47 | 28 | **334** |
| SFSL Banderdewa | 0 | 0 | 0 | 0 | 0 | **0** |
| SFSL Bhubaneswar | 10,107 | 9,994 | 8,591 | 5,143 | 2,253 | **36,088** |
| SFSL Dehradun | 255 | 435 | 341 | 467 | 511 | **2,009** |
| SFSL Dimapur | 0 | 0 | 0 | 0 | 0 | **0** |
| SFSL Imphal | 1,738 | 1,911 | 2,094 | 2,288 | 2,452 | **10,483** |
| SFSL Lucknow | 8,731 | 9,672 | 9,960 | 8,654 | 9,787 | **46,804** |
| SFSL Mumbai | 8,458 | 5,770 | 4,821 | 4,625 | 6,648 | **30,322** |
| SFSL Port Blair | 0 | 25 | 55 | 29 | 52 | **161** |
| SFSL Puducherry | | | 0 | 0 | 0 | **0** |
| SFSL Raipur | 9,877 | 8,734 | 4,851 | 498 | 797 | **24,757** |
| SFSL Shillong | 260 | 164 | 42 | 16 | 112 | **594** |
| SFSL Shimla | 333 | 423 | 653 | 1,234 | 1,697 | **4,340** |
| SFSL Thiruvananthapuram | 2,237 | 2,721 | 3,513 | 4,349 | 5,040 | **17,860** |
| SFSL Verna | | | | | | |
| **Grand Total** | **97,655** | **78,901** | **60,722** | **61,055** | **65,341** | **3,63,674** |

## Table 17. Year-wise examination and pendency rate across FSLs

**ER = Examination rate** **PR = Pendency rate**

| Laboratory | 2013 | | 2014 | | 2015 | | 2016 | | 2017 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | ER | PR | ER | PR | ER | PR | ER | PR | ER | PR |
| CBI-CFSL | 87.6% | 30.8% | 96.6% | 36.6% | 95.3% | 46.1% | 104.4% | 43.3% | 97.3% | 48.5% |
| CFSL Chandigarh | 119.2% | 142.6% | 69.4% | 40.5% | 121.3% | 80.3% | 126.9% | 60.4% | 99.9% | 30.3% |
| CFSL Shimla | 96.4% | 26.0% | 110.1% | 7.9% | 77.9% | 5.6% | 131.3% | 8.6% | 66.6% | 6.2% |
| RFSL Agra | 88.4% | 77.7% | 99.7% | 72.9% | 99.2% | 70.9% | 94.6% | 70.5% | 88.5% | 88.8% |
| RFSL Aurangabad | 168.2% | 31.5% | 94.5% | 10.0% | 77.5% | 10.7% | 89.3% | 26.0% | 92.7% | 41.2% |
| RFSL Berhampur | 47.6% | 170.5% | 100.1% | 231.0% | 277.4% | 163.0% | 109.1% | 155.3% | 73.1% | 89.1% |
| RFSL Dharamshala | 116.2% | 3.8% | 101.0% | 1.4% | 108.5% | 3.0% | 108.3% | 1.8% | 106.0% | 1.8% |
| RFSL Jagdalpur | 94.2% | 5.8% | 104.6% | 0.7% | 75.5% | 24.9% | 115.9% | 0.4% | 91.8% | 8.8% |
| RFSL Nagpur | 118.2% | 53.6% | 131.7% | 43.2% | 94.8% | 13.0% | 102.4% | 17.1% | 88.6% | 11.3% |
| RFSL Nashik | 161.7% | 32.7% | 140.4% | 4.8% | 98.9% | 17.6% | 112.7% | 3.7% | 93.6% | 9.9% |
| RFSL Pune | 115.1% | 26.4% | 113.7% | 22.7% | 84.0% | 8.5% | 99.3% | 30.7% | 87.3% | 25.0% |
| RFSL Ranipool | 97.7% | 2.3% | 97.8% | 2.2% | 93.2% | 6.4% | 96.9% | 2.6% | 92.7% | 6.7% |
| RFSL Thrissur | 0.0% | 24.2% | 0.0% | 22.4% | 0.0% | 36.4% | 0.0% | 61.9% | 0.0% | 83.9% |
| SFSL Agartala | 99.9% | 4.9% | 84.9% | 18.6% | 99.3% | 17.6% | 96.7% | 21.0% | 117.9% | 3.7% |
| SFSL Aizawl | 94.3% | 4.8% | 105.3% | 11.9% | 101.5% | 6.7% | 102.1% | 5.8% | 101.5% | 4.1% |
| SFSL Banderdewa | 100.0% | 0.0% | 100.0% | 0.0% | 100.0% | 0.0% | 100.0% | 0.0% | 100.0% | 0.0% |
| SFSL Bhubaneswar | 103.2% | 153.0% | 101.1% | 140.1% | 115.4% | 96.6% | 157.2% | 85.3% | 139.4% | 31.1% |
| SFSL Dehradun | 98.8% | 20.7% | 95.8% | 34.8% | 82.9% | 24.6% | 99.2% | 27.9% | 105.0% | 26.6% |
| SFSL Dimapur | 100.0% | 0.0% | 100.0% | 0.0% | 100.0% | 0.0% | 100.0% | 0.0% | 100.0% | 0.0% |
| SFSL Imphal | 56.9% | 348.3% | 67.8% | 355.2% | 60.6% | 450.3% | 55.3% | 527.2% | 75.9% | 360.6% |
| SFSL Lucknow | 76.2% | 72.1% | 91.5% | 87.3% | 97.8% | 77.5% | 91.7% | 74.8% | 89.5% | 91.4% |
| SFSL Mumbai | 117.9% | 42.7% | 106.0% | 23.7% | 105.1% | 23.2% | 88.0% | 22.8% | 95.1% | 29.2% |
| SFSL Port Blair | 103.7% | 0.0% | 88.2% | 11.8% | 70.9% | 53.4% | 117.4% | 19.5% | 88.4% | 26.1% |
| SFSL Puducherry | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| SFSL Raipur | 128.4% | 179.6% | 103.9% | 142.5% | 112.3% | 57.8% | 126.1% | 4.7% | 96.9% | 10.4% |
| SFSL Shillong | 58.2% | 41.8% | 74.0% | 26.0% | 110.6% | 7.7% | 97.1% | 2.9% | 77.6% | 22.2% |
| SFSL Shimla | 100.2% | 8.1% | 93.1% | 8.3% | 94.4% | 12.0% | 93.4% | 20.4% | 89.6% | 25.4% |
| SFSL Thiruvananthapuram | 75.3% | 97.4% | 66.3% | 98.7% | 66.6% | 136.2% | 70.3% | 128.5% | 94.2% | 127.8% |
| SFSL Verna | 0.0% | 0.0% | 1.4% | 0.0% | 2.2% | 0.0% | 7.2% | 0.0% | 8.7% | 0.0% |

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