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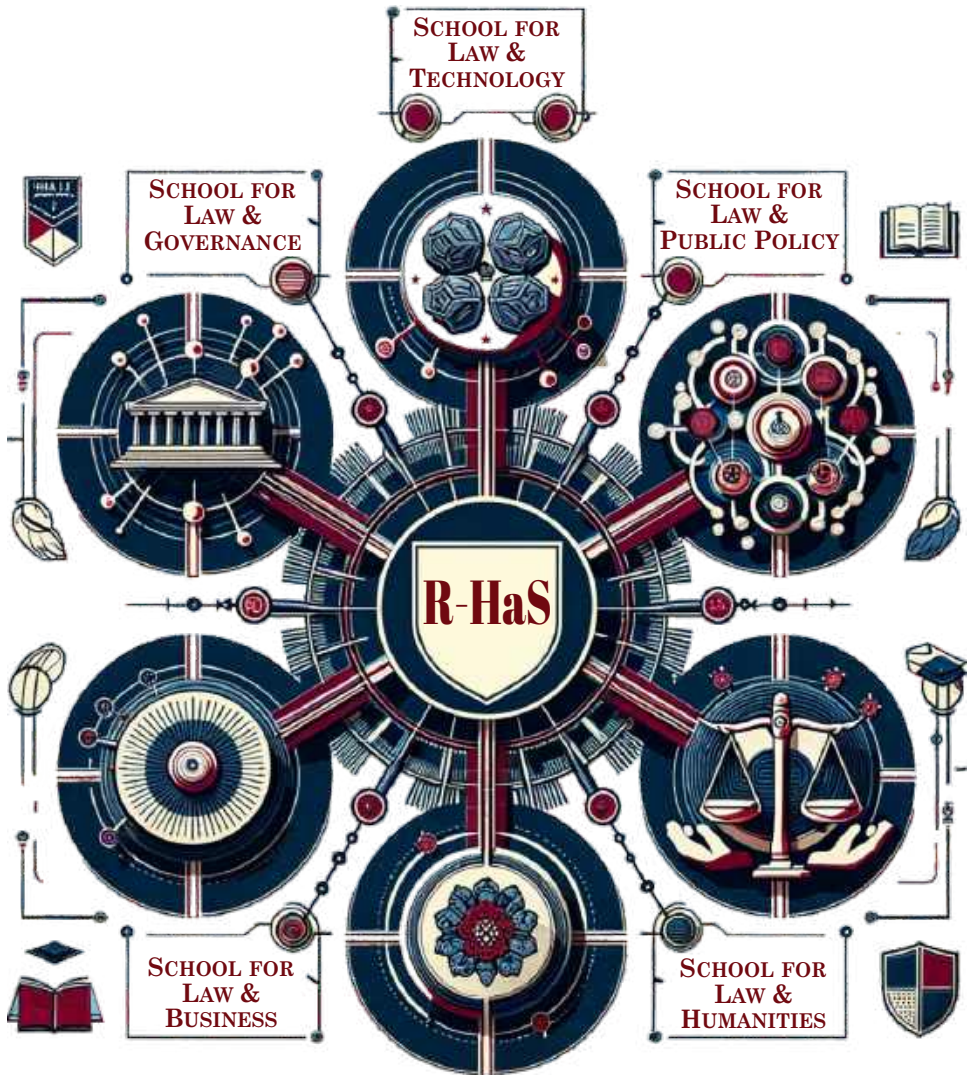


Student Essays on _____

LAW & SCIENCE

Center for Law & Sciences
SCHOOL FOR LAW & TECHNOLOGY





Student Essays on Law and Sciences

by

Centre for Law and Sciences, HNLU



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About the Centre for Law and Sciences (CLS)

The Centre for Law and Sciences at HNLU, Raipur was established under School for Law and Technology (SLT), in the year 2023. Its objective to develop research, teaching and advocacy in Law and its interface with science advances, innovation and technology. The Centre also aims to focus on promotion of interdisciplinary research and analysis on legal, ethical, and policy implications of new scientific developments and emerging technologies. The Centre seeks to provide a platform for research relating to scientific advancements and its impact on the society at large by advocacy inputs.

About the Publication

The Centre organized a National Level Online Essay Writing Competition on “Is Law the Ultimate Science?” The competition is premised on a popular quote from the American science fiction author Frank Herbert who wrote “Law is the ultimate science.” in his book Dune. In the infinite loop of catching up between legal framework and technological leaps, social transformations happen influenced by scientific innovations and get promoted or restricted by legal sanctions hereon. In the current techno-legal context, can be it surely ascertained those social transformations due to scientific innovations and technological leaps? Or in actuality the credits belong to the legal domain? Does law have the same objectivity and neutrality that science boosts? This essay competition was an opportunity for students to explore the possibilities of the question whether law is the ultimate science.

Editors

Dr. Debmitta Mondal

Head, Centre for Law & Sciences &
Assistant Professor, HNLU

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Assistant Professor, HNLU

MESSAGE FROM THE VICE CHANCELLOR, HNLU



It is with great pleasure and anticipation that I introduce this compilation of "*Selected Essays on Law & Sciences*." In assembling this collection, we have sought to explore the intersection of law and various scientific disciplines that play pivotal roles in shaping our contemporary world. The selected 15 essays delve into a diverse array of subthemes, providing insightful perspectives on crucial issues within forensic science, genetic science, neuroscience, cryptology and blockchain, environmental science, bioscience, food science, nutritional science, nuclear science, and social science.

In the realm of forensic science, the essays scrutinize the evolving landscape of crime investigation. From the analysis of scientific rigor in evidence collection, expert opinions, and the role of diverse forensic evidence in crime investigations are not only intellectually stimulating but also contribute to the ongoing dialogue surrounding the role of forensic science in the pursuit of justice.

Genetic science occupies a central place in the collection, offering profound insights into the ethical, legal, and social implications of genetic advancements. The essay on genetic science explores the topic relating to genome editing and modern demand for designer babies. The exploration of neuroscience in the collection sheds light on infamous incidents like Chernobyl accident and discusses international environmental rules like Transboundary Harm Principle, Non-Harm Principle and Environmental Impact Assessment (EIA) of projects to curtail the rippling effect of nuclear harm on society.

Cryptology and blockchain, as emerging fields, are dissected in the context of legal frameworks and societal implications. The essay navigates the complexities of blockchain technology and cryptology to show how an alibi or credible evidence can be established through time-stamping methods on blockchains.

Environmental science takes center stage in addressing the urgent concerns surrounding climate change, biodiversity loss, and sustainable development. The essay critically examines how scientific research and data driven approaches had provided proven methods of environmentally viable governance methods and legal policies like recovery of Yellowstone Grizzly Bear, Bald Eagle, etc. On the platter, essays relating to food science and nutritional science from various authors discussing the necessity of labelling rules, food nutritional standards in the food industry.

In conclusion, "*Selected Essays on Law & Sciences*" offers a thought-provoking journey through the intricate tapestry of law and various scientific disciplines. It is commendable that young scholarly students have contributed to these insightful essays and my congratulations to Dr. Debmita Mondal and Dr. Priyanka Dhar for their initiative of this unique competition and publication effort.

Prof. (Dr.) V.C. Vivekanandan

Vice Chancellor, HNLU and
Director, School of Law & Technology (SLT)

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PREFACE

In the vast realm of human knowledge, the convergence of law and science presents an intriguing frontier that calls upon scholars and practitioners to delve into the intricate dynamics shaping our contemporary era. This compilation, titled "Selected Essays on Law and Science," aims to shed light on the manifold aspects of this intersection, presenting a thoughtfully curated selection of contributions that navigate the intricate interplay between these influential domains.

The essays featured in this volume transcend mere academic exercises; instead, they collectively endeavour to unravel the far-reaching implications arising from the interrelationship between law and science. As we navigate the landscape of intellectual exploration, each essay offers a distinctive perspective, ranging from the philosophical foundations of legal reasoning amidst scientific progress to the practical challenges of formulating legislation that can keep pace with swiftly evolving technologies.

The process of selecting these essays was guided by a commitment to diversity of thought and thorough analysis. Contributors, hailing from diverse disciplines and global corners, bring a diverse array of perspectives, reflecting the worldwide challenges and opportunities inherent in the fusion of law and science. Addressing ethical considerations in forensic science and exploring the impact of blockchains on legal systems, each essay contributes a nuanced piece to the puzzle, encouraging readers to engage with the multifaceted dimensions of this crucial intersection.

As editors, our objective has been to curate a collection that stimulates intellectual curiosity and fosters a deeper understanding of the reciprocal influence between law and science. We extend our sincere gratitude to the contributors for their diligent scholarship and thoughtful reflections, which have been instrumental in bringing this collection to fruition.

This book is composed of 14 chapters on diverse topics like forensic science, environmental science, cryptology, and blockchain, nutritional science, and nuclear science.

Chapter 1 highlights the advancements in science and technology that have revolutionized the field of medical science, allowing parents to enhance facial features in their children. *Ms. Saumya Soni* further examines potential threats of genome editing and designer babies, which include not only social and ethical concerns but also dangerous gene alterations that can impact not only the target individuals but also future generations.

Chapter 2 highlights the profound significance of chronologically validated alibis within the legal domain, shedding light on their potential evolution through the seamless integration of blockchain technology and cutting-edge methodologies. *Mr. Aditya Bhura* delves into the technical intricacies of this system and scrutinizes the legal and ethical considerations encompassing its deployment, providing insight into the incorporation and integration of such pioneering solutions within the legal framework.

Chapter 3 examines the relationship between self-incrimination, forensics, and neuroscience by mapping the differences in perspectives between academia, the judiciary, and the state. *Ms. Fathima Rena Abdulla* suggests that the emergence and usage of neurotechnology in investigations underscore the interconnectedness of the mind and body, emphasizing the importance of safeguarding personal dignity and privacy.

Chapter 4 explores the interplay between law and science, shedding light on how they work to shape the path of environmental conservation. *Ms. Sangeeth Krishna* showcases examples of conservation to demonstrate how law and science have played parts in reviving species and healing the planet.

Chapter 5 is a case study revolving around the mysterious death of Sister Abhaya, a Catholic nun, and her subsequent investigation. *Ms. Nandana Arun* explains how scientific evidence like forensic analysis, narcoanalysis, medical records, and expert testimonies played a pivotal role in clarifying complex aspects of the case and establishing the truth. She suggests that the use of scientific evidence should be made an integral part of the criminal justice system with necessary checks and balances.

Chapter 6 represents the convergence of law and forensic science, delving into the intricate relationship between these two fields and

exploring the ways in which they collaborate, interact, and clash. *Ms. Ananya Mishra* briefly examines the scientific dimensions of law by emphasizing its theoretical foundations, then transitions to the world of forensic science, tracing its historical evolution and highlighting its interdisciplinary nature. She emphasizes the growing synergy between law and forensic science while reflecting on the evolving relationship with respect to the statement "law is the ultimate science."

Chapter 7 explores the longstanding relationship between science and the criminal justice system. *Mr. Bhavik Pahuja* argues that with the introduction of scientific techniques such as soil analysis, fingerprinting, and DNA, a substantial change is visible in the way investigations are conducted, contributing to the removal of reasonable doubt. He further elaborates on how handwriting analysis utilizes a combination of sensory, neurological, and physiological inputs, and the relationship between handwriting and criminal proclivity is a subject of research. He attempts to draw an analogical deduction whereby scientific advancements can be employed to understand the reasons for antisocial behaviour and the factors that shape the personalities of offenders.

Chapter 8 explores developments in the field of bioscience and suggests that with rapid advancements, there is a need for a regulatory framework. *Mr. Nandan Bharat Rathi* suggests that biotechnology has emerged as a leading field in science, and global democracies need to establish adequate laws, guidelines, and policies to cover the expanding aspects of biosciences.

Chapter 9 delves into the existing legal approaches to food safety regulations in India. *Ms. Shruti Sharma* explores the intersection of law and food science, with a focus on ensuring customer well-being through food safety regulations. The chapter examines how laws aim to achieve three key objectives: protecting public health, ensuring quality assurance, and empowering consumers. Through legislation and enforcement, India strives to provide its diverse population with access to safe and nutritious food, emphasizing the critical role of law in maintaining the integrity of the food supply chain and national well-being.

Chapter 10 discusses the multifaceted relationship between science and law, focusing on food laws and nutrition as the central theme. *Ms. Madhura Banerjee* argues that laws and their regulatory mechanisms have not yet developed sufficiently to address pertinent issues in our food system, both globally and nationally. She suggests that ethical considerations regarding public health risks must be taken into account and that the existing regulatory framework must be updated to meet the changing needs of society.

Chapter 11 explores the connection between Law and Forensic Science, highlighting their intricate relationship. *Ms. Arunita Roy Chowdhury* discusses specific cases to demonstrate how forensic science enhances legal processes, especially in addressing crimes like murder, rape, and poisoning. Emphasizing the need for justice to adapt to technological advancements, it underscores the vital role of forensic science in the legal system. Furthermore, she analyses landmark cases to showcase the profound impact of forensic science on law.

Chapter 12 addresses a pertinent global concern: nuclear energy. *Ms. Ananiasri Raghavan* argues that nuclear power plants in one nation can cause significant damage to other nations if mismanaged or if a disaster occurs. Using the example of Chernobyl, she contends that unless safety aspects of constructing, siting, and operating national nuclear power reactors are considered in domestic policies, the hazards of nuclear power operations have international dimensions.

Chapter 13 offers a jurisprudential exploration of the premise that law and science result from philosophical deliberations, citing significant historical events from the ancient Greek period. *Ms. Debjani Mukhopadhyay* explains how, during the pre-Socrates era, while science captivated minds, natural law also developed concurrently. She endeavours to comprehend the fundamental concepts of science and their applicability in legal jurisprudence.

Chapter 14 is *Mr. Ark Singh's* attempt to discuss the complex relationship between scientific evidence and legal objectivity, highlighting the interconnectedness of science and the legal system. It also delves into the difficulties of using scientific

evidence in a legal setting, considering the limitations placed on the extent to which technology can be legitimately employed.

We hope that this anthology sparks meaningful conversations among scholars, practitioners, and students alike. Whether you possess a deep understanding of the intricacies of law and science or are approaching these topics with fresh perspectives, we invite you to embark on a journey of exploration through the pages of this book. The essays presented here do not offer definitive answers but rather extend invitations to further inquiry, prompting readers to reflect on the implications of this intersection for our legal systems, ethical frameworks, and societal structures.

May these selected essays serve as catalysts for new insights, stimulate thoughtful discussions, and contribute to the ongoing dialogue shaping the future of law and science.

Dr. Debmita Mondal

Dr. Priyanka Dhar

DESIGNER BABIES - ENTERING A BRAVE NEW WORLD

Saumya Soni¹

ABSTRACT

Genome editing and designer babies has been a hot topic since many decades. Science and technology have advanced a lot in recent years. These scientific and technological advancements have the potential to revolutionize the field of medical science in innumerable ways. Parents can now enhance traits like Facial features, complexion, hair colour, height, gender, traits associated with higher intelligence, creativity, athletic ability, etc, in their children. They basically can get their babies custom-made like any designer bag or outfit. However, there are some concerning issues that may crop up with the advent of science at such a fast pace. Potential threats of genome editing and Designer babies include not only social and ethical concerns but also dangerous gene alterations that can ruin lives of not only the target individuals but can also pass down to their future generations. This essay highlights the potential advantages, disadvantages and the apprehensions associated with the designer baby technology. The author has tried to highlight the fate of mankind in a world where designer babies are common with the help of some hypothetical examples. The author has further added suggestions that may help to make sure that the technology is allowed to be researched on and used for ethical purposes.

INTRODUCTION

The concept of designer babies has been a controversial phenomenon in recent times. The idea of designer babies was a science fiction concept a few decades ago but science and technology have grown at such a commendable pace that it is now possible that parents can create babies with special features and

¹She is a 4th Year law student at Maharashtra National Law University, Nagpur.

personality traits. A designer baby is essentially a genetically altered offspring, whose genes have been edited in such a way as to ensure that they will have the features that their parents desire them to possess.² In simple words, designer babies are custom-made babies just like customized footwear, bags, or outfits. Sounds interesting right? These alterations can be achieved through various techniques such as gene editing, in-vitro fertilization (IVF), CRISPR, CRISPR-Cas9.³

As captivating as it may sound, the creation of designer babies, also referred as Genetically modified organisms or as 'engineered offspring' was initially being pursued by scientists in order to help mankind by editing genes in such a way that rare genetic diseases can be screened and eliminated before birth of the child. Diseases like cystic fibrosis, alpha-1 antitrypsin deficiency, haemophilia, beta thalassemia,⁴ and sickle cell diseases were the focal point of research and developments in this field. It was much later that research about gene editing for non-therapeutic purposes began to be considered in the bioscience community. The creation of precise genome-edited designer babies is now a reality, all thanks to advancements in mitochondrial DNA transfer and the development of genome-editing tools. However, there is not enough information available on the dangers of these editing tools, particularly when modifications can be passed down through generations.

ADVANTAGES OF DESIGNER BABY TECHNOLOGY

Genome editing in humans have several benefits. The first the most important is prevention of genetic diseases in off-spring. Designer babies can be designed in such a manner that potential genetic diseases can be screened and eliminated to create an offspring that is free from the genetic diseases that it could have otherwise

² Ly, Sarah, "Ethics of Designer Babies," Embryo Project Encyclopaedia (Oct. 16, 2023, 9:34 PM), <https://hdl.handle.net/10776/2088>.

³ Thomas Gaj, Shannon J. Sirk, Sai-lan Shui, and Jia Liu³, *Genome-Editing Technologies: Principles and Applications*, National Library of Medicine (Oct 17, 2023, 9:11 PM), <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5131771/>.

⁴ Laura Hercher, *A New Era of Designer Babies May Be Based on Overhyped Science*, Scientific American (Oct 15, 2023, 8:20 PM), <https://www.scientificamerican.com/article/a-new-era-of-designer-babies-may-be-based-on-overhyped-science/>.

genetically inherited. This can greatly reduce the suffering of individuals and families affected by conditions such as cystic fibrosis, sickle cell anaemia, and Down syndrome.⁵ This undoubtedly could improve the overall health and quality of life of the individual and his future generations. Victoria Grey is the first sickle cell patient who has been treated via CRISPR gene-editing technology in the United States. She is alive and the experiment seems to have worked for her. Doctors first took out cells from her bone marrow, and edited a gene using CRISPR. They further infused billions of such edited genes inside her body with the aim that the edited gene would produce a protein called fetal haemoglobin and reduce the symptoms of sickle cell disease.⁶ She is reportedly doing much better now and has fewer symptoms of the disease. As per reports, scientists are going to monitor her for 15 more years, to examine the success of this experiment.

Scientists believe that, other than the above-mentioned rare genetic diseases, health conditions like cystic fibrosis, sickle cell anaemia, and down syndrome, life-threatening diseases like cancer, heart disease, and diabetes can also be screened and eliminated before birth of the child by using gene editing technology. This would lead to considerable improvement in quality of life and longevity of life of individuals. Such advancements in the field of healthcare would not only benefit individuals and their families but will also reduce the economic and social burdens of healthcare systems leading to overall development and productivity of the whole society at large. ⁷

One of the most intriguing aspects of ‘designer babies’ is the potential that parents can now get their babies customized in laboratories and select the personality traits that they want their child to possess. Traits associated with the appearance of the child

⁵ Carina Graham, Stephen Hart, *CRISPR/Cas9 gene editing therapies for cystic fibrosis*, PubMed, (18. Oct, 2023, 2:20 PM), <https://pubmed.ncbi.nlm.nih.gov/33412935/>.

⁶ Rob Stein, Meredith Rizzo, *A Young Mississippi Woman’s Journey Through a Pioneering Gene-Editing Experiment*, Shots- Health news from NPR (Oct. 18, 2023), <https://www.npr.org/sections/health-shots/2019/12/25/784395525/a-young-mississippi-womans-journey-through-a-pioneering-gene-editing-experiment>.

⁷ Carina Graham, Stephen Hart, *CRISPR/Cas9 gene editing therapies for cystic fibrosis*, PubMed, (18. Oct, 2023, 2:20 PM), <https://pubmed.ncbi.nlm.nih.gov/33412935/>.

can also be tailored according to the preferences of parents. Features like blue eyes, blonde hair, tall height, fair skin, dusky skin, slim body, curves, muscles, etc can be customized altering the child's DNA. In this way, parents can make their child look a certain way, based on their favoured standards of beauty. Such individuals can be great supermodels, actors, news anchors, etc. they can make their mark in show business with great ease. Good looks will also make sure, individuals are confident and secure about themselves. This may also help eliminate problems like lack of self-esteem, inferiority complex in society.

Traits associated with intelligence, athleticism, or artistic talent can be induced in the child by parents. This has the potential to create some exceptionally talented, gifted individuals who can excel in various fields. When parents opt for higher intelligence for their child, the offspring is likely to possess exceptional analytical, problem-solving skills and cognitive abilities.⁸ Such an individual will be an academic overachiever, would be many times smarter than a common man, and would stand out in a crowd. When parents opt for athleticism in their child, the offspring produced will have exceptional physical attributes. When parents choose to enhance artistic abilities, their offspring may possess a natural aptitude for music, visual arts, or other creative pursuits, potentially becoming prodigies in their chosen fields.

A population with a diverse variety of upgraded skills and capabilities has a higher potential for innovation and advancement across several industries. Exceptionally gifted athletes can succeed in sports and related fields, while extraordinarily intelligent individuals can make enormous contributions to science and technology. Collaboration and synergy between individuals and teams can be fostered through a varied range of abilities and talents. For instance, a highly brilliant scientist can collaborate with an artistically endowed designer to develop fresh and groundbreaking products that combine innovation with technical expertise. Economic growth can be enhanced by a workforce composed of people with unique, exceptional abilities. Industries and sectors that depend on specialised skills, like technology,

⁸ Mary Todd Bergman, *'Perspectives on gene editing,'* Harvard Law Today (Oct. 18, 2023, 4:45 PM), <https://hls.harvard.edu/today/>.

entertainment, and sports, can grow and succeed significantly. A workforce made up of extraordinarily proficient individuals can increase a country's competitiveness worldwide. This can result in improvements in science, technology, culture, and sports that place a nation at the top of the list of acknowledged nations.

DISADVANTAGES OF DESIGNER BABY TECHNOLOGY AND ASSOCIATED APPREHENSIONS

The advantages of 'Designer babies' are enormous but there also are prominent threats they pose to mankind, some are known, some still unknown, and may manifest themselves in the worst possible ways. Social inequality is one of them. The development of such advanced technologies and scientific advancements may cost huge amounts of money which every parent cannot afford. This would create a situation of social divide that can be termed as 'biological elitism.'⁹ The phrase "biological elitism" refers to a scenario in which a wealthy class can acquire genetic modifications, hence becoming a biological elite with obvious advantages in health, intelligence, and talents. This would consequently lead us towards an extremely disheartening social dilemma where the gap between the rich and poor will keep widening. The only way a poor person can become rich and successful someday is by hard work, dedication, talent, and perseverance. But when rich families will start producing genetically modified superior kids, there will be no room left for the weaker sections of the society to cope with such technology. They subsequently will not be able to transform their lives even after putting in dedicated efforts because they will not have the potential to compete with genetically modified babies who certainly will not be any less than some sort of extraordinary super-humans.¹⁰

⁹ William Reville, 'Biological elitism: the result of tinkering with human genomes?' THE IRISH TIMES (Oct. 18, 2023) <https://www.irishtimes.com/news/science/biological-elitism-the-result-of-tinkering-with-human-genomes-1.3612763>.

¹⁰ Bonnie Steinbock, 'Designer babies: choosing our children's genes,' THE LANCET BLOG (Oct. 20, 2023, 10:01 AM), <https://www.thelancet.com/journals/lancet/article/>.

These circumstances would further worsen the social framework by creating disparities between the genetically enhanced humans and naturally born humans. Employers may choose to hire people who exhibit enhanced genetic features because they will have the impression that such individuals will be more productive or have fewer health problems. This might reduce the opportunities available to people without genetic improvements. Genetically enhanced kids may be given preference in educational institutions, resulting in unequal access to quality education and academic opportunities. Economic inequality can be exacerbated by genetic discrimination because people lacking improvements may have less access to resources and lucrative employment opportunities. Social hierarchies could be created because of genetic discrimination, with enhanced people being valued more than their non-enhanced counterparts.¹¹

Another huge concern regarding designer babies is the need to strike the right balance between autonomy and equity. Many argue that parents should have the right to choose the traits they want their child to possess and should thereby have the right to alter their child's genetic framework for the desired outcomes most suitable for their bright future. On the other hand, an ethical dilemma exists as a situation of imbalance in society would arise if 'designer baby' becomes an actively running medical practice. The wealthy and affluent will have customized, branded babies, with higher chances of becoming successful in life, meanwhile the generationally poor will remain poor and unsuccessful because their parents could not afford genetic enhancements. They would not be able to compete with genetically enhanced individuals, leading the poor to have very little or no scope for improving their lives even after making sincere efforts leading them to never get recognition for their hustle.¹² This can make them feel hopeless and emotionally vulnerable, making the masses vulnerable to

¹¹ Janna Thompson, 'What we risk as humans if we allow gene-edited babies: a philosopher's view', THE CONVERSATION BLOG (Oct. 20, 2023, 9:56 AM), <https://theconversation.com/what-we-risk-as-humans-if-we-allow-gene-edited-babies-a-philosophers-view-110498>.

¹² Alex Salkover and Vivek Wadhwa, 'When Baby Genes Are for Sale, the Rich Will Pay,' FORTUNE BLOG (Oct. 20, 2023, 10:05 AM), <https://fortune.com/2017/10/23/designer-babies-inequality-crispr-gene-editing/>.

mental health disorders like depression, anxiety, etc, thereby raising serious health-related concerns for the society at large. Suicide cases are also likely to rise, creating pathetically chaotic conditions for society.

Another huge disadvantage regarding designer babies is the violation of autonomy of the child. When parents design their babies according to their own aspirations, the baby has no choice or no say about their own bodies and well-being. The child basically does not have the right to choose its career, explore its hobbies, like naturally born babies have because their personality traits would have already been planned by their parents. They will not have the same mystery and excitement in their lives regarding self-exploration and self-realisation which undoubtedly is a beautiful aspect of human life.¹³

Example - 1

Let us look at the example of an Indian couple, Mr, and Mrs Chopra, who are obsessed with American culture and beauty standards. They have permanently settled in the US. They are planning to have a baby. They are adamant to have a female child designed according to American beauty standards as they aspire their daughter to pursue modelling and be a world-renowned supermodel in future. They want their baby to have the typical New York girl look and features. They have planned that the child will be white, will have blue eyes, will be 6 feet tall, will have blonde hair, and will have an hourglass shape figure. Their daughter Alexa Chopra is born. Mr and Mrs Chopra are so obsessed with the United States that they did not even give their daughter an Indian name. Alexa Chopra looks completely American. She looks nothing like her Indian parents. She grows up. She has been conditioned to accept that her goal in life is to be a glamorous supermodel. She has participated in many beauty pageants and runaway shows and has won many titles. Although she is happy with her life, she

¹³ Alison Berkley Mardo, Designer Babies: *‘Where Does Society Draw the Line?’* Aspen Institute (Oct. 18, 2013, 5:12 PM), <https://www.aspeninstitute.org/blog-posts/designer-babies-ethical-moral-biological-implications-future-genetic-technology/>.

has always wondered how her life would have turned out if she was not a designer baby. She has kept some big secrets from her family. She loves animals and deep inside she always wished she could become a veterinarian. She could never have enough courage to share her desires with her parents because she feared that she may hurt their feelings by not standing by their aspirations. Meanwhile, she often wishes she could stay away from the public eye and could have more privacy in life. Being famous welcomes a lot of scrutiny by the world. Living her life in the public eye made her prone to social anxiety and paranoia. Apart from her career choice, she sometimes wonders what she would have looked like if her genes were not altered to make her look American. She secretly adores her ancestral genes and wishes she could also look like her mother, father, grandparents, cousins. She feels like the odd one. She is deeply infatuated by Indian culture and beauty. She loves her Indian nickname 'Roshni,' that her grandma gave her. She wishes she could feel more connected to her own culture. This results in Alexa; aka Roshni Chopra being dissatisfied with her life. She continues to pretend to the world and to herself that she is happy but deep inside, she knows she has lost autonomy over her life.

Many critics argue that widespread genetic modifications and the obsession of the society to create “perfect” or highly customized babies can lead us to a homogenized society where there is lack of diversity and authenticity.¹⁴ If a society with widespread genetic modifications comes into existence, only certain personality traits and characteristics will be considered attractive, which would slowly result in the extinction of other traits.¹⁵

Many scientists expressed their concern about the growing demand for genome editing for non-therapeutic purposes. Parents want to alter genes responsible for skin colour, hair colour, height, etc. They also want to opt for genetic enhancements to induce higher degrees of intelligence, athletic ability, creativity, etc. Scientists

¹⁴ Mara Almeida, Robert Ranisch, '*Beyond safety: mapping the ethical debate on heritable genome editing interventions*', Spring Nature Blog, <https://www.nature.com/articles/s41599-022-01147-y>.

¹⁵ Cary Funk and Meg Hefferon, '*Public Views of Gene Editing for Babies Depend on How It Would Be Used*,' Pew Research Centre Blog (Oct. 17, 2023, 4:26 PM), <https://www.pewresearch.org/science/2018/07/26/public-views-of-gene-editing-for-babies-depend-on-how-it-would-be-used/>.

and researchers all over the world do not find it ethical to use genome editing techniques for such reasons that are not based on necessity. Not only is it very risky to use this technique, but it also has the potential to create a separate class of elite super-humans. The fear that widespread genetic alterations may reduce naturally existing variances in the population is the basis for the argument that using genetic engineering to produce “perfect” or highly customised babies could end up in a homogenised society and restrict diversity and individuality. This would result in a condition where only some specific traits will be considered desirable and everyone would opt for genetic alterations to achieve those traits. Some traits might completely wipe out the world. For example, some communities believe that fair skin tone is superior to dark skin tone. To fit into the beauty standards, the people of black community might get their offsprings’ genes altered. This will result in the black community slowly proceeding towards extinction. In a society where genetic engineering becomes common, all parents will opt for the similar characteristics for their offspring. At present, the most successful people in the world are those who have dedicatedly worked hard, over a long period of time. People like Elon Musk, Taylor Swift, Shahrukh Khan, Lata Mangeshkar, Shakira, MS Dhoni, could become successful and super popular only because of their hard work. In a society where perfection is so easily achievable, merely by altering the genetic framework of the embryo, Celebrity culture would cease to exist. Here is an example to understand the abovementioned hypothesis practically.

Example - 2

Mr and Mrs Chaturvedi are willing to have a baby. Mr Chaturvedi is a big fan of ‘The Weeknd.’ Mrs Chaturvedi herself was a singer when she was in college, but could never pursue singing as her profession. Due to their extreme obsession and emotional connection with music, both husband and wife want their child to make a career in music. They opted for gene alteration of their baby. Mr and Mrs Chaturvedi live in the 22nd century, an era where designer babies are very common. They are blessed with a boy. They named him Rishabh Chaturvedi. Rishabh can sing well. He can learn any musical instrument in less than 3 months. He even

has a breath-taking 6-octave vocal range. Rishabh participates in many high-profile talents shows. He also has a YouTube channel where he showcases his talent. Rishabh has turned 25 now, he started singing when he was 5, he could play 7 musical instruments brilliantly at the age of 20. But even after 20 years of active career in music, Rishabh could not achieve the level of success and fame that he used to dream of. This was happening because his talent was not unique. He was surrounded by several designer babies. Each baby was perfect. He even won two talent shows, had his fifteen minutes of fame and media attention, but again people forgot about him within 6 months. Mr and Mrs Chaturvedi were also disappointed. Rishabh had no stable source of income. His YouTube channel helped him earn a good amount of money for some years but gradually people moved on to other artists and he got lost in the crowd. Rishabh loved reading about Michael Jackson's stardom and watched his old videos. He has now understood that the world has completely changed and celebrity culture cannot be the way it used to be in the 20th or the 21st Century. His dreams of being a superstar could never be a reality. Mr and Mrs Chaturvedi also understood that their child is not special and can never become the next 'The Weeknd' or Michael Jackson, because celebrity culture is already dead. Genome editing has made everyone perfect. Hence, Perfection is the new definition of mediocrity.

Coming to the most detrimental aspect of designer babies, Genetic modifications might have unforeseen consequences on the health and well-being of individuals. Unintended changes to a person's genetic makeup may result from genetic modifications.¹⁶ These modifications could result in unanticipated health problems that might persist for years and may even pass on to the upcoming generations of the target designer baby. For instance, a change intended to improve a particular feature may unintentionally alter other genes, having unintended effects. Since genetic engineering technologies are still relatively new and rapidly developing, it is difficult to predict the long-term implications of genetic alterations.

¹⁶ Craig Holdrege, '*Understanding the Unintended Effects of Genetic Manipulation*,' The Nature Institute Blog (Oct. 17, 2023, 2:17 PM), <https://www.natureinstitute.org/article/craig-holdrege/understanding-the-unintended-effects-of-genetic-manipulation>.

The evaluation of the effectiveness and safety of these alterations may take decades or even longer.¹⁷

The field of genetic engineering is complicated, and altering a person's genetic makeup may have unforeseen repercussions. To guarantee that these technologies are adequately studied and their long-term effects are recognized, proper regulation is required. The growing trend of producing designer offspring can put parents under social and ethical pressure. Instead of letting their children develop naturally, parents may feel pressured to use technology to help their children adhere to society's standards of beauty, intelligence, and athleticism. Here is an example to illustrate the above-mentioned catastrophe.

Example - 3

Mr and Mrs Smith, an American couple, want to have a baby boy. Both husband and wife love basketball and are obsessed with NBA players and their lifestyle. They want their son to grow up and become one of the most famous basketball players in the US. They get their child's genes altered in such a way as to induce athleticism in his personality. They tailored their child's genes in such a way that he has broad shoulders, muscular body, height over 8 feet and great immune system, when he grows up. The couple want their child to set a record and be the tallest NBA player in history. The average height of an NBA player is 6 feet 6 inches.¹⁸ The tallest NBA player ever is Gheorghe Muresan who is 7 feet 7 inches tall. There are 13 NBA players in history who are over 7 feet tall.¹⁹ This is the reason why Mr and Mrs Smith had special focus on their baby's height and specifically wanted him to be taller than

¹⁷ Sebastian Schleidgen, Hans-Georg Dederer, Susan Sgodda, Stefan Cravcisin, Luca Lüneburg, Tobias Cantz & Thomas Heinemann, 'Human germline editing in the era of CRISPR-Cas: risk and uncertainty, inter-generational responsibility, therapeutic legitimacy', BMC Medical Ethics Blog (Oct. 17, 2023, 1:13 PM), <https://bmcmethics.biomedcentral.com/articles/10.1186/s12910-020-00487-1>.

¹⁸ *The Average Height of NBA Players from 1952-2022*, The Hoops Geek Blog (Oct. 18, 2023, 3:13 PM), <https://www.thehoopsgeek.com/average-nba-height/>.

¹⁹ Cameron Miller, '13 Tallest Players in NBA History, Ranked by Height', The Sportster Blog (Oct. 17, 2023, 3:46 PM), <https://www.thesportster.com/nba-tallest-players-history/#pavel-podkolzin-7-foot-5>.

8 feet to make him the tallest NBA player in the history of the US. Their son is born. Mr and Mrs Smith named him Theo. Theo Smith's childhood passes very happily. At the age of 14, when a newly made teenager Theo's body started transforming rapidly, his friends and family noticed some unusual changes in his body. His height grew from 6 feet 8 inches to 8 feet 5 inches in 2 months. The scary part was, his legs were abnormally long compared to his abdomen. His arms grew so long that they touched the ground. He became taller than 8 feet as his parents wanted but the proportions of his body were completely distorted. Theo's dreams got shattered. Since he was a little kid, all he dreamt of was to become a successful NBA player and to set the record of being the tallest NBA player ever. He rested assured that he will have all the bodily attributes required to achieve what he desired as he was a designer baby. The experiment got unsuccessful and Theo Smith has become a physically disabled young boy unlike what his family had planned for him. The doctor who designed Theo's genetic composition was held responsible for not highlighting the potential threats associated with this technology to Theo's parents. Mr and Mrs Smith sued him and he was sent to prison for 3 years for not being transparent about the threats associated with the technology and being reckless. Theo could not bear the pain and the humiliation he and his family were facing along with the loss of his career. He decided to end his life and hanged himself in his room. It has been 3 months and Mr and Mrs Smith cannot stop blaming themselves for Theo's death. The couple could not bear the pain of losing their child, society's taunts about their blind obsession, and the guilt over their unsafe choices about Theo's life. The couple ends up committing suicide 6 months after Theo's death. Several debates are ongoing wherein scientists and experts have pointed out that Theo's children could have also inherited the traits connected with his deformed genes if he was alive and chose to have a family. The incident shook the entire world to the core. Even though this story is mere fiction, it depicts the potential threats that the world can anticipate with regards to designer babies.

STATUS OF LAWS RELATING TO CRISPR AND DESIGNER BABY TECHNOLOGY ACROSS THE WORLD

Germline editing for non-therapeutic purposes has been heavily criticized by scientists all over the world due to the enormous threats it poses to mankind if it is allowed without sufficient research and regulatory framework. In November 2018, a Chinese researcher called He Jiankui reported the birth of twin sisters named Lulu and Lala, whose genome had been edited at embryo stage to induce HIV resistance, by using CRISPR/Cas method.²⁰ He was heavily criticized by scientists and researchers all over the world and was even sent to prison for 3 years for performing illegal medical practices.²¹ The scientific community found this experiment as premature and dangerous. Many of them argued that the motivation behind this study did not depict a strong sense of purpose or necessity, the potential benefits were quite small whereas the risks involved were enormous, which apparently made it criminally reckless.²²²³ After this incident, scientists working on germline editing stated that there should be more debate about this topic and there is a need for an international regulatory framework in this regard.

At present, the status of genome editing and associated safety concerns is not sufficient to allow it to be practiced as a safe medical practice. In entirety, the researchers found 125 policy documents from 96 different nations. Only 40 out of 96 countries have regulations that specifically address germline genome editing (i.e., not for reproduction), with 23 countries outright banning this research and 11 explicitly permitting it. Iran, Ireland, Japan,

²⁰ Sean C. McConnell, Alessandro Blasimme, 'Ethics, Values, and Responsibility in Human Genome Editing', AMA Journal of Ethics Blog (Oct 17, 2023, 4:37 PM), <https://journalofethics.ama-assn.org/article/ethics-values-and-responsibility-human-genome-editing/2019-12>.

²¹ Tina Hesman Saey, 'Strict new guidelines lay out a path to heritable human gene editing', Science News Journal (Oct. 18, 2023, 5:46 PM), <https://www.sciencenews.org/article/human-germline-gene-editing-crispr-strict-new-guidelines>.

²²Henry T. Greely, 'Stanford's Hank Greely on CRISPR People and Designer Babies', STANFORD LAW SCHOOL BLOGS (Oct. 20, 2023, 1:49 PM), <https://law.stanford.edu/2021/04/21/stanfords-hank-greely-on-crispr-people-and-designer-babies/>.

²³ Official YouTube Channel, The Economist Magazine (Oct 16, 2023, 6:23 PM), https://youtu.be/F7DpdOHRDR4?si=h2-hr7oZO_NOGlq.

Norway, Thailand, the United Kingdom, the United States, Burundi, China, Congo and India are those 11 countries.²⁴ In contrast, 78 out of 96 nations have policies regarding heritable genome editing (i.e., for reproductive purposes), of which 70 completely forbid it, five (Columbia, Panama, Belgium, Italy, and the UAE) forbid it with possible exceptions, and three (Burkina Faso, Singapore, and Ukraine) are undecided. Heritable human genome editing is not expressly permitted in any of the 96 nations.²⁵ Four nations (Albania, Bahrain, Belarus, and Croatia) purport to forbid all research involving human embryos in their policy documents. Given that no human embryo research is allowed, all four are categorised as forbidding germline genome editing. This broad ban is categorised as forbidding heritable human genome editing in Bahrain and Belarus. However, due to their membership of the Oviedo Convention, Albania and Croatia are categorised as forbidding heritable human genome editing. China, the United Kingdom, and the United States are the three countries that have been actively participating in the global policy discussions about genome editing.²⁶

India has outlawed reproductive cloning and germline gene editing. Even though germline editing is illegal in India, editing for therapeutic purposes is permitted, but subject to strict regulations.²⁷ Japan is neutral about research into germline gene editing, but it absolutely forbids genetic manipulation and re-insertion of an embryo into a woman's womb. China is going to introduce 'gene editing regulation' after the Chinese scientist was sentenced to prison for the birth of the twin girls whose genes were altered to induce resistance from HIV. The US has in a way

²⁴ Françoise Baylis, Marcy Darnovsky, Katie Hasson, and Timothy M. Krahn, 'Human Germline and Heritable Genome Editing: The Global Policy Landscape,' Liebert Pub Blog, <https://www.liebertpub.com/doi/10.1089/crispr.2020.0082>.

²⁵ Farah Qaiser, 'Study: There Is No Country Where Heritable Human Genome Editing Is Permitted,' Forbes (Oct 17, 2023, 8:40 PM), <https://www.forbes.com/sites/farahqaiser/2020/10/31/study-there-is-no-country-where-heritable-human-genome-editing-is-permitted/?sh=46261a4e7617>.

²⁶ Rob Stein, 'Controversial New Guidelines Would Allow Experiments on More Mature Human Embryos,' Shots- Health news from NPR (Oct. 17, 2023, 4:18 PM), <https://www.npr.org/sections/health-shots/2021/05/26/1000126212/new-guidelines-would-allow-experiments-on-more-mature-human-embryos>.

²⁷ Akshara Nair, 'The Designer Baby Quandary- An Insight into Gene Editing and Its Legality,' LIVE LAW BLOG (Oct. 20, 2023, 02:05 PM), [ner-baby-quandary-an-insight-into-gene-editing-and-its-legality](https://www.livelawblog.com/2023/10/20/the-designer-baby-quandary-an-insight-into-gene-editing-and-its-legality).

accepted the use of genome editing technology but there are still no proper regulations. In the US, in 2016, The national health department issued a report that mentioned guidelines and conditions under which gene editing was allowed. To ensure safety, meticulous research has been carried out in compliance with the NIH Guidelines. Genetically modified organisms (GMOs) were once viewed with suspicion in the UK, although this attitude is slowly changing. In contrast to other advanced countries, the UK is more accepting of germline editing. Scientists were given permission by the authority to alter the gene of live human embryos. These practices show that the UK is moving in the direction of accepting the new age of designer babies.²⁸

CONCLUSION AND RECOMMENDATIONS

The future of designer babies is a complicated and sensitive topic. The question whether this technology should be allowed or not attracts a lot of scrutiny. By keeping the current situation of genome editing and designer babies in mind, it can be said that this technology has not reached the degree of safety and reliability that is required for a medical practice to be allowed on a large scale.

'Designer babies' still attract controversy and speculations because of the enormous safety and ethical concerns that may crop up. Critics have been vocal about threats regarding social gap, homogenous society and chances of the gene alterations affecting future generations. Despite being tagged as 'unsafe,' it is a well-recognized fact that gene editing has the potential to revolutionize medical science in great ways and can be a boon to mankind when used for producing resistance against life threatening diseases. Here are some suggestions to consider.

It is important to create a strong ethical framework that considers the core ideals of autonomy, human dignity, and child welfare. There should be strict regulatory agencies and international agreements developed to supervise and regulate any technologies

²⁸ Neha Mallik, 'The Era of Designer Babies through Genetic Engineering,' IPLEADERS BLOG (Oct. 20, 2023, 22:55 PM), https://blog.ipleaders.in/genetic-engineering/#Position_in_the_USA.

connected to designer babies. These organisations should make sure that all applications adhere to moral standards and place a high priority on the protection and welfare of children. It should be illegal to employ designer baby technology to uphold prejudice against people based on their race, ethnicity, aptitude, or financial background. Instead of making already existing inequities worse, technology could be used to increase human potential and wellbeing.

The possible hazards, restrictions, and long-term effects of genetic editing must be thoroughly discussed with prospective parents. They should be educated about the hazards. Consent should be freely granted after being fully informed. For any genetic alteration method, strict safety and efficacy requirements must be met while considering potential off-target consequences and long-term health repercussions. Transparency in designer baby technology research and development should be promoted. To promote accountability, findings, methods, and results should be disseminated throughout the scientific community and the public. Modification of characteristics that might be deemed dangerous or detrimental to someone's health or wellbeing must therefore be outlawed. To avoid a dangerous rush towards the genetic augmentation of offspring, it is important to promote international collaboration and consensus on the use of designer baby technology.

ALIBI UNCHAINED: ENHANCING CREDIBILITY WITH BLOCKCHAIN

Aditya Bhura¹

ABSTRACT

This paper underscores the profound significance of chronologically validated alibis within the legal domain, shedding light on their potential evolution through the seamless integration of blockchain technology and cutting-edge methodologies. Chronologically validated alibis emerge as a pivotal and indispensable facet of legal cases, serving as an essential cornerstone in definitively ascertaining an individual's precise location at a particular moment, frequently constituting the decisive determinant in legal proceedings. Within these pages, we introduce an innovative approach to the verification of alibis, focused on the creation of a system that endows individuals with the capability to fabricate chronologically validated, tamper-resistant alibis. Leveraging the formidable potential of blockchain technology and advanced methodologies, this groundbreaking system establishes an unequivocally secure and immutable means of substantiating an individual's location, thereby conspicuously elevating the credibility of alibi evidence. The ramifications of this pioneering research transcend the confines of the courtroom, potentially heralding a transformative paradigm for investigative and adjudicative procedures in the digital era. This paper does not merely delve into the intricate technical intricacies of this system but also rigorously scrutinizes the legal and ethical considerations encompassing its deployment, thus providing invaluable insight into the progressive pathway for the incorporation and integration of such pioneering solutions within the legal framework, surpassing the scrutiny of automated AI assessment tools.

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INTRODUCTION: THE IMPERATIVE OF TIME-STAMPED ALIBI VERIFICATION

Within the jurisprudential domain, the role of alibis has remained central in adjudicating the culpability of individuals accused of criminal transgressions. An alibi, a plea asserting an individual's presence elsewhere at the time of an alleged offence, constitutes a fundamental element in the legal arsenal, frequently wielding profound influence over legal proceedings. However, the enduring challenge of substantiating the veracity of alibis has engendered not only wrongful convictions² but also the potential illusion of the culpable.³

This exigency underscores the exigent necessity to institute innovative and unequivocally secure methodologies for alibi verification, precipitating our exploration into the realm of time-stamped alibis. Time-stamped alibis denote alibi claims underpinned by digital records validating an individual's precise geographic coordinates at a specific juncture in time. These records, emanating from advanced technologies such as blockchain, harbour the potential to profoundly reshape the modus operandi through which alibis are established and scrutinized within the legal spectrum. Given the intricate nature of alibi verification, this scholarly endeavour seeks to traverse the intricacies of time-stamped alibis and their pivotal role in augmenting the credibility of alibi evidence. The guiding research query for this investigation is articulated thus:

"How can an apparatus be conceived to empower individuals in crafting time-stamped, incorruptible alibis through the utilization of blockchain and other advanced technologies, and what ramifications does this apparatus harbour for the legal edifice?"

To comprehensively expound upon this inquiry, the following salient research objectives have been postulated:

² Meredith Allison, Sandy Jung, & Amanda C. Benjamin, *Alibi believability: Corroborative evidence and contextual factors*, 38(4) Behavioral Sciences & the Law, 1, 2 (2020).

³ Lisa Kern Griffin, *SILENCE, CONFESSIONS, AND THE NEW ACCURACY IMPERATIVE*, 65(4) Duke Law Journal, 697, 725 (2016).

1. **Conceptualization of Time-Stamped Alibis:** This discourse endeavours to offer a rigorous conceptual elucidation of the construct of time-stamped alibis, unveiling their juridical relevance within legal proceedings and their transformative potential therein.

2. **Technological Implementation:** The exposition shall proffer an in-depth exploration of the pragmatic facets pertaining to time-stamped alibis, delineating the methodological intricacies and technological nuances germane to the formulation of a system that empowers individuals to forge time-stamped alibis. Emphasis shall be placed upon the application of blockchain technology and cognate advanced systems in ensuring the inviolability of records.

3. **Legal and Ethical Considerations:** Recognizing the profound implications intrinsic to the integration of time-stamped alibis within the precincts of the courtroom, this treatise will proffer a meticulous analysis of the legal and ethical dimensions enshrouding this paradigm shift. Encompassing issues of evidentiary admissibility, data privacy, security, and the potential quagmires and controversies within the extant legal framework, this section shall provide comprehensive scrutiny.

Through the judicious pursuit of these research objectives, this scholarly contribution aspires not merely to enrich the academic comprehension of alibi verification but, more profoundly, to propound a forward-looking paradigm intent on enhancing the probity and precision of the legal process. It underscores the transformative potential of blockchain and advanced technologies within the precincts of forensic science and jurisprudence, assuring that justice is dispensed with an elevated degree of certitude.

The verification of alibis plays an indispensable role in legal proceedings by serving as a means to corroborate an accused individual's whereabouts during a specific time frame, potentially exonerating them. Nevertheless, the process of validating alibis has been a persistent conundrum within the legal system, marked by inherent limitations and susceptibilities.⁴ This literature review

⁴ Meredith Allison, Sandy Jung, & Amanda C. Benjamin, *Alibi believability: Corroborative evidence and contextual factors*, 38(4) Behavioral Sciences & the Law, 1, 2 (2020).

endeavours to explore prevailing practices in alibi verification, emphasizing their deficiencies and introducing the potential of blockchain technology as a transformative solution to these challenges.

EXISTING METHODS FOR VERIFYING ALIBIS

Conventional approaches to alibi verification predominantly rely on eyewitness testimonies,⁵ surveillance footage,⁶ and paper-based records like sign-in logs at a given location. These methods, however, are replete with intrinsic limitations. Eyewitness accounts are vulnerable to inaccuracies and biases, surveillance footage may not comprehensively cover the relevant timeframe, and paper records are susceptible to forgery and tampering. These constraints have, regrettably, led to wrongful convictions and thwarted exonerations in numerous instances. The proclivity for human error and the potential for manipulation in these methods underscore the exigent need for more robust alibi verification techniques.

LIMITATIONS AND CHALLENGES IN CURRENT ALIBI VERIFICATION PROCESSES

The shortcomings of the prevailing methodologies for alibi validation are multifaceted. Furthermore, the advent of digital technologies has introduced a new array of challenges, including the capacity to fabricate convincing counterfeit alibi evidence through digital manipulation. Consequently, the extant state of alibi verification procedures falls short of providing the requisite level of security and certainty necessary for judicious legal proceedings.

⁵ Richard A Wise, Clifford S. Fishman & Martin A. Safer, *How to Analyze the Accuracy of Eyewitness Testimony in a Criminal Case*, 42 CONN. L. REV. 435, 440 (2009); *State v. Cotton*, 351 S.E.2d 277, 280 (N.C. 1987).

⁶ Tara M. Burke, & John W. Turtle, *Alibi evidence in criminal investigations and trials: Psychological and legal factors*, 1(3) Canadian Journal of Police and Security Services, 286, 286-294 (2003).

BLOCKCHAIN TECHNOLOGY AND ITS POTENTIAL APPLICATIONS IN ALIBI VERIFICATION

Blockchain technology⁷ emerges as a promising antidote to the quandaries plaguing alibi verification. Blockchain, characterized by its decentralized, tamper-resistant, and transparent digital ledger, records data across a network of interconnected computers. In the context of alibis, blockchain technology can guarantee the creation of time-stamped and immutable records attesting to an individual's whereabouts. Each alibi entry can be cryptographically sealed, rendering it impervious to tampering. The decentralized nature of the blockchain ensures that records are not under the control of a single entity, substantially mitigating the risk of manipulation.

Moreover, blockchain technology facilitates secure access to alibi records, permitting authorized stakeholders, including investigators, legal authorities, and relevant individuals, to verify alibi without compromising data integrity. The immutability and transparency of blockchain position it as a formidable candidate to redress the deficiencies inherent in current alibi verification methods, with the potential to usher in a revolution in how the legal system handles alibi evidence.

In summation, the existing paradigms for validating alibis in legal proceedings are fraught with profound limitations stemming from human error and technological vulnerabilities. Blockchain technology, with its capacity to generate secure, time-stamped, and tamper-proof records, presents a compelling solution to augment the credibility and reliability of alibis within legal proceedings. This review underscores the imperativeness of exploring this innovative approach to confront the enduring challenges in alibi verification.

⁷ Zibin Zheng, Shaoan Xie, Hongning Dai, Xiangpeng Chen and Huaimin Wang, *An Overview of Blockchain Technology: Architecture, Consensus, and Future Trends*, IEEE International Congress on Big Data, 557, 557-564 (2017).

A BLUEPRINT FOR CRAFTING TIME-STAMPED ALIBIS LEVERAGING BLOCKCHAIN AND ADVANCED TECHNOLOGIES

In this section, we introduce a comprehensive methodology that delineates the roadmap for conceiving time-stamped alibis. This proposed approach, albeit yet to be executed, meticulously outlines the critical stages imperative for the creation of a tamper-proof system poised to potentially revolutionize the alibi verification process.

1. Approach and Methodology

The methodology commences with a conceptual framework that lays the groundwork for the development of time-stamped alibis:

- **Scope Definition:** Our methodological outset entails a precise definition of the time-stamped alibi system's scope. This encompasses identifying the intended objectives of the system, envisaging its potential applications, and discerning the specific legal contexts in which it could find utility.

- **User-Centric Approach:** A cornerstone of our methodology resides in adopting a user-centric perspective. This necessitates an exhaustive exploration of user requirements to comprehensively grasp the specific needs of those furnishing alibis, legal practitioners, and other pertinent stakeholders.

- **Legal Standards Scrutiny:** In cognizance of the variances in legal requisites across jurisdictions, our methodology mandates a meticulous examination of the legal standards and prerequisites governing admissible alibis. This preliminary research is foundational, informing the development trajectory and ensuring compliance with pertinent legal constraints.

2. Blockchain and Advanced Technologies

The subsequent phase of our methodology pivots towards the integration of blockchain technology and advanced methodologies:

- **Permissioned Blockchain:** We propose the adoption of a permissioned blockchain network as the underpinning architecture for assuring the system's security and immutability.

This approach constricts access exclusively to authorized entities, amplifying the sanctity of alibi data.

- **Blockchain Advantages:** Our methodology underscores the manifold merits of employing blockchain technology for alibi verification. We accentuate the benefits of data immutability, tamper deterrence, and heightened transparency, each serving as pivotal elements in fortifying the veracity of alibi evidence.

3. Data Collection

Our prescribed approach streamlines the data collection process to ensure seamlessness and robustness:

- **User-Intuitive Interface:** We advocate for the design of an intuitive and user-friendly interface that facilitates the effortless submission of alibi information by individuals. This interface should encompass key data facets, including date, time, location, and supportive evidence.

- **Distinct Timestamps and Cryptographic Hashes:** In recognition of the paramount significance of data security, our methodology underscores the generation of unique timestamps and cryptographic hashes⁸ for each alibi entry. These components serve as the bedrock of the system's tamper-proof architecture.

4. Cryptography

Security and data integrity are paramount in our methodology:

- **Advanced Cryptographic Protocols:** We recommend the employment of advanced cryptographic protocols⁹ to safeguard alibi data against unauthorized access and tampering. These robust encryption methods are indispensable in preserving the confidentiality and integrity of alibi information.

- **Cryptographic Key Management:** Our methodology accentuates the criticality of cryptographic key management for access control. We emphasize the need to institute secure access policies that shield the confidentiality and integrity of alibi data.

⁸ Kevin Wahome Macharia, *Cryptographic Hash Functions* (2021).

⁹ Mohammad Khalid Imam Rahmani, *Cryptographic Algorithms and Protocols, A Step Towards Society 5.0*, 1, 3-6 (2021).

5. Hardware/Software Prerequisites

This segment elucidates the pivotal infrastructure and technological components requisite for manifesting the proposed system:

- **High-Performance Servers:** To ensure the reliability and consistency of the blockchain network, we propose the deployment of high-performance servers. This guarantees that the system operates with efficiency and steadfastness.
- **User Interfaces:** Our proposition endorses the creation of user-friendly software interfaces, accessible via web and mobile platforms. These interfaces should be meticulously designed for intuitiveness and accessibility, delivering an engaging user experience.
- **Technology Stacks:** We delve into prospective technology stacks and frameworks well-suited for the realization of the system. This encompasses considerations of scalability, security, and adaptability, ensuring the selected technology stack is harmonious with the system's overarching goals.

In summary, our methodology furnishes a comprehensive and strategic blueprint for the development of time-stamped alibis. While the practical implementation of the system remains a forthcoming endeavour, our approach meticulously delineates the pivotal steps and actions necessitated to give life to this innovative solution. Subsequent phases of this research would entail the practical development, rigorous testing, and meticulous evaluation of the system to assess its feasibility and efficacy within the legal landscape. The proposed methodology serves as a roadmap for a tamper-proof system with the potential to substantially elevate the credibility of alibi evidence in legal adjudications.

BLOCKCHAIN TECHNOLOGY IN ALIBI VERIFICATION: ENHANCING SECURITY AND CREDIBILITY

1. In-depth Explanation of Blockchain

Blockchain, a distributed ledger technology,¹⁰ extends far beyond its origins in cryptocurrency, notably exemplified by Bitcoin. Its fundamental structure consists of a chain of blocks, with each block containing a chronological record of transactions or data. These blocks are intricately linked, establishing an immutable ledger. The decentralized nature of blockchain is a cornerstone of its appeal. Operated on a network of computers, known as nodes, transactions are collectively verified and recorded. This decentralization imbues the system with transparency and security.

2. Benefits of Using Blockchain for Time-Stamping Alibis

The integration of blockchain technology into time-stamping alibis yields several profound advantages:

- **Immutability:** Data recorded in a blockchain is almost impervious to alteration or deletion. Each block holds a cryptographic reference to its predecessor, forming an indomitable chain of blocks that would require substantial computational power to tamper with. This robust immutability ensures the reliability of time-stamped alibis, effectively thwarting fraudulent changes or manipulations.
- **Security:** Blockchain harnesses advanced cryptographic techniques to fortify data. In the realm of alibi verification, this translates into a robust safeguard where once an alibi is inscribed on the blockchain, it is shielded from unauthorized access, thus diminishing the threat of data breaches or tampering.
- **Transparency:** The decentralized architecture of blockchain means that multiple copies of the ledger are disseminated across the network. This transparency bestows an elevated level of visibility and trust. All stakeholders in a legal case, ranging from

¹⁰ Reza Soltani, Marzia Zaman, Rohit Joshi, and Srinivas Sampalli, *Distributed Ledger Technologies and Their Applications: A Review*, 12(15) Applied Sciences 1, 1-16 (2022)

investigators to jurors, can access and authenticate alibi information, thereby promoting credibility and equity.

3. Challenges and Solutions in Blockchain Implementation

Despite its multifarious benefits, the integration of blockchain technology into alibi time-stamping is not bereft of challenges. A few pivotal considerations encompass:

- Scalability: With the expansion of the blockchain network, potential concerns arise related to performance, speed, and efficiency. These concerns can become pronounced when numerous individuals concurrently time-stamp their alibis. Scalability can be bolstered through solutions such as sharding or off-chain processing to optimize network performance.

- Privacy: The conundrum of preserving individuals' privacy while establishing a tamper-proof alibi system is a multifaceted issue. One potential resolution involves the implementation of cryptographic techniques enabling selective disclosure of information. This approach permits the revelation of only the requisite details while safeguarding sensitive data.

- Regulatory and Legal Frameworks: The utilization of blockchain in legal contexts may necessitate the formulation of new or adapted regulations. The establishment of legal standards pertaining to blockchain-generated alibis, their admissibility in a court of law, and considerations of cross-jurisdictional compatibility warrant meticulous deliberation to ensure a harmonious integration of blockchain into the legal paradigm.

In summation, blockchain technology presents an innovative solution for time-stamping alibis, proffering immutability, security, and transparency. While there exist challenges to surmount, including scalability and privacy concerns, the potential dividends are substantial. By comprehending the intricate mechanics of blockchain and methodically addressing these challenges, it is plausible to engineer an invulnerable system for alibi verification, thereby heightening the credibility and trustworthiness of alibi evidence within legal proceedings.

SYSTEM IMPLEMENTATION: CREATING TAMPER-PROOF TIME-STAMPED ALIBIS

The implementation of a time-stamped alibi system represents the concrete manifestation of a robust and tamper-proof solution for alibi verification. In this section, we delve into the intricate details of the system's development and deployment, the design of the user interface, and the utilization of advanced cryptographic techniques and secure data storage mechanisms that together guarantee tamper resistance.

1. Development and Deployment

The time-stamped alibi system has been meticulously engineered to be both resilient and user-friendly. It is strategically deployed within a secure and decentralized blockchain network. The system's architectural framework is composed of multiple essential components, including a user-friendly front-end interface, a sophisticated back-end processing module, and the blockchain infrastructure itself. This deployment strategy ensures that the system is accessible to individuals seeking to create time-stamped alibis, all the while maintaining the highest levels of security.

2. User Interface

The user interface is thoughtfully designed to be intuitive and accessible, accommodating individuals from diverse backgrounds. Users are provided with the capability to input their alibi details, including specific location data, a detailed account of their activities, and any corroborative evidence. This interface seamlessly integrates with external data sources such as GPS or surveillance systems, thereby allowing for real-time validation. Subsequent to the submission of their alibi particulars, the system promptly generates a timestamp and securely records the information on the blockchain. Users are furnished with a unique identifier, which not only enables them to access their alibi records securely but also ensures the integrity of their data.

3. Cryptographic Techniques and Data Storage

The utilization of advanced cryptographic techniques within the system is paramount in safeguarding against tampering. As users

submit their alibis, the data undergoes a rigorous process of hashing and encryption, employing cutting-edge cryptographic algorithms. These algorithms, in turn, generate a distinctive digital signature for each alibi entry, rendering any unauthorized alteration virtually impossible without immediate detection.

Data storage, crucial to the system's security, is meticulously decentralized across a multitude of nodes within the blockchain network. This decentralization strategy significantly enhances the system's security by mitigating the risks associated with data loss or manipulation. Furthermore, the immutability inherent in blockchain technology guarantees that once an alibi is recorded, it remains unaltered and permanently preserved.

In summary, the system implementation of time-stamped alibis encompasses a holistic approach to development and deployment, coupled with an intuitively designed user interface. The interface accommodates the input of alibi information and seamlessly integrates with external data sources for real-time validation. Advanced cryptographic techniques, combined with decentralized data storage within the blockchain, ensure the tamper resistance and security of alibi records. This system not only elevates the credibility of alibi evidence but also empowers individuals to possess a secure and immutable testament of their whereabouts within legal contexts.

LEGAL AND ETHICAL CONSIDERATIONS: INTEGRATING TIME-STAMPED ALIBIS INTO LEGAL PROCEEDINGS

This section scrutinizes the legal and ethical dimensions inherent in the incorporation of time-stamped alibis within courtroom deliberations. We delve into the implications of amalgamating blockchain technology and advanced methodologies into the legal framework, considering pivotal factors such as privacy, data security, and the admissibility of blockchain-based evidence. Moreover, we undertake a comparative analysis, juxtaposing the proposed system with prevailing legal benchmarks for alibi validation.

1. Legal Implications

a. **Admissibility of Blockchain-Based Evidence:** A paramount legal consideration is the admissibility of evidence derived from the proposed time-stamped alibi system. While well-established legal precedents exist for traditional forms of evidence like eyewitness testimonies¹¹ and surveillance footage,¹² the advent of blockchain-based alibi evidence necessitates a nuanced approach. Courts must grapple with issues pertaining to the reliability and tamper resistance of blockchain evidence, ensuring its alignment with requisite legal standards for admissibility.

b. **Authentication and Chain of Custody:** Establishing the authenticity of blockchain-based alibi evidence is of utmost importance. The legal framework must devise protocols to ascertain the veracity of data, the accuracy of timestamps, and the integrity of cryptographic hashes. Equally crucial is the maintenance of a transparent chain of custody, guaranteeing that the evidence remains untainted and inviolate throughout the legal proceedings.

c. **Jurisdictional Variations:** Significantly, legal benchmarks for alibi authentication can manifest divergences across jurisdictions. It is imperative to account for these regional disparities when advocating for the integration of time-stamped alibis. Complying with local legal requisites is indispensable for ensuring widespread acceptance and validity within the legal ecosystem.

2. Ethical Considerations:

a. **Privacy Safeguards:** The introduction of blockchain and advanced technologies in alibi authentication precipitates pertinent privacy concerns. Stakeholders providing alibis may express apprehensions regarding the storage and potential exposure of sensitive personal data. Establishing ethical guidelines to fortify the privacy of involved parties is imperative, necessitating robust data protection measures and stringent access controls.

¹¹ Ravasaheb @ Ravasahebgouda Etc. v. State of Karnataka, 2023 LiveLaw (SC) 225

¹² Tomaso Bruno v. State of U.P., (2015) 7 SCC 178

b. **Data Security Imperatives:** The immutable nature of blockchain technology is an asset from a security standpoint, yet it engenders ethical deliberations about data permanence. The system must incorporate mechanisms allowing individuals to request the expungement or anonymization of their alibi data post its legal relevance, underscoring the need for ethical data management protocols.

c. **Upholding Equity:** Core ethical tenets of equity and impartial access to the legal system assume paramount significance. Any framework facilitating the generation of time-stamped alibis must be architected to ensure equitable access for all, irrespective of socioeconomic status or technological acumen. Prudent measures should be instituted to forestall the engenderment of a digital divide in the sphere of justice access.

3. Comparative Analysis with Existing Standards:

The proposed system for time-stamped alibis marks a departure from conventional methods of alibi validation. Undertaking a comparative evaluation, we draw the following insights:

a. **Enhancing Credibility and Reliability:** Contrasted with established standards, the deployment of blockchain and advanced technologies substantially augments the credibility and reliability of alibi evidence. The incorruptible nature of data and the robust cryptographic security framework furnish a sturdy bedrock for ascertaining the authenticity of alibis.

b. **Fortification against Tampering:** In contradistinction to conventional methodologies, the proposed system excels in fortifying alibi data against tampering. It guarantees the immutable nature of records and the prompt discernibility of any efforts at data manipulation. This proffers a notable edge over conventional modes, susceptible to human biases and inadvertent alterations.

c. **Requisite Legal Adaptation:** The legal paradigm must undergo adaptation to effectively assimilate this innovative approach to alibi validation. Courts and legal bodies must devise procedural mechanisms to authenticate and endorse blockchain-based evidence. Though representing a departure from customary

practices, the adaptability of the legal apparatus assumes primacy in accommodating and harnessing this digital evolution.

In summation, the introduction of time-stamped alibis, bolstered by blockchain and advanced technologies, engenders a confluence of legal and ethical deliberations. The legal framework necessitates an evolutionary trajectory to address concerns of evidence admissibility, data authentication, and custodial integrity. Ethical underpinnings, encompassing privacy protection, data security, and equity, must be seamlessly interwoven into the architecture and implementation of the system.

In comparative light, the proposed framework presents substantive advantages in terms of credibility, reliability, and resilience against tampering. However, it embodies a substantive departure from conventional methodologies, necessitating the recalibration of the legal ecosystem to effectively embrace this innovative paradigm. In effectuating the complete potential of time-stamped alibis, the synergistic collaboration of legal luminaries, technologists, and ethicists assumes cardinal import, ensuring the sanctity of the legal process while safeguarding individual liberties.

FUTURE DIRECTIONS: ADVANCEMENTS IN TIME-STAMPED ALIBI SYSTEMS AND BEYOND

The trajectory of time-stamped alibi systems promises a future of continuous improvement and broader applicability, poised to reshape the legal landscape through the amalgamation of blockchain and advanced technologies. In this section, we delineate potential avenues for enhancing time-stamped alibi systems, probe alternative uses of blockchain within the legal domain, and deliberate on the scalability and adaptability of these systems across diverse legal jurisdictions.

1. Improvements for Time-Stamped Alibi Systems

One critical avenue for advancement involves the infusion of artificial intelligence (AI) and machine learning algorithms to automate the validation process of alibis, thereby diminishing the reliance on subjective human interpretation. This augmentation in

efficiency will undoubtedly bolster the reliability and expediency of the system. Additionally, the development of interoperable frameworks that seamlessly integrate with other legal technologies, such as e-discovery and case management systems, has the potential to streamline the entire legal process. Such integrative capabilities can substantially expedite investigations and proceedings, making the legal apparatus more effective and responsive.

2. Exploring Alternative Applications of Blockchain in the Legal Field

Beyond the sphere of time-stamped alibis, blockchain technology offers a multitude of prospects within various legal domains. Smart contracts, for instance, present the opportunity to automate and enforce contractual agreements, reducing the need for intermediaries and enhancing the efficiency of transactions. Decentralized identity verification can revolutionize secure authentication processes, safeguarding individuals' identities and personal information. Transparent supply chain management utilizing blockchain can ensure compliance and authenticity, a critical component in today's globalized world. Furthermore, blockchain's potential to facilitate secure and transparent voting systems has the capacity to elevate the democratic process and instil greater trust in governance by ensuring the integrity of elections.

3. Scalability and Adaptability Across Legal Jurisdictions

To ensure the global acceptance and implementation of time-stamped alibi systems, it is paramount to guarantee their scalability and adaptability across a multitude of legal jurisdictions. This demands a collaborative effort, uniting legal experts, policymakers, and technology professionals to construct standardized protocols that harmonize with diverse legal frameworks and data protection regulations on a global scale. International partnerships and initiatives for regulatory harmonization will further grease the wheels of integration, allowing these systems to seamlessly assimilate into diverse legal environments, irrespective of geographical boundaries.

To sum up, the future directions of time-stamped alibi systems traverse a broad spectrum of advancements, ranging from the infusion of AI for enhanced validation to the exploration of diverse applications of blockchain within the legal domain. Moreover, the focus on scalability and adaptability across varied legal jurisdictions stands as a linchpin for ensuring their widespread acceptance and harmonious integration into the global legal framework. The legal landscape is poised for a technological evolution, one that promises to augment efficiency, transparency, and the equitable dispensation of justice.

CONCLUSION: TIME-STAMPED ALIBIS - A PARADIGM SHIFT IN ALIBI VERIFICATION

This research has undertaken a deep exploration of the groundbreaking concept of time-stamped alibis, fortified by blockchain technology and advanced applications, revealing a profound transformative potential within the domain of alibi verification. The core findings of this study spotlight the pivotal significance of time-stamped alibis and the transformative possibilities they hold for the alibi verification processes.

Time-stamped alibis will emerge as a veritable game-changer on the legal stage. Their significance resonates in their capacity to furnish a secure, tamper-proof, and inherently credible mechanism for validating an individual's precise whereabouts at specific moments in time. The deployment of blockchain technology, renowned for its immutability and transparency, ensures that these alibis remain unassailable over time, deftly addressing the inherent pitfalls embedded in conventional alibi verification methodologies.

Nevertheless, the potential of this technology transcends the mere enhancement of the credibility of alibi evidence. It bears the promise of reshaping the very paradigms and norms that govern the legal domain. The embrace of blockchain-facilitated time-stamped alibis not only streamlines the verification process but also fosters an unswerving trust in the legal system. By affording a highly secure and dependable conduit for documenting and

authenticating alibis, it perceptibly diminishes the spectre of erroneous convictions and miscarriages of justice.

In summation, time-stamped alibis epitomize a revolutionary approach to alibi verification. Their prospective influence in redefining legal standards and ameliorating the precision and equity of legal proceedings is nothing short of monumental. As technology advances and legal frameworks evolve, the seamless integration of time-stamped alibis heralds a new epoch in alibi verification, one characterized by an unwavering commitment to security, credibility, and the sanctity of justice

SELF-INCRIMINATION, FORENSICS AND NEUROSCIENCE: PERSPECTIVES FROM ACADEMIA, JUDICIARY AND THE STATE

Fathima Rena Abdulla¹

ABSTRACT

This article examines the relationship between self-incrimination, forensics, and neuroscience by mapping the differences in perspectives between academia, judiciary and the state. We revisit the historical roots of the privilege against self-incrimination, emphasizing its origins in the defence counsel's emergence to safeguard the rights of the accused. Forensic science comes under scrutiny, revealing the pressing need for stringent oversight to prevent unreliable techniques from undermining the credibility of criminal investigations. Our analysis highlights the privilege against self-incrimination as a crucial factor in both the due process and crime control models, ensuring protection against coerced confessions and maintaining moral authority within the justice system. The emergence and usage of neurotechnology in investigations underscores the interconnectedness of the mind and body, emphasizing the importance of safeguarding personal dignity and privacy in addition to self-incrimination. This article seeks to make a case for a more appropriate balance between scientific testing and rights of the accused.

INTRODUCTION

The Judiciary, Academia and State are different institutions that seek to achieve different objectives. Sometimes, they have conflicting approaches towards the same problem. This is because the concerns and interests they are expected to address differ

¹ The author is a third-year law student at the National University of Advanced Legal Studies, Kochi.

significantly. Hannah Arendt's comment in her 1967 essay, *Truth and Politics* provide insight to this conflict;

“The judiciary, either as a branch of government or as direct administration of justice is carefully protected against social and political power, even Academia, to which the state entrusts the education of its future citizens, shares this trait. To the extent that Academe remembers its ancient origins, it must know that it was founded by Plato, the State's most determined and most influential opponent.”²

This Article seeks to trace how this fundamental conflict plays out in forensic laboratories within the context of self-incrimination. The authors believe this conflict to be the root cause of the problem described above and will try to prove that within the contents of this Article. From there, the article aims to arrive at a conclusion or perhaps, a solution to the conflict before us.

In section II, this article looks at how academic experts have influenced our understanding of self-incrimination. This article will explore the historical background, theories, and the role of research institutions. It will also discuss the conflicts within academia, like how some experts support self-incrimination to protect the accused, while others favour forensics to secure convictions. This article will also touch on how academia sometimes has different ideas than the government when it comes to the law.

Further, in section III, it takes a closer look at how law enforcement and the judiciary in India are adapting to new forensic techniques. This article will discuss the reasons behind these changes, including the need for advanced methods when traditional ones don't work. It will also explore the human rights angle and how the Supreme Court steps in to protect people's constitutional rights

Finally, in section IV, this article will look into the role of forensic

² Hannah Arendt, *Truth and Politics*, THE NEW YORKER (Feb. 25, 1967), <https://www.newyorker.com/magazine/1967/02/25/truth-and-politics>.

psychologists in this process and question the trade-off between using science to solve crimes and protecting individual rights. After a crucial decision by the Supreme Court, there are concerns that investigators are still using aggressive methods to get evidence from people. This article will also talk about how the Supreme Court's judgment sets a precedent in other cases, making it clear that scientific tests can't override the protection against self-incrimination. It will discuss the broader context of this protection, extending beyond evidence reliability to include the state's burden of proof and the accused's autonomy in choosing their defence.

In conclusion, this article discusses the need for clear rules and standards in forensic science, as emphasized in the Report of the Committee on Draft National Policy on Criminal Justice.³ This report highlights the importance of a strong policy framework that respects individual rights while advancing the pursuit of justice in an ever-changing legal landscape.

TRACING THE ACADEMIC DIALOGIC ON SELF- INCRIMINATION

This section seeks to explain how academia with its – historical scholarship, theories, techniques and research institutions – influenced how self-incrimination is interpreted today. It traces two different conflicts. The first conflict is the one within academia itself concerning – historical origins and conflicting ‘alliances.’ Here, we explore how historically, self-incrimination developed as a result of the emergence of the defence counsel whereas forensics evolved to aid the prosecution. Therein lies the fundamental conflict between the objectives of the two – one is allied with the defence counsel to protect the accused and the other with the prosecution to help with conviction. The second contradiction is the one between Academia and the State with regards to their conflicting approaches towards the criminal process. Finally, we examine how all of this falls within the broader framework and how there is a need for a common objective.

³ Ministry of Home Affairs, Report of the Committee on Draft National Policy on Criminal Justice (2007).

SELF-INCRIMINATION AND THE DEFENSE COUNSEL

In India, the doctrine against self-incrimination emerged as a mere extension of the common law doctrine brought in by the British. In *MP Sharma v. Satish Chandra*, the judiciary beautifully stressed the importance of historical narrative in interpreting the privilege of the right against self-incrimination. It said;

“In order, therefore, to arrive at a correct appraisal of the scope and content of the doctrine and to judge to what extent that was intended to be recognized by our Constitution-makers in article 20(3), it is necessary to have a cursory view of the origin and scope of this doctrine and the implications thereof as understood in English law and in American law and as recognized in the Indian law.”⁴

There are disagreements and an overall lack of clarity when it comes to tracing the origin of the doctrine of self-incrimination in common law, through which it was adopted in the Indian legal system. As E.H Carr put it, History is the unending dialogue between the past and the present.⁵ Overlooking the origins is important in order to determine the intended objective of the doctrine initially and to understand its implications today. There are primarily two differing, if not conflicting narratives concerning its origin.

The first one, which is the ‘Wigmorean’ narrative that is prevalent, has located the origins of the common law privilege in the second half of the seventeenth century.⁶ The dictum *nemo tenetur prodere seipsum*, concerning the nature of Christian responsibility loosely translated as “no one is obligated to accuse himself.” It clarified that a believer could confess his sins to a priest without having to

⁴ M.P. Sharma v Satish Chandra, 1954 SCR 1077.

⁵ E. H. CARR, WHAT IS HISTORY? (1961).

⁶ 8 JOHN H. WIGMORE, EVIDENCE IN TRIALS AT COMMON LAW § 2250, at 267 (John T. McNaughton rev. ed. 1961). See, John H. Wigmore, *the Privilege against Self-Crimination; Its History*, 15 HARV. L. REV. 610 (1902) and See, John H. Wigmore, *Nemo Tenetur Seipsum Prodere*, 5 HARV. L. REV. 71 (1891).

confess criminal acts to judges and prosecutors.⁷ According to Wigmore, the prerogative courts and the ex officio oath procedure in the ecclesiastical courts which used confessions for prosecution, fell as a result of this influential dictum. Under this narrative, in the mid-17th century, the common law courts in England in turn acknowledged this development by accepting the privilege against self-incrimination.⁸

The second narrative questions Wigmore's findings. They contend that Wigmore was a century off in his identification of the origins of the privilege against self-incrimination.⁹ As Langbein contends,¹⁰ the privilege was falsely traced back to the Christian dictum. Whereas, in reality, it was the work of the defence counsel. Earlier guilt of the accused was just assumed and there was no concept of defence counsel or rights for the accused. This was a court where on one side there was a prosecution with a lawyer and on the other side there was just the accused without a lawyer who only got to speak in the form of response to questions or accusations from the prosecution. So, a right to silence emerging in such a historical context is not only just absurd, it would've been something that worked against the accused.

Right to silence only makes sense when there's a defence counsel present. If the defence counsel was not present, the accused's right to remain silent in practice, would've meant waiving even the little defence that the accused had. When defence counsel appeared in the process, they were able to restructure the criminal trial so that the accused could be kept silent and they could put up an effective defence. As a result, it became possible to create genuine privilege against self-incrimination under common law.

Acknowledging the 'Wigmorean' fallacy and drawing the distinction here becomes important because it will affect how the purpose of the doctrine is perceived and interpreted. For instance, the historical narrative that was subscribed to on the law

⁷ R.H. Helmholz, *Origins of the Privilege against Self-Incrimination: The Role of the European Ius Commune*, 65 N.Y.U. L. REV. 962, 982 (1990).

⁸ 8 WIGMORE, supra note 5, § 2250, at 289.

⁹ John H. Langbein, *The Historical Origins of the Privilege Against Self Incrimination at Common Law*, 92 MICH L. REV. 1048, 17 (1994).

¹⁰ *Id.*

commission report on Article 20(3) was the Wigmorean one.¹¹ That misses the fact that it was actually the work of the defence counsel and was in essence, a right that helped bridge the power gap between the accused and the State/prosecution alliance, and one not merely concerned with religious liberties.

THE PROSECUTION BIAS

The majority of forensic methods were first developed in police departments as investigative aids intended to produce evidence that would connect suspects to crimes and secure convictions.¹² Due to its law enforcement roots, forensic disciplines have a natural alignment with one side of the adversarial process: the prosecution.¹³ Forensic practitioners work for prosecutors and communicate with them frequently, and they hardly ever collaborate with defence attorneys without prosecutors listening in.¹⁴ As a result of their pro-prosecution attitude and eagerness to give evidence that helps the prosecution's case even when it is unjustified, forensic professionals frequently consider themselves as members of the prosecution team.¹⁵ Even people who do not consider themselves to be a part of law enforcement may feel under pressure to deliver the outcome that the prosecution is looking for.¹⁶

Presently, India lacks a consistent and comprehensive legislative framework to regulate forensic facilities and ensure strict

¹¹ Law Commission of India, *180th Report on Article 20 (3) of the Constitution of India and Right to Silence* (2002), <https://cdnbbsr.s3waas.gov.in/s3ca0daec69b5adc880fb464895726dbdf/uploads/2022/08/2022081051.pdf>.

¹² Maneka Sinha, *Radically Reimagining Forensic Evidence*, 73 ALABAMA. L. REV. 879 (2022).

¹³ Michael J. Saks, *Merlin and Solomon: Lessons from the Law's Formative Encounters with Forensic Identification Science*, 49 HASTINGS L. J. 1069, 1092 (1998).

¹⁴ Nicole Bremner Casarez & Sandra Guerra Thompson, *Three Transformative Ideals to Build a Better Crime Lab*, 34 GA. ST. U. L. REV. 1007, 1008 (2018).

¹⁵ Paul C. Giannelli, *The Abuse of Scientific Evidence in Criminal Cases: The Need for Independent Crime Laboratories*, 4 VA. J. SOC. POL'Y & L. 439, 441 (1997).

¹⁶ See, Comm. On Identifying The Needs Of The Forensic Sci. Cmty., Nat'l Rsch. Council, *Strengthening Forensic Science In The United States: A Path Forward* 107–08 (2009), <https://www.ncjrs.gov/pdffiles1/nij/grants/228091.pdf>.

adherence to standard operating procedures and protocols.¹⁷ Recent legal cases involving scientific evidence suggest that courts have occasionally accepted discredited methods without addressing the use of flawed forensic procedures.¹⁸ For example, in 2019, the Delhi High Court mandated a narco-test facility at a Delhi FSL, resulting in a notable increase in narco-analysis tests.¹⁹ Similarly, in the Nirbhaya gang-rape case, the Supreme Court heavily relied on bite mark evidence, despite its globally acknowledged inaccuracies and its association with wrongful convictions.²⁰

In the above instance, the Supreme Court relied on skewed academic research and little expert testimony to get the questionable conclusion that the defendants were “most likely” to blame for the markings.²¹ Since there is no established cutoff point or quantifiable scientific criterion to decide its application in various circumstances, the judiciary's use of the “reasonable medical certainty” test is a cause of concern.²² Furthermore, forensic evidence cannot be justified just because there was no obvious manipulation with the sample in issue if the threshold of proof “beyond a reasonable doubt” has not been met.²³

Forensics is different from the rest of the sciences in that it is outcome-oriented and driven by adversarial interests.²⁴ Forensic methods are focused on processing cases and securing convictions, in contrast to the scientific process, which seeks to generate knowledge through the scientific method by encouraging continuous research and reevaluation of ideas and methods rather

¹⁷ Dr. Ambily P. & Ashna D., *A Socio-Legal Critique of the Regulation of Forensic Laboratories in India*, 7(2) NLUJ L. REV. 191(2021).

¹⁸ *Id.*

¹⁹ Eric H Holder Jr and others, *The Impact of Forensic Science Research and Development*, NATIONAL INSTITUTE OF JUSTICE (2015).

²⁰ Adebola Olufunmi Olaborede and Lirieka Meintjes-van der Walt, *The Dangers of Convictions Based on a Single Piece of Forensic Evidence* 23 POTCHEFSTROOM ELECTRONIC LAW JOURNAL 1, 34 (2020); Kelly Kostelnik et. al, *Freeing the Innocent: When Guilty Convictions are Overturned due to Errors in Bite Mark Analysis*, UNIVERSITY OF FLORIDA COLLEGE OF MEDICINE.

²¹ *Mukesh and Another v State (NCT of Delhi) and Ors* (2017) 6 SCC 1 36

²² Daniel Selby, *Why Bite Mark Evidence Should Never Be Used in Criminal Trials*, INNOCENCE PROJECT (Apr. 26, 2020); National Commission on Forensic Science, *Testimony using the term “Reasonable Scientific Certainty”* (2016).

²³ *Mukesh and Another v State (NCT of Delhi) and Ors*, (2017) 6 SCC 1 224

²⁴ *supra* note 10.

than the achievement of a specific outcome.²⁵ Despite the nomenclature, forensic disciplines other than DNA analysis did not develop out of academia, research institutions, or scientific laboratories; they do not have their roots in the sciences at all.²⁶ A scientific culture that would have encouraged independent evaluation, critique, and repeated testing did not develop. As a result, forensic methods acquired an immunity to standard scientific checks and balances.²⁷ This persistent lack of a scientific culture has turned into a major roadblock for reform initiatives.²⁸ Whatever the motivation, what is frequently produced in court is flawed, unreliable, unsubstantiated, or just not scientific at all. Nevertheless, it persuades jurors and judges.²⁹

TAKING A CRITICAL VIEW APPROACH TOWARDS CRIMINAL PROCESS

The American jurist Herbert Packer in a famous article theorized two models of criminal process: the “crime-control model” and the “due process model.”³⁰ Crime-control model, as the name suggests is concerned with controlling crime – increasing conviction rates, efficiency of administration, reliability of evidence etc. The due process model, in contrast, is more concerned with liberty of the individual rather than the efficiency of the criminal process. The idea is that these two models lie at the two opposite ends and there is a whole spectrum in between where different jurisdictions lie.

These models have been repeatedly applied in different contexts to understand the nature of the conflict between criminal rights and state legislations. Scholars like Bhatia have examined the

²⁵ Paul C. Giannelli, *Independent Crime Laboratories: The Problem of Motivational and Cognitive Bias*, 2010 UTAH L. REV. 247, 250

²⁶ Terrence F. Kiely, *The Houses of Deceits: Science, Forensic Science, and Evidence*, 35 LAND & WATER L. REV. 397, 415 (2000).

²⁷ D. Michael Risinger & Michael J. Saks, *A House with No Foundation*, ISSUES IN SCI. & TECH. (2003), <https://issues.org/risinger/>.

²⁸ SANDRA GUERRA THOMPSON, COPS IN LAB COATS: CURBING WRONGFUL CONVICTIONS THROUGH INDEPENDENT FORENSIC LABORATORIES 195 (2015) (“Instead of taking the lead in ensuring that the needed research was conducted, many forensic practitioners adopted a ‘circle the wagons’ mentality and attacked the critics.”).

²⁹ *supra* note 10.

³⁰ Herbert Packer, *Two Models of the Criminal Process*, 113 U. PA. L. REV. 1 (1964).

privacy conflict through this lens and have suggested how a shift towards 'due process' would partly 'fix' the problem. In the present context, it is tempting to apply this framework to the conflicts described above. At a glance, it is easier to make the generalization that forensics is influenced by the crime-control model and the right against self-incrimination is a product of the due-process. But, on a deeper look, this would be a false dichotomy to make. If forensic evidence was an agency for crime-control, then it should enhance the efficiency of the criminal process by increasing 'correct' conviction rates. But, as mentioned above, due to the unreliability of certain kinds of forensic evidence, if there was in fact an increase in conviction rates there would be a good chance that at least part of the resultant increase is because of false convictions. Therefore, it fails to even fall within the category of the crime-control model.

Likewise, the right against self-incrimination isn't neatly confined to the due process model; it has relevance in both crime control and due process models. Compelled testimony is often unreliable because it's not given willingly. People tend to avoid sharing self-incriminating evidence voluntarily, and history shows that forced and false confessions are common. This gives both the crime control model, which seeks precise guilt or innocence determinations, and the due process model, which aims to prevent rights abuses leading to forced self-incrimination, a good reason to protect this right.³¹ As the Canadian Supreme Court pointed out, self-incrimination protection serves the dual purpose of guarding against inaccurate confessions and preventing state power abuse.³²

Ian Dennis takes a different approach, arguing that the rule of law must maintain both factual accuracy and moral authority to remain valid.³³ In this view, the law of evidence can exclude evidence that is seemingly relevant but carries a high risk of being unreliable or that might undermine the moral legitimacy of the

³¹ Akhil Amar & Renee Lerner, *Fifth Amendment First Principles: The Self-Incrimination Clause*, (1995) 93 MICH. L. REV. 857.

³² *R v S.A.B.*, [2003] 2 SCR 678, 703.

³³ Ian Dennis, *Instrumental Protection, Human Right, or Functional Necessity? Reassessing the Privilege against Self-Incrimination*, 54(2) Camb L. J. 342, 352 (1995).

verdict, even if it appears reliable. Dennis illustrates this with the example of torture, showing how the pursuit of both factual accuracy and moral authority can clash.³⁴ When a verdict is reached following such a violation, it becomes contradictory as it can't effectively fulfil its essential roles: determining the defendant's moral guilt and suitability for punishment and conveying the message that the legal system upholds important values through punishment.³⁵

In conclusion, we can see the privilege against self-incrimination as more than just a safeguard or human right. It's a fundamental part of the criminal justice system, serving functional needs in specific situations. This perspective suggests that the privilege should have a distinct although limited role in the realm of criminal procedure.

THE POLICE, JUDICIARY AND THE STATE

This section delves into India's evolving law enforcement and judicial landscape, driven by the increased use of advanced forensic techniques. This part is structured around three main themes: custodial justifications, responses to human rights concerns, and Supreme Court intervention for safeguarding constitutional rights.

In the custodial justifications part, we explore changing consent dynamics, where advanced forensic methods are seen as vital tools for scientific investigations. We examine cases that justify these techniques when traditional methods fall short, often due to suspects' reluctance to provide consent for fear of self-incrimination. In the section addressing human rights concerns and the role of consent, we delve into India's constitutional safeguards against self-incrimination. We highlight potential shifts in public and suspect attitudes, as consent may be influenced by the desire to avoid harsh interrogation methods. We also discuss the Mecca Masjid case, where the rejection of narco-analysis played a pivotal role, shedding light on the work of legal

³⁴ *Id.*

³⁵ *Id.*

and human rights advocates. In the final part, we scrutinize the Supreme Court's intervention, particularly regarding potential violations of Article 20(3) of the Indian Constitution. We emphasize the need for clear guidelines on voluntariness, as seen in the *Dinesh Dalmia v. State* judgment. Additionally, we delve into the significant *Smt. Selvi v. State of Karnataka* case, where the Court aimed to balance crime control and due process models while examining relevant legislation.

CUSTODIAL JUSTIFICATIONS

The normalization and institutionalization of advanced forensic techniques by the high courts in India are accompanied by a fundamental shift in the perception of consent, particularly in the context of the investigative process.³⁶ Repeatedly, the courts assert that the question of consent is largely irrelevant, as these tests are perceived as an integral component of scientific investigations. This perspective is exemplified in the case of *Santokben Sharmanbhai Jadeja v. State of Gujarat*,³⁷ where the court justifies the use of these tests on the grounds that they represent the most effective means of acquiring information from the accused when no alternative methods are available. The court even suggests that the accused is responsible for the turn of events, as they are unlikely to provide voluntary consent since they are apprehensive that the results might go against them.³⁸

In the case of *Rojo George v. Deputy Superintendent of Police* (2006),³⁹ the Court highlighted that traditional investigative methods are not particularly effective in the contemporary era, where crimes often involve sophisticated techniques. Therefore, the court emphasized the necessity of permitting examinations such as narco-analysis. In the case of the

3698/*State of Andhra Pradesh v. Smt. Inapuri Padma and Ors.* (2008),⁴⁰ the court argues for the necessity of applying scientific

³⁶ JINEE LOKANEETA, *THE TRUTH MACHINES* 135, 139, 184 (2020).

³⁷ *Santokben Sharmanbhai Jadeja v. State of Gujarat*, 2008 CriLJ 68 (Guj).

³⁸ VEENA DAS, *ANTHROPOLOGY IN THE MARGINS OF THE STATE* (2004).

³⁹ *Rojo George v. The Deputy Superintendent of Police*, 2006 KERLT (2) 197.

⁴⁰ *State of Andhra Pradesh v. Smt. Inapuri Padma and Ors.*, 2008 CriLJ 3992

tests to extract information from culprits, with the rationale that such tests can help reduce custodial violence. This argument reflects an attempt by the high court and state officials to strike a balance between limiting state violence and permitting the use of scientific investigative techniques for the welfare of the population.⁴¹

The growing use of advanced forensic techniques in Indian legal proceedings highlights a significant shift in the perception of consent during investigations. Courts now consider these methods as vital components of scientific inquiries, diminishing the importance of voluntary consent. However, this approach raises concerns about individual agency, as the fear of self-incrimination can hinder voluntary consent. In response, advanced forensic techniques are viewed as necessary to address sophisticated crimes and reduce custodial violence, reflecting the evolving landscape of consent in investigative procedures.

RESPONDING TO HUMAN RIGHTS CRITIQUES AND THE ROLE OF CONSENT

The discussion surrounding the legal and ethical dimensions of advanced forensic techniques in India begins with a profound analysis of the constitutional prohibitions regarding self-incrimination. The Indian Constitution's scope appears to be grounded in preventing compulsion in matters of oral or written testimony. It explicitly prohibits the use of force in the disclosure of vocal declarations or written testimonial statements.⁴² The paramount concern is to protect an individual's volitional powers, ensuring that they are not coerced into delivering self-incriminating depositions as a witness.⁴³ Moreover, the introduction of these techniques is portrayed as a response to critiques from human rights activists, with an implication that any opposition to these methods might be seen as activists endorsing a

⁴¹ Jinee Lokaneeta, *Police Torture & The Truth Machines Of India*, <https://www.article-14.com/post/police-torture-the-truth-machines-of-india> (last visited Oct 20, 2023).

⁴² 8 WIGMORE, *supra* note 5, 2265, at 375.

⁴³ LOKANEETA, *supra* note 35.

return to more brutal interrogation practices.⁴⁴ In this scenario, the public and even suspects themselves might acquiesce to these techniques out of fear of facing more severe interrogation methods, essentially seeking these tests for exculpatory reasons.⁴⁵

However, the application of narco-analysis faced scrutiny in the Mecca Masjid case.⁴⁶ The refusal of the Central Bureau of Investigation (CBI) and National Investigative Agency (NIA) to accept narcoanalysis as valid evidence resulted in the exoneration of all individuals involved. This case underscores the importance of proactive involvement by legal and human rights advocates, as well as the absence of specific laws like the Unlawful Activities (Prevention) Act (UAPA), in dismantling the framework supporting narco-analysis.⁴⁷ One advocate contended that narcoanalysis violates human rights by intruding into the suspect's mind and subconscious, eroding the foundations of their self-respect and privacy.⁴⁸

Advanced forensic methods were introduced partly because of concerns from human rights activists and the fear of harsh interrogations. Sometimes, suspects and the public agree to these tests to avoid harsh questioning. However, when narco-analysis was challenged in the Mecca Masjid case, it led to acquittals. This shows the importance of legal and human rights advocacy, and there may be a need for new laws to ensure that investigations are fair and protect individual rights.

THE SUPREME COURT'S INTERVENTION AND THE PROTECTION OF CONSTITUTIONAL RIGHTS

A primary critique of advanced forensic techniques centers on the potential infringement of Article 20(3), the self-incrimination clause

⁴⁴ *Id.*

⁴⁵ *Id.*

⁴⁶ *Swami Assemanand vs National Investigation Agency*, Crl. Appeal No.D-539-DB of 2014 (O & M).

⁴⁷ *Marri Ramu, All Five, Including Swami Aseeman and, Walk Free in 2007 Mecca Masjid Blast Case*, THE HINDU, Apr. 16, 2018, <https://www.thehindu.com/news/cities/Hyderabad/all-5-acquitted-in-the-2007-mecca-masjid-blast-case/article61866029.ece> (last visited Oct 20, 2023).

⁴⁸ *Id.*

within the Indian Constitution.⁴⁹ High courts have navigated around the application of this article to these techniques by creatively interpreting the constitutional definition of "statement." This nuanced debate is exemplified in the case of *Ramchandra Ram Reddy v. The State of Maharashtra (2004)*,⁵⁰ where the judge argued that polygraph and brain mapping results, not being verbal responses, should not be considered statements and, therefore, not subject to constitutional protections. This perspective shifts attention to narco-analysis, where statements are elicited in response to questions during the procedure.

However, high courts contend that the Constitution restricts only inculpatory or incriminating statements, asserting that whether a statement is incriminating can only be determined after the tests are conducted. This effectively sidesteps the question of the initial use of these techniques and their potential unconstitutionality.

A significant development arises in the judgment of *Dinesh Dalmia v. State*,⁵¹ where the Madras High Court asserts that subjecting an accused to narco-analysis may not necessarily be considered a testimony by compulsion. The court argues that while compulsion may be present during the initial stages of the tests, after the administration of the drug, the statements given by the individual are voluntary. This raises a crucial question about the true voluntariness of these statements, as the person is in a subconscious state during the process, potentially rendering their consent legally invalid under Indian law.

In *Smt. Selvi v. State of Karnataka*,⁵² the Supreme Court seeks to strike a balance between the crime-control model, emphasizing the removal of obstacles for investigating agencies, and the due process model, emphasizing the protection of the accused's fundamental rights. The Court limits the protection against self-incrimination under Article 20(3) to breaches of mental privacy. The Supreme Court concludes that there is no specific authorization for taking

⁴⁹ Gautam Bhatia, *Privacy and the Criminal Process: Selvi v State of Karnataka*, (2018), <https://papers.ssrn.com/abstract=3166849> (last visited Aug 22, 2023).

⁵⁰ *Ramchandra Ram Reddy v. The State of Maharashtra (2004)*, 1 (2205) CCR 355 (DB)

⁵¹ *Dinesh Dalmia v. State*, 2006 CriLJ 2401 (Mad).

⁵² *Smt. Selvi and Ors. vs. State of Karnataka*, (2010) 7 SCC 263.

voice samples, and such authorization cannot be implied from existing statutes, asserting that compelled voice spectrograph is not permissible under the prevailing legal framework.

However, the case of *Devani v State of Gujarat* underscores the need for further clarification to establish a consistent balance. The Gujarat High Court in *Devani* held that investigating authorities cannot legally compel an accused to undergo a voice spectrograph test based on statutory interpretation. Nevertheless, it finds that taking voice samples does not violate Article 20(3) of the Constitution. While the Supreme Court does not outright reject the techniques, it insists on ensuring consent in their usage, dismissing the presumption that they are a natural part of the investigative process for the benefit of the subjects. It leaves room for their voluntary administration under specified safeguards.

As we conclude, it is essential to underscore the significance of consent and the imperative of implementing safeguards. The delicate equilibrium between modernizing investigative methods and safeguarding constitutional rights remains the focal point of this evolving landscape, inviting further scrutiny and reflection.

THE CASE AGAINST (UN)SCIENTIFIC TESTS: NEUROSCIENCE AND SELF INCRIMINATION

In the aftermath of the *Selvi* decision, there are reports suggesting that investigators, who primarily rely on defendants as their main source of evidence, continue to employ coercive tactics to obtain bodily samples, subject individuals to psychological testing, and extract involuntary confessions within detention facilities.⁵³ This raises concerns about the effective implementation of the *Selvi* decision.

THE OVERLOOKED ROLE OF FORENSIC PSYCHOLOGISTS

⁵³ Abhinav Sekhri, *The Right Against Self-Incrimination in India: The Compelling Case of Kathi Kalu Oghad*, 3 INDIAN LAW REVIEW (2019).

Of particular concern is the seemingly overlooked role of forensic psychologists in this context. Despite the Selvi ruling addressing issues related to consent and psychological testing, it failed to acknowledge the crucial role played by forensic psychologists in extracting confessions within forensic laboratories.⁵⁴ This omission not only raises questions about the legitimacy of "scientific investigations" as a substitute for physical torture, endorsed by the Indian government but also underscores concerns that forensic psychologists have informally assumed the role of interrogators, thereby creating an additional site for confessional interrogation.⁵⁵

However, in the Mecca Masjid case, the assumption of guilt and the acquisition of evidence through framing and torturing suspects, along with the reliance on truth machines rather than independent investigations, became integral to policing.⁵⁶ The violation of human rights occurred as the technique, instead of "abusing the body," targeted the suspect's mind and subconscious, gradually undermining their mental privacy.⁵⁷ This Supreme Court ruling serves as a precedent in other cases, emphasizing that while tests like narcoanalysis and brain mapping may be necessary for gathering evidence against the accused, they must not override the protection against self-incrimination. Furthermore, the Supreme Court clarified that the accused cannot use these scientific tests to demonstrate innocence.⁵⁸

EXPANDING THE PRIVILEGE AND THE ROLE OF NON-EPISTEMIC JUSTIFICATIONS

The privilege against self-incrimination is grounded in more than just concerns about evidence reliability. It is also rooted in non-epistemic justifications, which stress the state's burden of proof

⁵⁴ Jinee Lokaneeta, *Police Torture & The Truth Machines Of India*, *supra* note 41.
⁵⁵ *Id.*

⁵⁶ Sudipta Kaviraj, *On the Enchantment of the State : Indian Thought on the Role of the State in the Narrative of Modernity*, 46 *EUROPEAN JOURNAL OF SOCIOLOGY / ARCHIVES EUROPÉENNES DE SOCIOLOGIE / EUROPÄISCHES ARCHIV FÜR SOZIOLOGIE* 263 (2005).

⁵⁷ *Id.*

⁵⁸ *Sidhu Yadav v. State of NCT of Delhi*, High Court of Delhi, Criminal Miscellaneous (Main) No. 1150 of 2017.

and the accused's autonomy and free will in selecting their defence. Consequently, the privilege should be extended to include protection against compelled physical examinations, acknowledging that it does not entirely prohibit the use of accused individuals to establish guilt. In some instances, guilt is established through lawful methods, such as eavesdropping, physical evidence at a crime scene, voluntary confessions, or an inability to withstand cross-examination during trial. Building on the Selvi decision, the Supreme Court has set a far-reaching precedent. It underscores that, even though procedures like narco-analysis and brain mapping may be viewed as necessary for gathering evidence against the accused, they must not supersede the safeguard of protection against self-incrimination. Additionally, the Court explicitly states that the accused cannot utilize these scientific tests to establish their innocence.

Furthermore, the field of neuroscience challenges traditional distinctions between the body and the mind. It underscores the interconnected nature of these aspects, emphasizing that individuals' bodies and documents are integral components of their identities.⁵⁹ Any intrusion into the body is deemed an invasion of personal dignity and privacy. For example, the Supreme Court of Canada has articulated this perspective by affirming that Canadians regard their bodies as an outward expression of themselves, a uniquely important and personal aspect of their identity.⁶⁰ There exists a profound link between manipulating individuals' bodies and influencing their wills.⁶¹

CONCLUSION

From the above analysis, a central argument emerges: the imperative to harmonize the preservation of individual rights with the integration of cutting-edge forensic science, all while acknowledging the profound mind-body connection elucidated by

⁵⁹ LAURENCE R. TANCREDI, *HARDWIRED BEHAVIOR: WHAT NEUROSCIENCE REVEALS ABOUT MORALITY* (2005)

⁶⁰ *R v. Stillman*, [1997] 1 S.C.R. 607, para. 87 (Can.)

⁶¹ Robert Bonvouloir Foster, *Comment, The Right Against Self-Incrimination by Producing Documents: Rethinking the Representative Capacity Doctrine*, 80 NW.U.L.REV. 1605, 1641 (1986)

neuroscience. The privilege against self-incrimination transcends the conventional legal paradigms by acting as a unifying factor for both due process and crime control models. Its safeguarding is vital in averting coerced and unreliable confessions, ensuring accurate determinations of guilt or innocence while maintaining moral authority.

Moreover, our examination of forensic science spotlights a pressing need for regulatory oversight.⁶² Inconsistent adherence to standards and the reliance on scientifically debunked techniques pose significant threats to the integrity of criminal investigations. The forensic disciplines' outcome-driven nature demands rigorous monitoring, transparency, and quality control. Neuroscience, as we've seen, further complicates this as it challenges traditional distinctions between the mind and the body, highlighting the interconnected nature of these aspects. Individuals' bodies and documents are integral components of their identities, making any intrusion a violation of personal dignity and privacy.

Hence, we must modernize investigative methodologies while upholding core rights and recognizing the profound connection between the mind and body. It is the art of balancing science and justice, where the protection of individual dignity, the pursuit of truth, and an understanding of the mind-body connection stand as paramount objectives.

⁶² Ministry of Home Affairs, *Report of the Committee on Draft National Policy on Criminal Justice* (2007).

PROTECTING OUR HOME: THE CRUCIAL ROLE OF LAW AND SCIENCE IN ENVIRONMENTAL CONSERVATION

Sangeeth Krishna G S¹

ABSTRACT

The mission to safeguard our environment, our home relies on an ever-changing partnership between two influential forces: law and science. This essay explores the interplay between these realms, shedding light on how they work to shape the path of environmental conservation.

Firstly, we delve into the role of science, uncovering its methodology and its significance in environmental research. Scientific knowledge lays the groundwork for informed policies and guides conservation efforts by showcasing real life examples that demonstrate the profound impact of science on preserving our environment.

Next, we explore the framework surrounding conservation, highlighting the importance of environmental laws and international agreements. These legal structures serve as a protective shield against harm. They illustrate how government agencies and regulatory bodies become guardians of our environment. By showcasing stories of conservation, we unveil how law and science have played parts in reviving species and healing our planet. We delve into obstacles such as conflicting interests, emerging technologies, and moral dilemmas, while offering recommendations for the future.

As we come to an end, we find ourselves standing at a point. The decisions we make now will shape our presence in the history of Earth. The balance between law and science has the power to create a future where taking care of the environment is a symbol of our shared duty and a source of optimism for generations.

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INTRODUCTION

Our planet with its landscapes and complex ecosystems is facing a dire situation. The environmental degradation that once seemed distant has become a reality. Glaciers once seen as symbols are retreating and the delicate balance of life, in our oceans, forests and grasslands is in jeopardy. Consequently, we are confronted with challenges, which calls for action. This essay delves into the heart of this challenge by exploring the intersection and interdependence of law, science, and environmental conservation. To tackle the challenges, we must understand the interconnectedness between law, science, and conservation.

Take a moment to consider the range of issues that surround us, climate change, habitat destruction, widespread pollution, and the looming threat of species extinction. These problems are deeply intertwined with one another. Hence, addressing them requires an interdisciplinary approach. In this context, law serves as the framework that can govern human behaviour and its impact on the environment.

Science being the guardian of truth provides insights based on evidence that are crucial for making informed decisions and policies. The noble pursuit of conservation aims to protect and preserve the tapestry of life on our planet, relying on both science and law to mobilize resources, establish regulations and inspire action.

Our world currently stands at a juncture balancing on the edge of an impending disaster. As we confront these challenges, it becomes imperative to recognize how law, science and conservation intersect and strengthen each other. This understanding goes beyond being an exercise; it holds paramount importance that transcends national boundaries, ideological differences, and personal interests.

From safeguarding the remaining habitats of endangered species to devising strategies for mitigating climate change and preserving the integrity of our ecosystems, this exploration into the relationship between law, science and environmental conservation emphasizes their profound significance. Together they play a role in charting a path towards the future. One that ensures not only

our wellbeing but also secures the legacy for generations yet to come, by protecting all life on Earth.

THE ROLE OF SCIENCE IN ENVIRONMENTAL PRESERVATION

Science plays a profound role in our efforts to comprehend, safeguard and restore our planet. This section examines the contributions of science to preservation, including its methodologies, influence on policy making and real-world impact.

1. The Importance of the Scientific Method

The scientific method serves as a guiding principle for investigation. It offers an approach to uncover truths about the world. This methodology entails observation, hypothesis formulation, rigorous experimentation, data collection, meticulous analysis, and the drawing of conclusions. Notably, the scientific method strives to eliminate subjectivity and bias making, thereby making it a highly dependable and reproducible tool for understanding phenomena.

In the realm of environmental conservation, the scientific method acts as a keystone. It enables scientists to systematically explore ecosystems from the molecular level to the vast landscapes. It is through the application of this framework, environmental researchers are able to unravel the factors driving ecological challenges, such as climate change impacts, habitat destructions, pollution issues or species endangerment. By following this approach, scientists can also offer evidence-based insights that are crucial for making well informed decisions in conservation efforts.

The importance of this method is profound. It serves as a guiding light of objectivity in a world that is often clouded by opinions and biases. In the realm of environmental conservation, it enables us to bypass speculation and base our actions on facts, observations, and thorough analysis. Moreover, it also provides a framework for learning and adaptation, allowing us to refine our strategies as new data and insights come to light.

2. The Role of Scientific Research in Shaping Environmental Policies

Scientific research forms the foundation upon which environmental policies are constructed. Robust studies and peer reviewed findings serve as the building blocks for crafting legislation, regulations, and management strategies. It is through the examination of data, governments and international organizations, develop and improve policies aimed at addressing environmental threats and challenges.

Environmental policies for reducing emissions, regulations on land use, and designations of protected areas often originate from discoveries and assessments. Collaboration between scientists and policymakers offers insights into the impacts of policy choices, while providing recommendations firmly rooted in empirical evidence. The collaboration between science and law has resulted in policies such as the Kyoto Protocol², which focuses on reducing greenhouse gas emissions, and the Endangered Species Act³ in the United States which provides a framework for protecting endangered wildlife.

To truly appreciate the impact of contributions to environmental conservation, we need to examine various successful case studies. These examples demonstrate how scientific research has been applied to real world conservation efforts and produced favourable results.

A great illustration is the recovery of the bald eagle population in North America. Scientists armed with data identified that the pesticide DDT was a factor in their decline and its harmful effects on eggshell thickness. This scientific insight led to regulations banning DDT, enabling the bald eagle's population to bounce back from the brink of extinction.

Another compelling example related to environmental conservation comes from the ocean. Researchers have played a pivotal role in identifying the threats caused by overfishing on the fish stocks in

² UNFCCC, https://unfccc.int/kyoto_protocol, (last visited Nov. 21,2023).

³ WWF, <https://www.worldwildlife.org/pages/the-us-endangered-species-act>, (last visited Nov. 21,2023).

our oceans. These studies have contributed to implementing catch quotas and sustainable fishing practices that ensure long term health and resilience of these ecosystems.

As evident from the above case studies, it is clear that science is not merely an observer but an indispensable guide and catalyst for change. It uses the approach to uncover the mysteries of our surroundings, provides real world evidence that influences policy choices and through examples of success showcases its long-lasting importance in protecting the environment. Thus, the role played by science in environmental conservation efforts is commendable.

THE LEGAL FRAMEWORK FOR ENVIRONMENTAL CONSERVATION

The protection and preservation of our environment heavily rely on a framework. In this section we will explore the role played by laws and regulations, international agreements and treaties, as well as the actions taken by government agencies and regulatory bodies, in ensuring the wellbeing of our planet.

1. Laws and Regulations for Environmental Protection

Environmental laws and regulations serve as the foundation for governance within each country. These are sets of rules, standards and guidelines established by governments to manage and control activities that impact the environment. They encompass a range of issues such as air and water quality, land use, wildlife conservation and waste management.

The significance of these laws lies in their ability to enforce behaviour while holding accountable those who cause harm to the environment. For instance, in India, the Air (Prevention and Control of Pollution) Act, which sets air quality standards, regulates emissions from sources and imposes penalties on violators. These laws provide a framework for addressing pollution concerns as well as managing resources and promoting conservation efforts. Environmental regulations supported by the system act as a deterrent against damage. They ensure that both

individuals and corporations are obligated to consider the impact of their actions while taking measures to mitigate any harm caused.

2. International Agreements and Treaties

When it comes to environmental issues, they often go beyond borders, which is why international cooperation becomes crucial in addressing global challenges. This is where international agreements and treaties come into play, bringing nations together to tackle problems that affect the planet. These agreements cover a range of topics, such as biodiversity conservation, climate change mitigation and the protection of oceans and wildlife.

To highlight a few examples, we have the Paris Agreement⁴ that aims to combat climate change by setting targets for reducing emissions. Then there is the Convention on Biological Diversity⁵ that strives to safeguard biodiversity. These agreements establish a framework for nations to follow and serve as a foundation for global action. The significance of agreements and treaties lies in their ability to foster unity when facing crises. They encourage cooperation and provide a legal structure for countries to collaborate towards shared environmental goals. Thus, they acknowledge that environmental conservation knows no boundaries and necessitates efforts from all nations.

3. The Role of Government Agencies and Regulatory Bodies

At the national level, respective government agencies and regulatory bodies, play the roles in implementing environmental laws and regulations. These agencies are responsible for monitoring conditions, issuing permits, conducting research studies, and ensuring compliance with established environmental standards, by individuals and corporations alike.

For instance, in the United States, the Environmental Protection Agency⁶ (EPA) has the responsibility of preserving the environment

⁴ UNFCCC, <https://unfccc.int/process-and-meetings/the-paris-agreement>, (last visited Nov. 21,2023).

⁵ UN, <https://www.un.org/en/observances/biological-diversity-day/convention>, (last visited Nov. 21,2023).

⁶ Britannica, <https://www.britannica.com/topic/Environmental-Protection-Agency>, (last visited Nov. 21,2023).

and public health. They achieve this by enforcing regulations that pertain to air and water quality, disposal of waste and chemical safety. These agencies frequently collaborate with institutions to evaluate conditions and risks.

Government agencies and regulatory bodies hold significance for two reasons. First, they effectively translate the framework into practical actions on the ground. They also serve as a link between principles and tangible environmental protection efforts. Secondly, these agencies possess the authority to enforce laws and regulations, ensuring that everyone follows them and holding accountable those who violate them. Consequently, their work is vital in transforming guidelines into commitments and commitment into conservation.

Thus, legal framework for conserving the environment comprises a network of laws, regulations, international agreements, as well as the efforts of government agencies and regulatory bodies. It is a system that forms the foundation for protecting our environment by aligning national and international actions, with the shared goal of safeguarding our planet for present and future generations.

THE INTERSECTION OF LAW AND SCIENCE

The harmonious partnership of law and science is crucial for addressing challenges. In this section, we will delve into how scientific evidence is utilized in legal proceedings, the difficulties encountered in translating science into legal policies and the importance of interdisciplinary collaboration in this dynamic relationship.

1. Scientific Evidence in Legal Proceedings

Scientific evidence plays an important role when it comes to legal proceedings, especially in the aspect of environmental conservation. It serves as an excellent tool for establishing facts, proving cause and effect relationships, and aiding decision-making processes within the system. This becomes particularly evident in cases involving harm, pollution, habitat destruction or species endangerment. For example, let's consider a lawsuit concerning

contamination of a water source. In this case, scientific data may be presented to demonstrate the presence of pollutants and their harmful effects. These scientific findings form the basis upon which the legal case is built. Expert witnesses are also called upon to testify and explain the intricacies, to judges and juries.

The significance of evidence in proceedings, lies in its capacity to act as an impartial arbitrator of facts. It provides an objective foundation for resolving disputes and making informed legal decisions. Thus, the use of evidence is crucial, in ensuring that legal decisions are based on reality and prosecuting those who caused environmental damage.

2. Difficulties in Applying Knowledge to Legal Policies

Although incorporating research into legal proceedings is important, there are unique challenges involved in translating scientific findings into actionable legal policies. Environmental issues are often intricate and multifaceted, and scientific studies can offer a range of solutions. Policymakers must navigate this complexity by striking a balance between recommendations and feasible regulations.

One of the challenges lies in reconciling the uncertainties in scientific research with the need for precise legal standards. While science often deals with probabilities and uncertainties, legal standards demand concrete rules. Finding the equilibrium between environmental regulations based on the best available science, while also providing legal clarity remains an ongoing challenge.

Another obstacle pertains to the influence of economic interests, which sometimes lead to distorting or manipulating findings, to serve specific agendas. Safeguarding the integrity of science, within the framework of law is an enduring battle. Understanding these challenges is crucial because it highlights that translating science into law is not straightforward. It involves navigating terrain and frequently engaging in debates. However, it is crucial to develop policies that are both effective and fair, in safeguarding the environment and promoting sustainability.

3. The Importance of Collaborating across Disciplines

In the field of environmental conservation, where complex issues go beyond legal boundaries, collaborating across disciplines is of utmost importance. Scientists, lawyers, policymakers, and other experts need to join forces to tackle multifaceted challenges comprehensively.

Collaboration across disciplines ensures that both the scientific and legal aspects of conservation are taken into account. Scientists bring data, research findings and insights to the table, while legal experts provide the frameworks for implementing these discoveries in a sound and impactful manner. A prime example of collaboration can be seen in the establishment of marine protected areas. Scientists pinpoint habitats and areas in biodiversity, through their data driven research on their ecological significance. Legal experts then navigate through the process of designating these areas as protected zones, with considerations for negotiations involving stakeholders and adherence to treaties.

The importance of collaborating across disciplines, lies in its ability to generate solutions that strike a balance between conservation needs and societal demands. By bridging the gap between science and law, it ensures that legal frameworks are informed by up-to-date knowledge, while providing tools for implementing necessary conservation measures. Thus, by collaborating across disciplines, we can bridge the divide and ensure that both fields work together seamlessly to tackle the pressing issues our environment is facing.

SUCCESS STORIES IN ENVIRONMENTAL CONSERVATION

Amidst the environmental challenges, there are shining examples of conservation initiatives that have successfully preserved our planet, thanks to a harmonious blend of law and science. This section delves into these success stories, highlighting the roles played by the interplay of law and science in those achievements.

1. Examples of Successful Conservation Initiatives

i. Bald Eagle Recovery

The remarkable resurgence of eagles in North America stands as a tale of successful conservation efforts. From the verge of extinction due to factors such as DDT pesticide use, hunting and habitat loss, bald eagles made a comeback. Legal protections provided by the U.S. Endangered Species Act and the banning of DDT were instrumental in their recovery. Scientific studies focused on monitoring population levels, nesting sites and studying the impact of contaminants played a role in assessing their health and guiding conservation measures.

Legal measures like the Endangered Species Act offered protection to eagles by making it illegal to harm or disturb them. Scientific studies demonstrated that the decline in eagle populations is caused by DDT contamination. Consequently, prompted a ban on DDT, an action that allowed eagle numbers to recover.

ii. Yellowstone Grizzly Bear Recovery

The recovery of grizzly bears in Yellowstone National Park is another achievement worth celebrating. Legal safeguards provided by the U.S. Endangered Species Act, alongside research into bear behaviour, habitat requirements and population dynamics have been paramount to this success story. It exemplifies how long-term monitoring coupled with management strategies, guided by data can make a significant difference.

Legal protections ensured that grizzly bears were shielded from hunting and habitat destruction. Simultaneously, research informed management decisions such as establishing hunting quotas and preserving habitats were also instrumental. Undoubtedly, the long-term success of grizzly bear recovery relied on both safeguards and science-based management.

iii. The Montreal Protocol⁷

Montreal Protocol shines as a beacon for environmental conservation efforts. The treaty was designed to eliminate substances that deplete the ozone layer. It has resulted in a significant decrease in ozone depletion. Scientific research on the effects of ozone depletion provided the foundation for this treaty, which established targets and guidelines for participating countries based on frameworks.

This international agreement exemplifies the collaboration between law and science. Scientific research has shed light on the depletion of the ozone layer and the harmful effects caused by substances that deplete it. The treaty established a framework to gradually phase out these substances, while encouraging countries to embrace more environmentally friendly alternatives.

The success stories of preserving species and ecosystems, highlight the role of both law and science. A robust legal foundation is essential for safeguarding these entities, while scientific insights provide guidance for informed decision making and policy formulation. Together they create a combination that paves the way for conservation achievements. Such accomplishments serve as inspiration for endeavours in preservation.

OBSTACLES IN ENVIRONMENTAL CONSERVATION; LEGAL AND SCIENTIFIC DILEMMAS

The realm of environmental conservation encounters its share of obstacles, and this section delves into the legal and scientific challenges that cast doubts on our journey to protect the environment.

1. The Impact of Vested Interests and Political Factors

One major challenge in environmental conservation revolves around the influence wielded by vested interests and political

⁷ UNEP, <https://www.unep.org/ozonaction/who-we-are/about-montreal-protocol>, (last visited Nov. 21,2023).

factors. These interests, often tied to industries and economic concerns, can impede the efforts to establish and enforce environmental laws and regulations. Political decisions influenced by campaign contributions, lobbying and economic considerations, may prioritize short term gains over term sustainability.

Take the fossil fuel industry's impact on climate policy as an example. Despite consensus establishing a connection between greenhouse gas emissions and climate change, resistance to stringent regulations (often driven by vested interests) has hindered meaningful action. Moreover, differing ideologies and global power dynamics add complexity when it comes to cooperation on environmental matters. Tackling this challenge necessitates not only legal frameworks but also concerted efforts to minimize the influence of special interests on policy making processes. Transparency and exerting pressure by the public can play tremendous roles in mitigating these influences.

2. The Impact of Emerging Technologies on Conservation

While emerging technologies offer solutions, they also pose challenges to environmental conservation. Advancements in biotechnology, artificial intelligence and geoengineering have the potential to either benefit or harm the environment. However, the rapid development of these technologies often surpasses the ability of regulatory systems to keep up, resulting in a delay in implementing measures.

For example, gene editing techniques like CRISPR hold promise for conserving endangered species, while it also raises legal concerns. What are the consequences of altering an organism's code? How should it be regulated to prevent disruptions? Similarly, geoengineering aims to tackle climate change through large scale interventions, and it comes with both advantages and risks. The legal frameworks have not yet fully addressed the implications and potential consequences associated with these technologies.

Addressing this challenge requires fostering collaboration among scientists, legal experts, policymakers and ethicists to develop informed, adaptable and ethical regulations. Striking a balance between promoting innovation and safeguarding the environment remains a task.

3. Ethical Considerations in Conservation Efforts

Environmental conservation goes beyond science and law, it inherently involves ethical considerations too. Questions regarding the allocation of resources, the ethical prioritization of species and the fair treatment of indigenous communities in relation to their rights to land and resources, present intricate dilemmas. For instance, when conservation efforts result in the displacement of communities, it raises concerns about justice and human rights. Moreover, choosing to focus on species at the expense of known ones brings forth moral quandaries. The existing legal frameworks sometimes struggle to strike a balance between these considerations, leading to conflicts between conservation efforts and the well-being of communities.

Finding resolutions for these moral dilemmas in conservation necessitates an approach that involves engaging in dialogue with all stakeholders, abiding by ethical guidelines and integrating indigenous and local knowledge into decision making processes. It also requires the development of frameworks that acknowledge these complexities and offer effective as well as morally sound solutions.

Addressing the scientific challenges associated with conservation is as intricate and multifaceted as the ecosystems we strive to safeguard. Taking into account vested interests, political factors, emerging technologies and ethical dilemmas, demands deliberation, interdisciplinary collaboration and adaptable legal frameworks. Recognizing these challenges while actively working towards resolving them are steps towards achieving sustainable and equitable environmental conservation efforts.

THE FUTURE OF LAW, SCIENCE AND ENVIRONMENTAL CONSERVATION

The future of conservation relies heavily on the partnership between law and science. In this section we delve into the importance of collaboration and innovation, the role of education and public awareness, and present solutions and recommendations for achieving a sustainable future.

1. The Importance of Ongoing Collaboration and Innovation

Environmental conservation is an evolving field that demands continuous teamwork between law and science. The challenges we encounter such as climate change and biodiversity loss are dynamic and interconnected, necessitating solutions.

i. Interdisciplinary Research

Scientists and legal experts must come together to effectively tackle emerging challenges. For instance, legal frameworks should be flexible enough to address new technologies, while science must inform these adaptations.

ii. Embracing Innovation

Embracing advancements is crucial in our efforts. Progress in data analysis, remote sensing, and artificial intelligence, can greatly assist in monitoring and managing ecosystems. It is essential for our legal framework to adapt accordingly, while upholding standards.

iii. Global Cooperation

Given the interconnected nature of challenges, global cooperation is imperative. Nations must continue collaborating through agreements, similar to the Paris Agreement, to address cross border issues such as climate change and biodiversity preservation.

iv. Corporate Responsibility

Companies can innovate and adopt practices that are environmentally friendly, but it is crucial for legal frameworks to provide incentives and regulations to encourage these changes.

2. The Importance of Education and Public Awareness

Education and public awareness play a significant role in conserving the environment. In order to ensure a sustainable future, it is essential to educate and involve the public in understanding the significance of preserving our environment. Some steps in this direction are:

- i. **Environmental Education:** Schools and educational institutions should prioritize teaching concepts. This includes imparting knowledge about ecology, sustainability, and the real-world implications of environmental degradation. Both scientific and legal education should also emphasize their roles in conservation efforts.
- ii. **Media Engagement and Advocacy:** The media holds tremendous influence in shaping opinions. Environmental organizations and advocates must continue raising awareness about issues by translating scientific information into accessible narratives.
- iii. **Advocacy and Citizen Involvement:** Public participation plays a role in holding governments and corporations for their environmental actions. Legal frameworks should actively encourage engagement as well as whistleblower protection related to environmental matters.

3. POTENTIAL SOLUTIONS AND RECOMMENDATIONS

The future of law, science, and environmental conservation relies on several key solutions and recommendations:

- i. **Strengthening Legal Frameworks:** It is important to consistently update and bolster environmental laws and regulations so that they align with the latest scientific advancements, emerging technologies, as well as ethical considerations. Moreover, strict enforcement of these laws is crucial.
- ii. **Encouraging Practices:** It is important for systems to provide incentives, tax benefits and penalties to promote sustainable practices. This includes supporting the use of energy and imposing consequences for carbon emissions.
- iii. **Investing in Scientific Research:** We should allocate resources towards research, in order to tackle emerging challenges. Government organizations and individuals need

to back studies on climate change, biodiversity and innovative conservation technologies.

- iv. **Advocating for Transparency:** Transparency in environmental matters is essential. Governments and corporations should make information about their performance, pollution levels and resource usage, easily accessible to the public.
- v. **Global Commitment:** It is crucial to foster commitments when it comes to addressing issues. Encouraging collaboration through agreements and treaties that prioritize sustainability is significant.
- vi. **Engaging Local Communities:** Involving communities in conservation efforts is essential. We must recognize their rights and appreciate the relevance of their knowledge in preserving ecosystems.
- vii. **Embracing Innovation:** Embracing and supporting the latest technologies which can contribute to environmental conservation efforts is the need of the time.

The future of preserving our environment relies on the collaboration between law and science. This partnership is vital in tackling the complex challenges our environment faces. Additionally, educating the public and raising awareness are equally important, in fostering a sense of responsibility and inspiring informed action. By establishing frameworks offering incentives for sustainability and fostering global collaboration, we can strive to create a future that is more sustainable and environmentally aware.

CONCLUSION: FORGING A SUSTAINABLE FUTURE THROUGH THE NEXUS OF LAW, SCIENCE, AND ENVIRONMENTAL CONSERVATION

In the tapestry of our existence, the intricate interplay between law, science and environmental conservation holds great importance. It weaves its way through the chapters of our planet's history like a thread. This thread reflects our responsibility to protect and

preserve the ecosystems, diverse web of life and fragile climate of Earth. As we reach the end of this exploration, we find ourselves standing at a moment in our shared story. The choices we make today will leave an enduring mark on the annals of time.

The complex relationship between law and science in the realm of conservation serves as both a testament to ingenuity and a reminder of our vulnerable situation. These two disciplines have emerged as advocates calling for a harmonious co-existence. Further, they provide us with guidance through the landscape of challenges. Science, with its commitment to seeking truth has illuminated areas previously clouded by ignorance. It has helped us understand the intricacies of climate change, habitat loss, species endangerment, and pollution. Thus, it forms a foundation, for making well informed decision, a foundation rooted in objectivity provided by scientific methodologies.

The legal system plays a pivotal role in safeguarding our environment. It provides a foundation for protection by setting rules and regulations. International treaties and agreements promote cooperation in addressing crises. Government agencies and regulatory bodies ensure that these laws are upheld, bridging the gap between policies and their implementation. The legal system has not only safeguarded our environment, but also holds accountable those who violate its boundaries.

However, this intricate system is not without its flaws, there are challenges to overcome in our quest for conservation. The influence of interests, political factors and economic considerations often impact the development and enforcement of policies. Additionally, emerging technologies bring forth legal dilemmas that must be addressed. Balancing the needs of conservation with the rights of communities is a balancing act. In light of these challenges, we find ourselves at a turning point where law and science must work hand in hand more than before. Moving forward requires collaboration, innovation, interdisciplinary research, and the willingness to embrace advancements and scientific insights.

Emerging technologies like renewable energy, precision conservation and innovative data monitoring provide hope for the future. Education and public awareness play a role in this

transformation, shaping the mindset of future generations. They have the power to instil a sense of responsibility in everyone, making us realize that the fate of our planet rests in our hands. Also, the influence of advocacy, media narratives and informed citizens cannot be underestimated, they hold sway over governments, corporations, and international players.

In this endeavour, some recommendations and solutions were found and it is hoped they will guide us. Strengthening frameworks, incentivizing practices, and fostering global commitments are essential for moving forward. Transparency in environmental matters, acknowledging communities and traditional knowledge, provide additional directions. By embracing solutions alongside scientific research efforts, we can unravel the complexities of our environment.

The intersection of law, science and environmental conservation presents not challenges but profound opportunities. It's an opportunity to create a new chapter in history characterized by collaboration, innovation, and global cooperation. It presents us with a chance to take care of our planet by working together and preserve its beauty, diversity, and equilibrium.

Now the question is whether we will embrace this opportunity and create a legacy of environmental conservation that future generations can benefit from. The decision is in our hands, transcending borders, ideologies, and self-interest. It's a decision for the Earth itself and all the life it supports. As we stand on this precipice, let's make choices because the fate of our planet hangs in the balance. The balance between law and science.

A CLOSER LOOK AT THE ROLE OF SCIENTIFIC EVIDENCE IN THE SISTER ABHAYA MURDER CASE: UNRAVELLING TRUTHS AND CONTROVERSIES

Nandana Arun¹

ABSTRACT

The case revolves around the mysterious death of Sister Abhaya, a Catholic nun, and the subsequent investigation. Scientific evidence played a pivotal role in clarifying complex aspects of the case and establishing the truth. This includes forensic analysis, narco-analysis, medical records, and expert testimonies. However, the use of scientific evidence also brought complexities and challenges. Allegations of evidence tampering, suppression, and the influence of media and public opinion complicated the proceedings. The case-study illustrates the dual nature of scientific evidence – it can be a powerful tool for uncovering the truth, but it can also be a subject of intense scrutiny and controversy in high-profile legal proceedings. This analysis underscores the importance of scientific evidence in criminal investigations. It shows how forensic science and expert testimony can contribute to solving complex cases. It highlights the need for objectivity and integrity in the handling of evidence, and it emphasizes the potential for both justice and controversy when scientific findings are presented in the legal arena. In summary, the Sister Abhaya murder case demonstrates the significance of scientific evidence in legal proceedings. It's a reminder that the pursuit of truth in complex cases can be both facilitated and complicated by the use of scientific evidence, making it an integral part of the criminal justice system while also subject to scrutiny and debate.

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INTRODUCTION

Global legal systems rely on two fundamental principles: legal objectivity and scientific evidence, which are vital for justice. Legal objectivity means making decisions based on facts, evidence and the law, rather than personal biases or preferences. It ensures fairness and impartiality in the legal system. Scientific evidence plays a key role in the legal process, covering various scientific fields, like forensics, medical records, and expert testimony. It often forms the core of cases, clarifying complex issues, supporting facts, and revealing the truth. Scientific evidence is paramount in the criminal justice system. These principles help administer justice fairly and precisely, a justice that is without prejudice and based on objective and verifiable information. Legal objectivity and scientific evidence work together to uphold the principles of fairness and truth in the legal system, providing a solid foundation for justice worldwide.

The Sister Abhaya murder case, also known as the St Pius X Convent Murder Case², continues to be one of the most mysterious and controversial criminal cases in India. Lasting for over three decades, the case involves the murder of Sister Abhaya - a catholic nun- in 1992 at St. Pius X Convent, Kottayam. Discovering the nun's body in a well led to the case initially being written off as suicide. Despite the initial investigation results, suspicions and foul play shrouded the case. The case is an example of how scientific evidence played a crucial role in shaping the narrative of this case and delving into the truths and controversies that surrounded the case.

BACKGROUND

St Pius X Convent was a haven for spiritual reflections and devotion. Sister Abhaya, a Catholic nun was found dead in a well of the church in Kottayam in 1992. The initial investigation concluded that her death was suicide. The death of the nun contrasted against the supposed spirituality of the place. The case

² Jomon Puthen Purackal And Anr. v, Union Of India (Uoi) And Ors 1996 SCC OnLine Ker 198.

saw the light of justice through scientific evidence and one strong eyewitness, while other testaments were erratic.

A. Sequence of events

In the early hours of 27th March 1992, Sister Abhaya was reported missing. It was informed that she woke up at 4 a.m. to get ready for an exam and was last seen going to the kitchen to drink water. Following a short search, Sister Abhaya's lifeless body was discovered in the well of the convent hostel.

B. Investigations

The Kottayam Police Station initially treated it as an unnatural incident and intensified their inquiry. The post-mortem examination suggested that drowning might have been the cause. Various organizations and authorities conducted a series of investigations, ranging from the formation of the Action Council to the handling of the case by the CBI. Father Thomas Kottoor, Father Jose Poothrikkayil, and Sister Sephy emerged as the main suspects during these investigations.

After a painstaking 28-year-long inquiry, Father Kottoor and Sister Sephy were found responsible for Sister Abhaya's murder. They were sentenced to life imprisonment on December 23, 2020. In contrast, Poothrikkayil was acquitted by the special CBI court¹.

C. Culprits and their involvement

- i. Father Thomas Kottoor, a catholic priest, was found guilty of murder and sentenced to life in prison and was also convicted of destroying evidence. He was found guilty u/s. 302, 201 r/w 34 IPC and 449 IPC and therefore, received a lifetime imprisonment for the same.
- ii. Father Jose Poothrikkayil, another Catholic Priest, although sentenced to lifetime imprisonment for his role as a co-conspirator, was acquitted due to lack of evidence.

¹ Sister Abhaya Murder: 28 Years On, Kerala Catholic Priest, Nun Convicted, NDTV.COM, <https://www.ndtv.com/india-news/sister-abhaya-murder-case-two-found-guilty-by-kerala-court-28-years-after-crime-2341922> (last visited Oct 22, 2023).

Sister Sephy, a fellow nun residing at the St. Pius X Convent, received a life sentence as well. Her involvement included participation in the conspiracy to murder Sister Abhaya and the destruction of evidence connected to the crime. Sister Sephy is found guilty u/s. 302, 201 r/w 34 IPC and not found guilty u/s 449 IPC.

D. Motives

According to the prosecution, Kottoor and Sephy were having an affair and on the 26th night Sister Abhaya is said to have accidentally walked in on Kottoor and Sephy in a “compromising position”. A panicked Sister Sephy hit Abhaya with an axe. The three accused together dumped Abhaya’s body into the well.

E. Judgement

This case, with its intricate web of truths and controversies, is a reminder of the challenges in uncovering the truth and upholding justice in the face of intricate circumstances and potential misuse of evidence. The judgments are pronounced with following sentences:

- i. Accused No. 1 (Father Thomas Kottoor) and Accused No. 3 (Sister Sephy) have been sentenced to life imprisonment and a fine of Rs. 5,00,000/- (Rupees Five Lakhs only) is levied on each of them for the offense u/s 302 r/w 4 of the Indian Penal Code. In case the fine is not paid, they have to serve a two-year term of simple imprisonment.
- ii. They are sentenced to serve seven years of rigorous imprisonment, and a fine of Rs. 50,000/- (Rupees Fifty Thousand only) is placed on each of them for the offense u/s 201 r/w 34 of the Indian Penal Code. If they fail to pay the fine, the convicts will be subjected to a one-year term of simple imprisonment.
- iii. Accused No. 1 (Father Thomas Kottoor) is further ordered to serve a life sentence and is subject to a fine of Rs. 1,00,000/- (Rupees One Lakh only) for the offense u/s 449 of the Indian Penal Code. If he fails to pay the fine, he will be subjected to a one-year term of simple imprisonment.

iv. The sentences of 1 and 3 shall be served simultaneously.

During the delivery of the verdict, the judge made a noteworthy observation, remarking: “The current case has languished unresolved for a span of 28 years, bearing a resemblance to the sentiment Lord Macaulay expressed in his essay and drafted as: ‘the Judges moved and the case stood still’

USE OF SCIENTIFIC EVIDENCE

Scientific evidence has played a central role throughout the investigations and the subsequent trials of the case. The results of forensic inquiries, toxicology reports, crime scene analysis, and fingerprint analysis helped create a framework for understanding the events and circumstances that led to the death of Sister Abhaya. Various scientific techniques like brain mapping, narco-analysis and polygraphy techniques were employed¹. The case is an instance of the utilization of scientific tools to provide objectivity and rationality in resolving complex cases.

A. The Findings of the Autopsy and Forensic Examinations

Forensic Pathology is another branch of science that helps in investigations and trials of crimes. Autopsy and forensic examinations played a crucial role in the Sister Abhaya murder case. These tests help in unearthing the details regarding the death like the cause, time of death, information regarding the injuries on the body and various other potential factors.

Cause of Death Determination: Through a post-mortem examination, the cause of death of a person. Detailed examinations and analysis helped in ruling out causes and finally reaching the actual cause of death. They were able to conclude whether she died due to homicidal violence, accidental causes, or suicide. In this case, the findings were crucial to establishing the cause of death to be a homicide and not the initially believed suicide.

¹ Gowsia Farooq Khan & Sheeba Ahad, ROLE OF FORENSIC SCIENCE IN CRIMINAL INVESTIGATION: ADMISSIBILITY IN INDIAN LEGAL SYSTEM AND FUTURE PERSPECTIVE.

Identification of Injuries: Forensic pathologists carefully examined Sister Abhaya's body for any injuries or trauma. Their findings included identifying specific injuries, such as wounds, bruises, fractures, or other forms of physical harm. Their findings help in identifying specific injuries and wounds thereby determining the cause of death.

Time of Death Estimation: Forensic experts also worked to estimate the approximate time of Sister Abhaya's death. This estimation involved examining factors such as the state of decomposition and body temperature. Understanding the time of death was crucial in piecing together the timeline of events leading to the crime.

Documentation of Wound Patterns: Forensic pathology involved documenting the pattern of wounds on the victim's body. Documenting the patterns of wounds and injuries of the victim's body along with the size, shape and location of injuries can help in reconstructing the sequence of events that led to the death of Sister Abhaya. This helps to identify the nature of the assault.

Forensic analysts and Forensic pathologists were important witnesses in the trial. Their expert testimonies helped to confirm a clear and convincing story of the crime to the court and the jury. This also confirmed it was a homicide, not just a suicide by drowning.

B. Significance of Toxicology Reports

The toxicology reports were instrumental in confirming the findings of forensic pathologists' finding, ruling out alternative deaths and providing evidence regarding the theory of homicide. The toxicology reports were crucial in ruling out the possibility of poisoning as the cause of death. They also helped narrow down the possible reasons for the death.

Determining the Presence of Toxins: Toxicology reports aimed to determine the presence of any harmful substances, drugs, or toxins in Sister Abhaya's body. This was essential in ruling out alternative causes of death, such as poisoning, overdose, or any substances that might have contributed to her demise.

Confirmation of the Cause of Death: The presence or absence of toxic substances could confirm or refute the initial theory of suicide or accidental poisoning. If toxicology reports showed no traces of such substances, it strengthened the case for homicide, as other possible causes were eliminated.

Corroborating Forensic Findings: Toxicology reports worked in conjunction with other forensic findings, such as the examination of injuries and the autopsy report. A lack of toxic substances could support the forensic pathologists' conclusion that Sister Abhaya's death was not a result of poisoning, thus bolstering the homicide theory.

Excluding Misadventure or Accident: Toxicology reports were essential in excluding the possibility of accidental poisoning or ingestion of harmful substances. By demonstrating the absence of toxins that could be accidentally ingested, the reports could support the argument that her death was not accidental.

Supporting the Homicide Theory: The absence of toxic substances in the toxicology reports could further support the homicide theory by eliminating any alternative explanations for Sister Abhaya's death. This was crucial in presenting a compelling case against the accused individuals.

Forensic pathologists ran toxicology tests on Sister Abhaya's body to look for drugs, poisons, or other substances. This was crucial to rule out other reasons for her death and confirm that poisoning or drugging wasn't involved. The fact that no toxic substances were found served as strong evidence, eliminating one of the possible theories about her death.

C. Role of Crime Scene Analysis

The role of crime scene analysis in the Sister Abhaya murder case was critical in unravelling the details of the crime, establishing the sequence of events, and providing important forensic evidence. It played a central role in building a case against the accused individuals and contributed significantly to the investigation and legal proceedings. They studied blood stains, the condition of the well, and any objects present to piece together what likely happened before Sister Abhaya's death. This scientific evidence

helped them figure out the order of events leading to her demise. This analysis was crucial in understanding how she died and in building a case against the accused. It played a significant role in revealing the circumstances of her death and forming a case against those responsible. The steps involved in crime scene analysis are establishing the Crime Scene, evidence collection, crime scene reconstruction, blood stain analysis, and photographic documentation.

D. DNA Analysis

DNA Analysis played a key function in the case. The DNA evidence from the crime scene was compared with the samples of the accused. This helped link the victim and the scene to the perpetrators. In India, courts have allowed the collection and usage of DNA evidence in cases while conforming to various acts². Section 45 of the Evidence Act³ indirectly allows for the admission of DNA as evidence and such evidence can only be construed as ‘mere belief’ tendered by an expert⁴. Courts have upheld the use of DNA evidence while considering the well-being of the public and constitutional mandate. There should be a balance of public interest as covered under Article 20(3)⁵ and Article 21⁶ as mentioned in *Thogorani v. State of Orissa*⁷ while also maintaining the right to privacy⁸. The typical steps followed include collection of DNA samples, comparison with crime scene evidence, forensic DNA profiling and identification of perpetrators. DNA analysis help identify the perpetrators through the DNA found on the victim or the crime scene by corroborating with the DNA collected from suspects.

E. Fingerprint Analysis and Suspect Identification

Fingerprint analysis is a very dependable way to identify people. Each person’s fingerprints are unique, so it’s a strong method for

² Dr Himanshu Pandey and Anhita Tiwari, *Evidential Value of DNA: A Judicial Approach*, *Bharati Law Review* 12, 17 (2017).

³The Evidence Act, 1872, S. 45.

⁴ Subhash Chandra Singh, *DNA Profiling and the Forensic Use of DNA Evidence in Criminal Proceeding*, 53 *JILI* (2011) 195, 214.

⁵The Constitution of India, Art. 20(3).

⁶The Constitution of India, Art. 21

⁷*Thogorani v. State of Orissa*, 2004 SCC OnLine Ori 297.

⁸ Supra note 6.

connecting a suspect to a particular place or object. In the Sister Abhaya case, this analysis was vital for identifying any potential suspects who might have been at the crime scene. It involves the identification of individuals, potential weapons, or objects, linking suspects to the crime scene and excluding innocent parties (like thief Adakka Raju in this case). The presence of fingerprints on specific objects could help eliminate alternative explanations for the crime. For example, if a suspect's fingerprint was found on a murder weapon, it would strongly suggest their involvement in the crime and undermine claims of accidental death or suicide. Overall, fingerprint evidence served to strengthen the overall case against the accused individuals. When combined with other forms of evidence, such as forensic pathology, crime scene analysis, and witness testimonies, fingerprint analysis contributed to building a comprehensive and convincing case against the suspects.

The use of fingerprint analysis and suspect identification in the Sister Abhaya murder case was essential in connecting individuals to the crime scene and potential objects involved in the crime. This forensic evidence, when combined with other findings, contributed to a strong and compelling case against the accused individuals, ultimately helping to secure justice for Sister Abhaya.

F. Narcoanalysis, Brain Mapping and Polygraphy tests

Various scientific techniques such as narcoanalysis, brain mapping and polygraphy test have been utilized throughout the case so as to reach the perpetrators and corroborate along with the evidence. These techniques can be used for the purpose of improving the investigation and not as evidence without their consent⁹. But in the case of Rojo George v. Deputy Superintendent of Police¹⁰, the court is of the opinion that with the rise of modern and sophisticated crimes, such methods must be employed rather than traditional questioning.

Narcoanalysis: It is a diagnostic and psychotherapeutic technique that utilizes psychotropic drugs. This induces a stupor which is used for investigative purposes. This technique is also called truth serum or drug hypnosis.

⁹Selvi & others v State of Karnataka (2010) 7 SCC 263.

¹⁰ Rojo George Vs. Deputy Superintendent of Police 2006 (2) KLT 197

Brain Mapping: Brain Mapping or the P-300 test is a psychological test where the accused is interviewed so as to understand whether the accused is suppressing any information.

Polygraph Tests: These tests are another tool of examination to know if someone has committed a crime or not through their heart rate, pressure or any other vitals of the human body.

Although the culprits admitted to the crime, detailed how they committed the crime and also the involvement of each culprit. These tests could not be used as evidence according to the High Court appeal as moved in by the accused¹¹. However, it paved the way for the investigators to move on further and confirm their institutions.

G. Summary

The forensic analysts, forensic pathologists, fingerprint analysis, and crime scene experts served as expert witnesses during the trial. They presented their findings and conclusions in court, explaining the scientific basis for their determinations. They provided testimony to the court, explaining the significance of the evidence analysis, expert opinion, and its relevance to the case. Their testimonies played a crucial role in providing the court and the jury with a clear understanding of the cause of Sister Abhaya's death and the involvement of homicidal violence.

The discoveries made through forensic pathology in the Sister Abhaya murder case were instrumental in debunking the initial theory of suicide and establishing that her death was indeed a homicide. The identification of injuries, determination of the time of death, documentation of wound patterns, and toxicology analysis collectively contributed to a compelling case against the accused individuals. Forensic pathologists' expert testimonies played a crucial role in shaping the narrative of the case and ensuring justice for Sister Abhaya.

¹¹ Sister Abhaya's death case: Narco test result not part of marked evidence — Thiruvananthapuram News - Times of India, <https://timesofindia.indiatimes.com/city/thiruvananthapuram/narco-test-result-not-part-of-marked-evidence/articleshow/79884871.cms> (last visited Oct 23, 2023).

ALLEGATIONS OF MISUSE AND CONTROVERSIES

Scientific evidence is meant to bring clarity and fairness to criminal cases, but in the Sister Abhaya murder case, there have been ongoing claims of mishandling and disputes related to the use of such evidence.

Allegations of Evidence Tampering: During the investigation and various trials, accusations of tampering with and hiding evidence have raised concerns about the trustworthiness of scientific evidence. Claims of altering or hiding important forensic discoveries have made the case even more complicated. For example, the convincing evidence of Sister Stephy's hymenoplasty in 2008 was considered valid¹² for Sister Abhaya Murder case trial. But as observed by Delhi HC in 2023, the virginity test of a female is unconstitutional and in violation of Article 21 of the constitution¹³.

Accusations of Cover-Ups: The case has seen many claims of concealment, often involving powerful people or groups. These allegations have sparked concerns about interference in how scientific evidence is gathered and presented. The idea that a powerful group shields individuals from investigation has been a recurring theme in the case's disputes.

Delays and Legal Developments: The Sister Abhaya case has faced long delays and many legal twists and turns¹⁴. It includes both acquittals and retrials, making it legally complex. These changes and delays have led to concerns that legal tactics and evidence manipulation might be at play.

¹²Sister Abhaya murder case: Virginity test unconstitutional, says Delhi HC, HINDUSTAN TIMES (2023), <https://www.hindustantimes.com/india-news/sister-abhaya-murder-case-virginity-test-unconstitutional-says-delhi-hc-101675757174037.html> (last visited Oct 25, 2023).

¹³A truthful thief, an unlikely confession and a secret surgery: How a priest and a nun were sentenced to life, ONMANORAMA, <https://www.onmanorama.com/news/kerala/2020/12/24/sister-abhaya-case-cbi-court-verdict-how-priest-and-nun-sentenced-life.html> (last visited Oct 25, 2023).

¹⁴ 17Murder in the convent: The Hindu Editorial on Sister Abhaya murder case, THE HINDU, Dec. 23, 2020, <https://www.thehindu.com/opinion/editorial/murder-in-the-convent-the-hindu-editorial-on-sister-abhaya-murder-case/article33405415.ece> (last visited Oct 25, 2023).

LESSONS AND IMPLICATIONS

The Sister Abhaya case teaches us about the importance of using scientific evidence properly in criminal cases and the need to maintain honesty and fairness in investigations and legal proceedings. It serves as a strong reminder of these principles.

The Importance of Scientific Evidence: This case, which went unsolved for years, eventually found resolution through advances in forensic science. It highlights the power of scientific evidence, forensic progress, and the dedication of investigators and legal professionals in achieving justice, even in long-standing unsolved cases. It underscores the critical role of scientific evidence in uncovering the truth and ensuring accountability in complex criminal cases. It shows how autopsy reports, toxicology tests, crime scene analysis and fingerprint analysis are vital in establishing the truth and supporting legal proceedings.

Transparency and Ethical Conduct: The controversies surrounding the Sister Abhaya case highlight the necessity for transparency and ethical conduct throughout the investigative and legal processes. It is vital for maintaining public trust in the legal system. It ensures the rights of all individuals involved in a case, including the accused, witnesses, and victims, are protected. It reduces the risk of evidence tampering, coerced confessions, or other misconduct that can lead to the conviction of innocent individuals. It promotes accountability within law enforcement agencies, ensuring that investigators and prosecutors act with integrity and do not engage in misconduct. It reassures the community that the case is being treated with the utmost professionalism and integrity. Maintaining transparency and ethical conduct is crucial to preserving the integrity of the evidence. In cases involving DNA and forensic analysis, the chain of custody and handling of evidence must be beyond reproach to ensure its admissibility in court. The public's confidence in the legal system is vital for the effective administration of justice. Cases like Sister Abhaya's have a lasting impact on society. How the case is handled and whether transparency and ethics are upheld can set precedents for how similar cases are treated in the future. Ensuring that evidence is collected and presented without bias, manipulation, or suppression is essential for a just legal system.

Impact of the Legal System: The Sister Abhaya Murder case also reveals the impact of the legal system on the handling of scientific evidence. The delays, acquittals, and retrials have raised questions about the effectiveness and efficiency of the legal process in ensuring justice. The case raises questions about the effectiveness and efficiency of the legal system in ensuring justice, particularly in complex cases involving scientific evidence. It highlights the need for reforms and improvements in the legal process to address delays, uphold the integrity of scientific evidence, and maintain public confidence in the legal system. This case can serve as a learning opportunity for the legal system. It underscores the importance of streamlining legal proceedings, ensuring that scientific evidence is properly considered, and preventing unnecessary delays in high-profile cases.

Role of Media and Public Influence: As a new trend in this era of information technology, this case is also an indicator of the role of media and public influence. The media and public views have had a big impact on how people see the Sister Abhaya case. The widespread and sometimes exaggerated news coverage has made the case more publicly visible and has made the arguments about it even more complicated.

CONCLUSION

The Sister Abhaya murder case remains an enduring enigma, marked by the intricate use and alleged misuse of scientific evidence. Forensic examinations, toxicology tests, crime scene analysis, and fingerprint analysis all play a crucial role in uncovering the truth. Yet, the case also highlights the challenges and disputes that can arise when dealing with such evidence.

THE DNA OF LEGAL SCIENCE: A CLOSER LOOK AT FORENSIC SCIENCE

Ananya Mishra¹

ABSTRACT

The convergence of law and forensic science represents a unique and dynamic interplay between legal principles and scientific methodologies. This research paper delves into the intricate relationship between these two fields, exploring the ways in which they collaborate, interact, and clash.

This paper will briefly introduce the Main topic that is Law is the ultimate science and give a background of the plot of Dune by Frank Herbert as far as is necessary to understand the role of law in it. Paper begins by examining the scientific dimensions of law, emphasizing its theoretical foundations and the argument for its classification as a science. It then transitions to the world of forensic science, tracing its historical evolution and highlighting the interdisciplinary nature that characterizes it. The discussion proceeds to dissect the scientific methodologies.

Furthermore, the paper delves into the legal principles governing forensic science, addressing the admissibility of forensic evidence in court, the role of expert witnesses, and the criteria used for establishing guilt or innocence. The intersection of law and forensic science is exemplified through compelling case studies that illustrate the collaboration and tensions between the two disciplines. The debate over whether law and forensic science can be considered the ultimate sciences is a focal point of this paper. Arguments against their convergence are examined alongside counterarguments.

In conclusion, this research emphasizes the growing synergy between law and forensic science, while reflecting on the evolving relationship with respect to the statement "law is the ultimate science."

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INTRODUCTION

*“Law is the ultimate Science”²
-a line from Frank Herbert’s Dune.*

Frank Herbert's "Dune," a highly acclaimed science fiction novel from 1965, recently had a 2021 film adaptation. While the series has been extensively studied in various fields, including religion, chaos theory, language, politics, ecology, and history, its legal aspects have been largely overlooked. Despite a character praising law as the "ultimate science," it appears that power dynamics overshadow the role of law in the narrative. Law is often seen as a by-product of power, not a driving force. This perspective challenges the idea that “law is the ultimate science” in Dune.³

Analysing the legal aspects of Frank Herbert's Dune series is a fascinating endeavour. Indeed, while the narrative may seem to focus on politics, ecology, and religion, the presence and significance of law in the series should not be overlooked. The Dune universe does exhibit a deep scepticism towards organized authority, which can have both positive and negative consequences. It underscores the potential for law to prevent abuse of power but also highlights the absence of independent guardians to uphold and enforce the law effectively.

This perspective adds another layer of complexity to the statement law is the ultimate science.

THE NATURE OF LAW AND ITS SCIENTIFIC DIMENSIONS

“I shall argue that legal practice is an exercise in interpretation not only when lawyers interpret particular documents or statutes but generally.”⁴

- Ronald Dworkin (Law as interpretation)

² Herbert, Frank. Dune, Hodder paperback (2006)

³ Vol. 35:2, Dr. Bjornstjern Baade, The law of Frank Herbert’s Dune: Legal culture between cynicism, Earnestness and Futility, Law & Literature, pp. 247-277 (2023)

⁴ Dworkin, Ronald. “Law as Interpretation.” Critical Inquiry, vol.9, no.1, pp. 179-200, 1982.

Law is the command of the sovereign, Law is an instrument to regulate human behaviour, be it social life or business life. The nature and meaning of law have been described by various jurists. However, there is no unanimity of opinion regarding the true nature and meaning of law.

Describing something as a science typically implies a systematic approach to understanding, analysing, and explaining phenomena. While science strives for objectivity and precision, in the context of social sciences, like law, the exacting and precise nature of the natural sciences may not always apply for several reasons:

1. **Subjectivity in Human Behaviour:** Social sciences often deal with human behaviour and societal constructs, which are inherently subjective and complex. Unlike natural phenomena, human actions are influenced by a wide range of individual and societal factors, making exact measurements and predictions challenging.

2. **Interpretation of Laws and Norms:** Laws and legal systems are designed with a degree of flexibility to adapt to changing circumstances and interpretations. This inherent flexibility means that legal concepts can be open to interpretation by judges, lawyers, and scholars, leading to different conclusions in specific cases.

3. **Evolving Societal Norms:** Society's values and norms change over time, which can influence how laws are interpreted and applied. What was considered acceptable or unacceptable in the past may differ from contemporary standards, making it difficult to have a fixed, unchanging standard for legal analysis.

4. **Precedent and Case Law:** In legal systems like common law, prior legal decisions and case law play a significant role in shaping interpretations and judgments. However, these precedents can sometimes be inconsistent or open to interpretation, leading to different outcomes in similar cases.

5. **Role of Discretion:** Judges and legal practitioners often have a degree of discretion in applying the law, which can introduce subjectivity into legal decisions. This discretion can be influenced by personal beliefs, values, and legal philosophy.

6. Appeals and Revisions: The existence of appeals and opportunities for case review acknowledges that the legal system is not entirely precise. If a party believes an error occurred in the interpretation or application of the law, they can seek a different result through the appeal process.

In summary, while science aims for exactness and precision, social sciences like law are influenced by the inherent subjectivity of human behaviour, evolving societal norms, and the way they are interpreted with changing time. This subjectivity and adaptability can lead to different conclusions and make the legal system less exacting and precise compared to some natural sciences.

FORENSIC SCIENCE: A CONFLUENCE OF SCIENCE AND LAW

Forensic science is the study and application of scientific knowledge and methodology for the resolution of legal questions and problems for individuals and as well as for the society. It involves the observation, documentation, collection, analysis, assessment, and scientific interpretation of evidence during the course of an investigation.

Forensic science is a comprehensive blend of scientific knowledge that plays an important role in facilitating justice across criminal, civil, legislative, and societal domains. It encompasses well-established techniques like analysing fingerprints, DNA profiling, ballistics, explosives, firearms, and cultural artifacts. Despite these advancements, a notable gap remains between the realms of law and forensic science. Challenges persist in fully validating the evidentiary value of forensic findings within our legal system.

Incorporating forensic science into the judicial framework is a complex task, requiring extensive research and careful analysis. The ever-changing nature of forensic technologies means that ongoing efforts are necessary to establish their legitimacy and effectiveness in legal proceedings. This research paper seeks to delve into and address the intricate relationship between law and forensic sciences, with the aim of bridging existing gaps and enhancing the integration of forensic science within the legal system.⁵

⁵ Charul Mishra, Forensic science under criminal law, ipleaders (29 October 2023) (https://blog.ipleaders.in/forensic-science-criminal-law/#Importance_of_Forensic_Science_in_Law)

HISTORICAL DEVELOPMENT AND EVOLUTION OF FORENSIC SCIENCE

Forensic science has evolved through various historical stages, one of which is the *Medieval Era (500-1500 AD)*. During this time, a notable instance of early forensic use occurred in China in 1248 with the publication of the book "Washing Away of Wrongs" by Song Ci. This ground-breaking work emphasized the importance of autopsy reports, impartial investigations, and methods to reveal hidden injuries on bodies, including using sunlight under a red-oil umbrella and vinegar. The book also detailed techniques for calculating the time of death based on weather and insect activity, aiding in distinguishing between murder and suicide.

Notably, the book featured a case where flies played a crucial role in identifying a culprit, as human blood doesn't easily vanish from the weapon used. Additionally, various methods from different parts of the world were employed to determine innocence or guilt, resembling early precursors to the polygraph test. For instance, in ancient India, suspects were required to fill their mouths with dried rice and then spit it out, while in ancient China, rice powder was placed on their tongues. In Middle Eastern cultures, suspects were made to lick hot metal rods, based on the belief that guilt would result in a drier mouth due to reduced saliva production. If rice stuck to their mouths or their tongues were severely burned, they were considered guilty.

Furthermore, there's an intriguing historical account where a street merchant identified a customer who owed him money by recognizing the customer's fingerprints on an invoice. The judge considered these prints as irrefutable evidence, marking an early example of forensic science integrated into the legal system.

In the *Modern Era (1500-1800 AD)*, a significant development occurred in 1659 when the term "forensic" was officially recognized in the English language by the Merriam-Webster Dictionary. This marked its inclusion in everyday language, even though it had been used in medical texts for several years prior. By the Enlightenment Era in the 18th century, a notable shift took place in the investigation of crimes. It transitioned from relying on torture to obtain confessions to a more evidence-based approach, reducing

the influence of paranormal beliefs in courtrooms that had previously influenced judicial decisions before the integration of forensics.

Two examples from English legal proceedings during this period showcase the increasing use of logic and structured procedures in investigations. In 1784, in Lancaster, a man named John Toms was accused of murdering Edward Culshaw with a pistol. During the examination of Culshaw's body, a pistol was used to secure powder and balls in the muzzle was found in his head wound. This was perfectly matched a torn newspaper discovered in Toms' pocket, leading to his conviction.

Another illustration can be found in Warwick in 1816 when a young maid servant was discovered submerged in a shallow pond with signs of a violent attack. The police apprehended the perpetrator by tracing footprints and locating a corduroy cloth with a stitched patch in a muddy area near the pond. Wheat grains and chaff were also found near the cloth. The breeches of a farm labourer working in a nearby field, which matched the corduroy cloth perfectly, led to his conviction and subsequent punishment for the crime.

In the *Post-Modern Era*, spanning from the late 1800s to the present day, forensic science has evolved into a widely utilized and established field of criminal investigation. A pivotal moment in its history was the application of forensic science to solve the infamous case of Jack the Ripper, a serial killer who terrorized London in the 19th century.

The foundation for modern forensic science was laid by the Austrian criminal jurist Hans Gross, primarily in the 19th century. His work, including the "Handbook for Coroners, Police Officials, Military Policemen," marked the birth of criminalistics. This pioneering book amalgamated knowledge from various fields like psychology and physical science, which had not been integrated in previous research.

The convergence of these diverse disciplines proved highly effective in combating crime. A noteworthy figure in the development of forensic science is Alphonse Bertillon, a French criminologist, and the creator of Anthropometry. He posited that each individual is

unique, and through precise physical measurements, a distinctive personal identification system could be established. In the late 1870s, Bertillon introduced the Bertillon system, which measured 20 distinct parts of the body to identify criminals and citizens uniquely. By 1884, this system had led to the conviction of nearly 240 repeat offenders, illustrating its effectiveness in law enforcement.⁶

ROLE OF FORENSIC SCIENCE IN THE LEGAL SYSTEM

The legal system has a clear understanding of the crucial role played by forensic evidence in criminal trials. Forensic techniques and methods are preferred because they significantly reduce the potential for bias and discrimination. Consequently, DNA profiling and various other forms of forensic evidence are widely accepted in courts worldwide. It's fascinating to note that the earliest application of forensic techniques dates back to ancient China in 650 A.D., involving finger and palm print recognition.

Forensic testimony is a common practice globally, utilized for both convicting and exonerating individuals. As a result, forensic science laboratories have witnessed significant growth worldwide in recent decades. Furthermore, various special acts have been enacted in countries like the United States, Canada, and Australia to enhance the delivery of forensic services. These acts emphasize the importance of efficient crime scene management, ensuring the detection of crimes and potentially leading to higher conviction rates.

Forensic evidence is often employed in cases involving both convicted and acquitted defendants. This has driven a substantial increase in the number of crime laboratories across the world, responding to the growing demand for forensic expertise. As the world continues to evolve, law enforcement agencies face increased pressure to collect more accurate and comprehensive evidence. Media coverage frequently highlights the significance of forensic

⁶ Khushi Shah, Forensic law: a Developmental Study, Legal service India (<https://www.legalserviceindia.com/legal/article-1251-forensic-law-a-developmental-study.html>)

science but also underscores errors in locating and identifying evidence, particularly in high-profile cases.

Expert testimonies provide valuable insights in international criminal proceedings, with forensic expertise being no exception. Ad hoc trials and judgments have frequently relied on findings from exhumations and examinations. While the interaction between law and science has been a topic of exploration in national judicial systems, the mixed court system introduces new dimensions to this debate. It's worth noting that an officer with additional forensic training could potentially become overly confident and inadvertently compromise evidence, rendering it inadmissible. However, the solution lies in improving the proper collection of substantial evidence from crime scenes rather than exacerbating the issue, especially when competent forensic science instructors are involved.⁷

SCIENTIFIC METHODOLOGIES IN FORENSIC SCIENCE

Forensic Science, employing a multidisciplinary approach, serves as a vital link connecting various strands of evidence in investigations and applies scientific principles to legal contexts. Let's explore the diverse branches within Forensic Science:

1. *Forensic Toxicology*: This discipline investigates the presence of harmful substances in the body and their effects. It draws from analytical chemistry, clinical chemistry, and pharmacology to aid in the examination of poisoning or drug-related deaths.
2. *Forensic Psychology*: Forensic psychology combines psychological insights with legal and criminal matters. By studying criminal behaviour, forensic psychologists deduce offenders' personality traits, contributing to criminal profiling and other roles like victim counselling and trauma assessments.
3. *Forensic Podiatry*: This branch applies specialized knowledge of

⁷ Cyril H. Wecht, John T. Rago, Forensic science and law, Taylor & Francis (22 December 2005).

foot anatomy and function to analyse foot-based evidence in criminal cases.

4. *Forensic Pathology*: Forensic pathologists examine cadavers to determine the cause of death, collecting and analysing medical samples to provide evidence for legal proceedings.

5. *Forensic Odontology*: Forensic dentists analyse dental evidence to assist in identifying victims in cases where bodies are unrecognizable. They play a crucial role in comparative identification through dental anatomy and dental work.

6. *Forensic Linguistics*: Linguistic experts contribute to criminal investigations by analysing written and spoken language to infer characteristics of perpetrators, such as age, education, and cultural background.

7. *Forensic Geology*: This field examines earth materials in legal contexts, providing geological expertise to aid investigations.

8. *Forensic Entomology*: Forensic entomologists use insect knowledge to estimate the time of death or location based on insect activity.

9. *Forensic Engineering*: This branch investigates mechanical and structural failures that result in injury or property damage, applying engineering principles to legal matters.

10. *Forensic DNA Analysis*: DNA profiling is instrumental in identifying individuals and linking them to criminal activities, utilizing biological evidence such as hair, blood, and skin.

11. *Forensic Botany*: Botanical evidence is examined to answer legal questions and help identify suspects through plant-based evidence.

12. *Forensic Archaeology*: Geophysical techniques assist in locating buried items in legal contexts, and forensic archaeologists contribute to excavations and age determination.

13. *Forensic Anthropology*: Forensic anthropologists analyse human remains to determine identity and cause of death, particularly valuable when dealing with degraded bodies.

14. *Digital Forensics*: This emerging field involves extracting and analysing digital evidence, playing a pivotal role in cybercrime investigations.

15. *Forensic Ballistics*: Forensic ballistics analyse firearm-related evidence to determine details of incidents involving firearms.

Forensic science continues to evolve, uncovering hidden information within traces and imprints. It serves as a crucial bridge, uniting scientific exploration with legal inquiries, and plays a vital role in the pursuit of truth and justice.⁸

PRINCIPLES IN FORENSIC SCIENCE

1) Principle of Individuality:

The Principle of Individuality posits that every object, whether occurring naturally or crafted by human hands, possesses a unique quality or characteristic that sets it apart from all others. In essence, nothing in the vast expanse of the universe is an exact replica of something else. This concept finds vivid illustration in the realm of forensic science, where it serves as the foundational element.

Consider, for instance, the human fingerprint, a quintessential example of distinctiveness. Fingerprints are not only one-of-a-kind but also enduring, making them a tangible manifestation of an individual's uniqueness. Remarkably, even identical twins, who share much in common, do not possess identical fingerprints.

This fundamental principle extends beyond the realm of biology to include objects as seemingly uniform as grains of sand, salt crystals, seeds, or everyday items like currency notes, laptops, and typewriters. While these items may appear similar at a cursory glance, a closer examination invariably reveals unique attributes that distinguish them from one another.

In the practice of forensic science, this principle takes on paramount importance. Evidence collected from crime scenes,

⁸ Anshika Dhingara, Law and forensic science, The amicus Qriae, 29/10/2023(<https://theamicusqriae.com/law-and-forensic-science/>)

whether in the form of fingerprints, footprints, or tool marks, is meticulously scrutinized and analysed with unwavering adherence to the belief in the individuality and distinctiveness of each piece of evidence. This bedrock concept is not merely the cornerstone of forensic science; it is the linchpin upon which the entire discipline hinges, guiding investigators and forensic experts in their relentless pursuit of truth and justice.

2) Law of progressive change

Law of progressive change or The Principle of Ongoing Transformation underscores the fact that everything undergoes change as time passes, and nothing remains in a static state. This transformation occurs at varying rates, dependent on the specific object or sample.

In the realm of forensic science, the timely and proper securing of a crime scene is of paramount importance. This is because various factors, including weather conditions (such as rain, heat, or wind) and the presence of animals or humans, can significantly impact the integrity of the crime scene. For instance, in a busy highway accident, critical evidence may be lost if not promptly preserved.

The principle is exemplified in the way evidence itself can change over time. Bullet fragments may develop rust, firearm barrels can become less secure, shoes accumulate wear and tear marks, and wooden objects may deteriorate due to termite infestation, among other changes. The longer the delay in securing and analysing evidence, the more pronounced these alterations become.

This concept becomes especially critical when dealing with samples that are not inherently durable. In such cases, delays can introduce complications to the investigation, as the identification process is hindered by variations in the essential identifying features. Without suitable preservation methods, tissue samples can begin degrading rapidly and demand immediate analysis.

Moreover, it's not just physical evidence that evolves over time; criminals themselves undergo changes. If apprehended promptly, their identity can be established. However, with time, they may become unrecognizable except through their fingerprints or other permanent characteristics.

In essence, the Principle of Ongoing Transformation underscores the urgency and precision required in forensic science, as both evidence and individuals are subject to continual change, making timely and meticulous analysis a fundamental requirement for the pursuit of justice.

3) Locard's principle of exchange (law of exchange)

This fundamental principle, attributed to the pioneering French scientist Edmond Locard, forms the bedrock of criminology and forensic science. It is the Principle of Exchange, stating that when two entities come into contact, they inevitably leave traces on each other.

In cases where a criminal, their weapon, or instrument interacts with the victim or their immediate surroundings, a reciprocal exchange of evidence occurs. In this process, the criminal leaves behind traces at the crime scene while also picking up traces from the location or individuals they have encountered. These traces, often imperceptible to the untrained eye, play a pivotal role in forensic investigations. Skilled experts can identify and link these traces to their source, creating a decisive connection between the criminal, the crime scene, and the victim.

Locard's principle encompasses various forms of evidence, including fingerprints, tire marks, bullet residues, footprints, hair samples, skin, muscles, bodily fluids, blood, and pieces of clothing. The application of DNA analysis directly aligns with this principle, as it scrutinizes items believed to have been handled by the perpetrator.

4) Principle of Comparison

This principle holds immense significance in laboratory investigations. It states that "Only similar items can be effectively compared." It underscores the importance of providing comparable samples and specimens when evaluating questioned items. For example, if a murder is committed using a firearm, sending a knife for comparison would be futile. Thus, the crucial condition of this principle is to supply specimens or samples of a similar nature for a meaningful assessment alongside the questioned samples obtained from the crime scene.

5) Principle Of Analysis

This principle asserts that "The quality of any analysis can be enhanced through the collection of the correct sample and its proper preservation following prescribed procedures." This not only leads to superior results but also prevents tampering, contamination, and the destruction of samples. For instance, packaging a sensitive item like a hard disk in a paper bag can lead to damage, especially in the presence of strong electromagnetic fields, resulting in compromised results. Therefore, it is essential to use appropriate and effective collection and packaging techniques to maintain the integrity of evidence.

6) Law of Probability

This law posits that "All identifications, whether definitive or tentative, are made based on probability, whether consciously or unconsciously." It emphasizes that while many people may share certain characteristics or features, the likelihood of these characteristics aligning in a specific case can be quite low.

For instance, if a missing woman is described as having a tattoo of a bear on her right hand and an old head injury, and an unknown woman is found murdered with these exact characteristics, the probability that the unknown corpse is that of the missing woman is high. The chance of the deceased being another woman with these same attributes is exceedingly rare, possibly one in millions.

7) The Law of Circumstantial Facts:

According to this law, "Facts themselves cannot be erroneous, deceptive, or entirely absent, but human accounts can be." This law underscores the importance of circumstantial facts and asserts that information provided by a person may or may not be accurate. In an investigation, facts that are identified and discovered tend to be more reliable and precise than any eyewitness account, emphasizing the significance of empirical evidence over human testimony.⁹

⁹ (Law and principles of forensic science: forensic finger print , 2019)

THE INTERSECTION OF LAW AND FORENSIC SCIENCE: ADMISSIBILITY OF FORENSIC SCIENCE IN INDIAN COURTROOMS

In the context of Indian legal proceedings, the admissibility of forensic reports is delineated in Sections 45 and 46 ¹⁰of the Indian Evidence Act. These statutory provisions encompass the following key elements:

1. *Expert Testimony*: The court, at its discretion, places reliance on individuals possessing specialized knowledge and expertise relevant to the facts under consideration in a case. Such individuals are recognized as skilled professionals with the requisite technical and field-specific acumen.

2. *Official or Expert Reports*: The court considers the evidentiary weight of reports presented by officials or experts who have arrived at their conclusions through established techniques, guided by a genuine and bona fide intention to uncover the truth.

3. *Relevance Based on Expert Opinion*: Notwithstanding the potential for certain evidence to appear irrelevant in the eyes of the court, the court grants it relevancy when such classification is endorsed by the informed opinion of an expert. This deference to expert opinion underscores the significance of expert guidance in determining the relevance of evidence.

In essence, the admissibility of forensic science evidence in Indian courtrooms is governed by these provisions, highlighting the pivotal role of expert testimony and reports in judicial proceedings.

CASE STUDIES ILLUSTRATING THE SYNERGY BETWEEN THE TWO FIELDS:

1) Kishan Chand vs. State of Himachal Pradesh

In the case of Kishan Chand vs. State of Himachal Pradesh, the accused faced charges of raping a child between the ages of 10 to 12 years. Subsequently, the accused was convicted for this offence, with the conviction being substantiated by forensic reports generated by experts. These reports were effectively corroborated

¹⁰ (The Indian Evidence Act)

with circumstantial evidence. ¹¹Notably, the Regional Forensic Science Laboratory (RFSL) of Mandi utilized various forensic techniques, including DNA profiling, the Benzidine test, Gel-diffusion technique, and the Acid Phosphatase test, to assist in establishing the case.

2) Mukesh and Ors. vs. State of Delhi

Similarly, in the case of Mukesh and others vs. State of Delhi, the accused faced charges related to dowry, and they were ultimately acquitted of these charges. The accused successfully refuted false allegations made by the wife, who claimed to have experienced dowry cruelty and to have been poisoned. ¹²However, forensic reports conclusively demonstrated that there was no presence of poison in her stomach, as determined through Toxicology and ballistics tests.

These instances underscore the invaluable role of forensic reports in shaping the outcomes of legal cases. Nevertheless, it is essential to acknowledge that there have been instances where judges have, for various reasons, either due to external pressures or the absence of corroborative evidence, neglected the significance of forensic reports. For example, the well-known Aarushi Talwar case, also referred to as the Noida double murder case, saw the victim's parents and their servant accused of her murder.¹³ Although forensic reports, combined with narcotics testing, contradicted these allegations, the accused were convicted due to media pressure and the lack of alternative evidence.

Numerous cases exist where forensic reports, despite their necessity, have not been presented, leading to judgments that inadequately consider the medical aspects of the victim's circumstances.

IS LAW THE ULTIMATE SCIENCE?

Law is often hailed as the ultimate science for regulating human behaviour, but it is far from infallible. The existence of lacunae within the legal framework is a clear testament to this. These gaps,

¹¹Kishan Chand v. State of Himanchal Pradesh, 2018.

¹²Mukesh and ors v. state of Delhi , 2017.

¹³Dr. Nupur Talwar v State of UP, 2017.

ambiguities, and inadequacies in the law demonstrate that it cannot be the ultimate science.

Firstly, laws are created by humans and are subject to the limitations of human knowledge and foresight. Societal dynamics and technology evolve at a pace that often surpasses the law's ability to adapt. This leads to situations where new technologies or social phenomena are not adequately addressed, leaving a void in the legal framework.

Furthermore, the interpretation of laws can vary significantly, creating inconsistencies and contradictions in their application. Courts and legal scholars often grapple with differing interpretations of statutes, leading to legal uncertainty and unpredictability.

Moreover, the law's dependence on individual discretion, such as that of judges or law enforcement, can result in inconsistency and injustice. Personal biases and subjective judgments can influence legal outcomes, undermining the notion of law as an objective and ultimate science.

In conclusion, the existence of lacunae in the legal system highlights that law is a human construct, subject to flaws and limitations. While it serves as a vital tool for maintaining order and justice, it is not an infallible, ultimate science. Recognizing these imperfections is essential for continually improving and adapting the legal system to the changing needs of society

THE INSPECTION OF PHYSICAL EVIDENCE, WITH SPECIFIC REFERENCE TO HANDWRITING ANALYSIS IN FORENSICS: UNDERSTANDING THE GROUND LEVEL SITUATION

Bhavik Pahuja ¹

ABSTRACT

Science and the criminal justice system have long been inextricably linked. Soil analysis, fingerprinting, and DNA analysis have all contributed to the removal of reasonable doubt. To write, writers use a combination of sensory, neurological, and physiological inputs. Visual perception, shape interpretation, CNS pathways, and hand physiology all have an impact on the desired outcome. The relationship between handwriting and criminal proclivity remains a mystery. It's difficult to enter an abnormal mind to identify, evaluate, and explain its causes, let alone recommend approaches, treatments, and rehabilitation plans. For example, in India, and perhaps other case-law countries, insanity does not result in criminal penalties. Every time one commits horrible atrocities, since they are unable to distinguish between right and evil, Understanding the reasons for antisocial behaviour and the factors that shape the personalities of offenders, especially psychopaths, is very important, so learning about them is very important.

INTRODUCTION

Forensic has numerous meanings, one of which is judicial. In its more recent meaning, Webster includes "relating to or dealing with scientific knowledge applied to legal problems." The

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judicial system can benefit from using science, computing, medicine, and other fields of knowledge to help resolve disputes, be they criminal, civil, or administrative. Criminalistics is the application of forensic science to criminal matters. Criminology is the Criminalistics, on the other hand, is the application of science to the investigation and prosecution of criminal prosecutions. "Forensic science" refers to a range of scientific disciplines that deal with the application of their scientific skills to law enforcement and judicial concerns. In reality, "applying science to solve crimes" means examining physical evidence in the field or the lab. Hairs, fibres, latent fingerprints, and biological material are examples of physical evidence.

The scientific testing used in criminalistics is reliable and objective. Physical evidence is not the same as testimonial evidence, such as written or spoken comments from victims or witnesses, which is different.²

In forensics, physical evidence is the decisive factor. Selective research means precisely what it sounds like. On a regular basis, other minute items from the crime scene are analysed and scrutinized. In forensics, even the tiniest piece of information can be crucial, which is why all investigators, whether police, medical, or government, must be vigilant. Regardless of other evidence, physical evidence is crucial (confessions, testimony, or video surveillance). With the exception of actual evidence, all sources of information are questionable. Physical evidence, when correctly identified and preserved, can provide objective and trustworthy information about an incident. A disrupted chain of custody could render precisely obtained evidence inadmissible. This is a widespread problem in the world of criminology. Every piece of evidence that could be used against the defendant is properly documented. Consistent documentation is essential in order to prove the "traceability" and "continuity" of the timeline of evidence, which includes evidence that was brought to court from the criminal site. It should be highlighted that in forensics areas like handwriting analysis, practical experience outweighs

² Barry A.J. Fisher, William J. Tilstone, Catherine Woytowicz, *Introduction to criminalistics: The foundation of forensic science*, (Academic Press, 1st edn., 2009).

academic degrees, and tangible evidence is therefore critical in criminal investigations.

Since each case has its own collection of facts, issues, and history, it is difficult to club them all. However, materials whose scientific research could contribute to the resolution of a crime can be included. When presented with the unexpected, an investigator who is conversant with these approaches and capabilities can reach reasoned conclusions. A skilled evidence collector must also be able to make decisions on the spur of the moment. Physical evidence assists in identifying the culprit and victim, as well as determining the location of the incident. Evidence is recognised, collected from the scene of a place and delivered to a testing ground for investigation.

1. Tangible proofs must be collected as part of a criminal investigation. Section 157 of the Criminal Procedure Code³ says, the site ought to be thoroughly investigated. This lesson focused on categorising various aspects of physical evidence.
2. Everything that can be used to link a suspect, victim, and crime scene is considered physical evidence. Depending on the crime and the circumstances, almost anything can be considered tangible evidence. In some circumstances, it is impossible to recover precise physical evidence. Incriminating evidence, such as bloodstained clothing and finger and foot prints, is commonly collected at crime scenes. The jury weighs the evidence. After that, the tangible evidence must be gathered and carefully packaged. It is vital to avoid contaminating the evidence.
3. When evidence is collected at a crime scene, it is often unclear how important it will be later in the investigation. As a result, forensic scientists must cover every inch of the crime scene and consider every piece of evidence crucial. As a result, until a crime scene has been thoroughly studied in a laboratory or an investigation has been

³ Code of Criminal Procedure 1973, § 175. No. 5, Acts of Parliament, 1908 (India)

concluded, every minor detail must be deemed crucial. In most situations, forensic professionals are unable to recover usable evidence from crime scene artefacts. Unexpected evidence, such as a fingerprint or strand of hair, might widen the scope of an investigation. In today's environment, physical evidence such as fingerprints, body fluids, gun/arm residues, hair fibres, and narcotics can be retrieved from a crime scene in today's environment.

Review of literature

1. **Boriz Rosenberg (2007)**⁴ emphasized the range of consequences and issues that must be addressed by professionals who conduct forensic research during physical examinations in studying and scrutinizing the many elements during the inquiry, regardless of stage of processing. The collection, from the scene to the courtroom, should be done efficiently, along with the challenges faced by forensic personnel and police to handle them and avoid degradation.
2. **Dr. Aleksandar Ivanovic (2019)**⁵ addresses the problem of forensic science standardization and accreditation as a critical aspect in obtaining the trustworthiness of forensic evidence. In this regard, the author provides a succinct description of the application of ISO 17025, which refers to the accreditation of forensic laboratories. The document describes forensic organisations in Europe that are ISO17025. The paper's author also discusses what he sees as the future of forensic certification and standardization. That is primarily related to the work of the technical committee TC 272, which is centred on the development and application of forensic standards that will encompass a

⁴ Boriz Rosenberg, *New Approach for Detecting Unknown Malicious Executables*, The journal of forensic research 8, 2755-2790 (2007).

⁵ Ivanović, A., 2019. Accreditation and standardization in forensic science—present and future of reliability of forensics examination and expertise. *Journal of Eastern European Criminal Law*, (01), pp.200-212.

whole forensic procedure, beginning with the discovery of on-site evidence.

3. Horvath and Meesig (1996)⁶, In a study of Canadian detectives, discovered that forensic materials and scientific analysis were not as effective in punishing the victim as they were in gaining leverage in police interviews, whereas in Japan, the situation was rectified because statements were being backed up by physical investigations simultaneously, so review was neutral and helpful. To figure out how valuable something is, you need to look at all of the physical evidence. Claude Roux and Frank Crispino (2012)⁷ This article explains how the mainstream view of forensic science as a bridge of regulations largely assisting system of criminology, (alias. "forensics" herein) exhibits a number of abnormalities and major limits. While the symptoms have been extensively studied, we contend that many of the often-proposed treatments may not address the underlying issue. This is why we think the forensic science community should return to its roots, which are the study of crime and its traces. Forensic fields should not be broken up any further. This should lead to the development of holistic models that will help scientists use technology and become more involved in police work, crime investigation, and criminology.

4. Durlabh Singh Kowal and Pradip Kumar Gupta (2021)⁸ in their research focused on the critic's issues stated that a disordered mind must be examined in order to offer treatment, insanity as a ground is not penalised yet because it is incapable of distinguishing right from evil. To begin, one must understand the origins of antisocial behaviour and the personalities of psychopaths. Forensic graphology and psychiatry are fields of research that focus on mental disease

⁶ Horvath, F.S., & Meesig, R.T. (1996). *The Criminal Investigation Process and the Role of Forensic Evidence: A Review of Empirical Findings*. *Journal of Forensic Sciences*, 41, 963-969.

⁷ Claude Roux, Frank Crispino & Olivier Ribaux, From Forensics to Forensic Science, 24 CURRENT Issues CRIM. Just. 7 (2012).

⁸ Kowal, Durlabh & Gupta, Pradeep. *Handwriting Analysis: A Psychopathic viewpoint*. The International Journal of Indian Psychology. (2021).

and criminal behaviour. Both tactics provide a sense of uniqueness. Therapy and change benefit both humans and psychopaths. Combining these perspectives can aid in the explanation of criminal behaviour. These findings are based on technologies for handwriting analysis. Additionally, psychopaths write in a unique way. As with profiling and graphology, it aids in the identification of suspects. Psychopaths commit crimes not maliciously but as a result of their antisocial personality disorder. Concealment, evasion, and deception are all characteristics of psychopaths or criminal trait clusters. Handwriting A psychopath's qualities include impulsivity, deception, dependency, vanity, and ostentation. India's judiciary must establish their own legal category for psychopaths, which India's judiciary must expeditiously. In popular Indian scripts, these methods can be used to look for psychopaths

5. **Meera Bangotra (2016)⁹**, In her work, she discussed deception and detection strategies in crime investigation in India. She goes on to say that the employment of modern techniques has increased efficacy, but with new technology comes modern risks, as a matter of legal consistency, and it can't be denied that not all. However, in some cases, these tricks and tests can unknowingly lead to a violation of personal liberty, which is protected under article 20(3)¹⁰ of the constitution, *which is the right against self-incrimination*, so it should be kept in mind at all times that the new tactics should be in accordance with our main statute, which is the constitution, whose foundation has to be adhered to at all times.
6. **Bilginer Gülmezoğlu (2011)¹¹**, This research describes how new techniques for encapsulating the specific aspects of a

⁹ Bangotra, M., 2016. *Use of modern scientific deception detection techniques in criminal investigation in India: A study from constitutional and human rights perspective*. Journal of global research & analysis, 5, p.55.

¹⁰ INDIA CONST. art.20(3).

¹¹ Önder Kirli, M. Bilginer Gülmezoğlu, "Writer identification from handwriting text lines", *Innovations in Intelligent Systems and Applications (INISTA) 2011 International Symposium on*, pp. 133-137, 2011.

person's writing style have been introduced to allow text-free grounds author identification. To measure contributions of synthesis to the accurate recognition rate, Three well-known classifiers are used to apply the found attributes. The extracted performance is also compared to the query's author count. All three classifiers were quite accurate. Here is an example of a system that uses the specified approaches for extracting handwriting.

7. **D. Bertolini (2013)**¹², investigates the use of textual descriptors to verify and identify writers in her work. To solve verification challenges, we use a distillation technique based on dissimilarity quotient. The framework's performance on the writer identification problem is also assessed, as is the performance of the dissimilarity-based method in comparison to other feature-based strategies. We employ two datasets to accomplish these goals: the Brazil letters the IAM database and the database. We demonstrate that both LBP and LPQ classifiers surpass the previous results for the verification task by about much anyway 6 %. The LPQ characteristics from the BFL and IAM datasets are employed 96.7 percent and 99.2 percent of the time, respectively, to make the suggested technique work.

HANDWRITING ANALYSIS AS A FORENSIC EVIDENCE.

A forensic scientist's work does not end when they leave the lab. It's in court that the evidence's importance is finally decided in the second part. In contrast, forensic scientists must persuade juries of the validity of their findings.

1. **Investigating the evidence-** forensic scientists must first and foremost be able to apply physical and natural science principles and processes to the analysis of various sorts of physical evidence in order to succeed. Physical evidence is

¹² D. Bertolini, L.S. Oliveira, E. Justino, R. Sabourin, "Texture-based descriptors for writer identification and verification", *Expert Systems with Applications*, vol. 40, pp. 2069, 2013.

the only type of evidence that does not have any inherent flaws or biases.

2. **Importance of this evidences-** as a result of lapses in memory or erroneous judgement, many people have been falsely accused and convicted of crimes. Investigators may be fooled while assessing the facts and events surrounding a crime for the first time. Because no two persons are capable of producing the identical writing, the science of handwriting analysis is based on the concept of variation, which states that no one can replicate their own writing exactly. It is normal for a person's handwriting to have minor variations in a person's handwriting.

USAGE/IMPLEMENTATION IN FORENSICS- In forensics, handwriting is employed in a variety of civil and criminal cases as immediate and remote evidence. The grave is the most valuable piece of handwritten evidence. **SUCIDE NOTE:** If the handwritings of recognized individuals can be identified upon investigation, it can be determined if the information was accurate, fabricated, or the result of a malevolent act by a third party. In a nutshell, to ascertain the truth in these circumstances.

THE FUNDAMENTAL PREMISE OF HANDWRITING ANALYSIS

When two items share a combination of independent discriminating elements in such a way that their relationships with one another are sufficiently numerous and significant to rule out their occurrence by possibility, and there are no unexplained stark differences, it can be asserted that they originate from the prime source. The following are the premises:

1. ***No two persons have exact same actions and handwriting***
2. ***No two Person never writes signatures in same way***

METHODOLOGY

Just before analysis begins, a sample of writing and an unidentifiable sample are reviewed for distinguishing traits. Some

of the qualities that the examiner is searching for are letter or word spacing, slanting, style deviations, proportionality, and individual traits. The following phase is comparison, in which the examiner compares and contrasts the two samples to identify differences. The examiner is now looking for similarities between the two samples, but no one similar trait, no matter how specific it can pinpoint a match, can be utilised to evaluate the results.

WHO PERFORMS THE ANALYSIS?

Forensic document exams should be performed by qualified specialists, preferably by members of a well-known professional standard such as the American Board of Forensic Document Examiners (ABFDE) or the American Society of Questioned Document Examiners (ASQDE). The pre-requisite for membership in organisations varies; nonetheless, before being able to join, an expert ought generally to have completed a two-year annual full-time traineeship under the supervision of a qualified forensic document expert. Examiners must receive college credits to maintain their membership status and abilities.

HOW AND WHERE IS THE ANALYSIS CONDUCTED?

Professional examiners of forensic documents work in self-laboratories or in state provided facilities. If corporation is unable to analyse papers, they may choose to send the evidence to a nearby lab or employ a private entity of said segment. Forensic document examination processes and equipment are based on well-developed principles of biochemistry. Microscopes, imaging scanners, A standard Discussed Documents area in a crime lab contains infrared and UV light sources, video analysis tools, and specialised equipment such as electrostatic detecting devices (EDD) and analytical chemical components. Numerous personnel of examiners employ purely non-destructive techniques.¹³ Using light electrostatics, materials

¹³ R. Plamondon and S. N. Srihari, "Online and off-line handwriting recognition: a comprehensive survey," in

are checked ink discrepancies. Other types of methods, such as liquid chromatography, are regarded to be harmful due to the fact that they necessitate the removal of inute amounts of ink from the concerned material. They could be sent to labs that specialise in particular segment of ink analysing systems.¹⁴

Text extraction from indented impressions Documents having indented impressions that are not apparent to the naked eye can be viewed using a gadget for electrostatic sensing (EDD), the **Electrostatic Detection Apparatus**. Text extraction from indented impressions (ESDA) With the help of applied charges and toner, an EDD visualises sections of indented writing that are otherwise invisible for the human retina.

This functions on concept that needed regions from a paper have a lower negative charge than their surrounding areas, which is supported by scientific evidence. This attracts the toner used in the EDD to these spots, disclosing any previous indentations.

This technique has been used to retrieve probable imprints from layers of paper beneath the real text. According to studies, impressions can be seen from documents that have been around for 60 years, as long as the materials haven't been damaged or poorly kept.¹⁵

Handwriting is defined as a collection of basic strokes linked together by rules. This type of handwriting closely resembles human handwriting. This type of matching technique can be used as the foundation of a handwriting recognition system.¹⁶ The Supreme Court heard a lot of cases about the admissibility of expert testimony. In these cases, the Court said that the jury (judges) had a duty to look at expert testimony. In *Daubert v. Merrell*

IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 22, no. 1, pp. 63-84, Jan. 2000.

¹⁴ Nishika Prajapati, *History and Development of Forensic Science in India*, [\(2020\)](https://www.legalserviceindia.com/legal/article-2975-history-and-development-of-forensic-science-inindia.html)

¹⁵ Supra note 12.

¹⁶ M. Eden, "Handwriting and pattern recognition," in IRE Transactions on Information Theory, vol. 8, no. 2, pp. 160-166, (1962).

*Dow Pharmaceuticals, Inc*¹⁷. and *Kumho Tire Co. v. Carmichae*¹⁸ referring jury work to "gatekeepers" Those who must determine the legality and legitimacy of expert evidence were discussed.¹⁹ In a variety of issues, such as suicide notes, kidnapping information, contracts, signature verification on official documents, and much more, handwriting inspection is an analytical approach that can only be accomplished efficiently by a well-known expert.

CHECKING GENUINENESS

The first step is to verify the authenticity of the document that needs to be verified in order to proceed. The usage of video spectral comparators is required in order to expose writings that have been added using a different or UV protected ink.²⁰ When it comes to secret information, that responds differently depending on the wavelengths and tonal variations that have been tested, Certain artificial techniques can be used to improve the readability of a page by altering its colour, intensity, and background synchronization.²¹

HAND WRITING EXAMINATION

The examiner examines several areas of the writing to discover whether there are any similarities or differences. Pen pressure and lifts are taken into consideration, as well as space between words and characters. The baseline (the character's

¹⁷ *Daubert v. Merrell Dow Pharmaceuticals, Inc* 509 U.S. 579 (1993).

¹⁸ *Kumho Tire Co. v. Carmichae* 526 U.S. 137 (1999).

¹⁹ Mnookin, Jennifer L., *Scripting Expertise: The History of Handwriting Identification Evidence and the Judicial Construction of Reliability*.

Available at SSRN: <https://ssrn.com/abstract=292094> or <http://dx.doi.org/10.2139/ssrn.292094> <last accessed 22 November 2023>

²⁰ Gurley, B.M. and Woodward, C.E., 1959. *Light-pen links computer to operator*. *Electronics*, 32(47), pp.85-87.

²¹ A. Marcelli, A. Parziale and C. De Stefano, "*Quantitative evaluation of features for Forensic Handwriting*

Examination," 2015 13th International Conference on Document Analysis and Recognition (ICDAR), 2015, pp.

1266-1271.

location in reference to an imaginary or ruled line) is also taken into consideration by the examiner along with height relationships and the quality of the line's beginning and finishing strokes. The identity of an author can't be formed by just one part of his or her writing. Instead, identity is created by combining the most important aspects of the writings, and there are no significant differences.

Despite the issues raised by the Daubert decision in 1993, forensic document inspection has been routinely employed in courts. As a routinely recognized discipline under Frye²². Published researches till date validates the knowledge and aid the rationale of distinct handwriting individualism. Approved guidelines provide research uniformity. These criteria are abided by document examiners in both public (local, state, federal, and international) and private laboratories. Academic and practical research is helping to strengthen the scientific foundation for handwriting comparison, which benefits the forensic document inspection community.²³

VARIATION

Variation is a necessary component of the creative process. Similarly, to how some writers exhibit greater control or talent than others, certain authors exhibit a greater or lesser degree of diversity in their writing owing to their skills, age or conditions surrounding their writing. Unlike machines, we are not capable of writing in the same manner each time we sit down to write. Signatures are not similar each time they are signed, even when exceptionally talented authors appear to be. is an excellent example of how an examiner may consider a writer's unique characteristics when establishing who created a piece. When comparing signatures, it is possible to account for variations in the total number of signatures since the author modifies some properties that vary from signature to signature.

²² Frye v. United States, 293 F. 1013 DC1923).

²³ Harrison, D., Burkes, T.M. and Seiger, D.P., 2009. *Handwriting examination: Meeting the challenges of science and the law*. Forensic Science Communications, 11(4), pp.1-13.

In Vandavasi Alias vs S. Kamalamma And Others²⁴, The inference could be that, in contrast to fingerprints, from which specific authentic information can be gleaned, handwriting, whether in electronic scanning formats that are emerging day by day in the current era and eventually replacing conventional ways, requires human intellect and experience. Extreme care and caution must be exercised in order for it to be considered a legal document admissible in court. After all, even the most accomplished professional can make mistakes.

Limitations of forensic document examination

The following circumstances may impede or limit the study of questioned documents:

- Non-original proof.
- Inadequate number of known specimens submitted for comparison.
- Incompatibility of the questioned documents with known samples.
- Inadequately submitted contemporaneous literature for comparison.
- Writing distortion or obfuscation.

CONCLUSION

The various procedures, aspects, as well as evidence, along with instances and practical examples of the aforementioned topic and suggestions that could lead to betterment, keeping in mind that the lacuna it currently faces should be formalized in order to make the examination of physical evidence less hassle, error, and misinterpretation free. The prime goal is to ensure that no incorrect inference is made and to uphold the principle of Fair justice.

²⁴ Vandavasi Karthikeya Alias vs S. Kamalamma And Others 1993 (3) ALT 320.

Keeping in mind the length of the study, the loopholes of several defied man-made and computer technologies that are approaching for automatic detection of handwritten forensics were discussed, with a main emphasis on handwriting analysis expert advice. The expert's evidence is only a piece of evidence and is given weight, and it must be weighed with other premises of a case, since it is an opinion and not solely a final deciding factor in a respective case, therefore it is correct to call it corroborative evidence.²⁵

When we scrutinize the State of Kandhu Charan Barik case and per the court, handwriting experts need not know everything there is about recognize. It is crucial to validate the handwriting expert's opinion for reasons the expert agrees with. As long as the judge has his knowledge and skills, his job is to help him do his job. The court will then make the following decision based on the core of the case and the accuracy of forensics. This is what the court will do. So, in the end, we can say that the expert's opinion must be backed up by enough, strong, and reliable evidence.

Laying down just machines automatic handwriting analysis scanners with defied and dynamic algorithms existing in market like 'MATLAB²⁶, AHWAS²⁷, It is not the end of human manual handwriting analysis. My opinion is that forensic diagnosis is very risky because it is very vague. At the end of the day, it's the human intellect that can make conclusions based on thoughts and life experiences. The brain just works the way it is supposed to and has a limit to what it can do on its own. Forensic document examinations are improving as the medium through which handwriting and other relevant evidence can be shown grows. However, manual intelligence is still needed because computers are machines that can malfunction after all their technology.²⁸ any time It can also lead to the loss of important

²⁵ Balakrishna das V. Radha AIR 1989 All 133.

²⁶ 29 D. Houcque. *Applications of MATLAB: Ordinary Differential Equations. Internal communication*, Northwestern University, pages 1-12, 2005.

²⁷ West, Peter. *Handwriting Analyst's Toolkit: Character and Personality Revealed through Graphology. Hauppauge, NY: Barron's Educational Series, 2004.*

²⁸ Basant Rao V. State 1950 cr.LJ 181.

information or data, which is needed to keep track of records in court as proof.

Technology is never the same. It's always getting better, and it takes time for experts to be sure and accurate about AI decidability. No one knows for sure if all these exams should be used, but it's still an open question. It's true that we'll have more time and money in the future, so we'll have to change our ways a little.

When it comes to corroboration methods, it might be difficult to encapsulate them due to the fact that the expert's experience may not be readily available to another person who can explain them in the same way as the expert.²⁹

Nevertheless, A handwriting expert's competence cannot be ignored fully because, as shown from its origin, it is the fundamental technique of distinguishing and scrutinising the letters in situations involving suicide, suicide notes, and declarations. As has been established, the suicide rate, particularly in India, is rising, as is the case with everything else. According to the National Crime Records Bureau in New Delhi, crimes have increased by 10–15 percent in the last year, coinciding with the coronavirus outbreak.

SUGGESTIONS

The following are a few of the present author's suggestions for improving the current examination of physical evidence with regards to handwriting analysis regime:

- There are a variety of automatic handwriting analysers available in today's time and all have different sets of algorithms and detection techniques with different accuracy levels. Considering the fact that we will have to adapt to technological advancements for forensic detection, there should be a universally standardized and acceptable software so that the document evidence produced in court is easier for the judges to verify.

²⁹ 32 Suleman U. Menon V state of Gujarat 19612 cr.LJ 78.

- To make sure that forensic standards are met by the government, both at the state and federal level, it should come up with the right protocols and frameworks.
- To improve the speed with which justice is served, the private sector should support the outsourcing of evidence investigation rather than restrict it to government labs.
- Extensive research is still left to be done in the fields of document verification with forensic science to make the admissibility in courts strong and valid evidence as an authentic source in the court hierarchy.

LAW AND BIOSCIENCE: NAVIGATING COMPLEX SYMBIOTIC ALLIANCE

Nandan Bharat Rathi¹

ABSTRACT

Bioscience is one of the main branches of science, it has been the forefront area where a lot of research and innovations take place. With such rapid advancements in this field, there is a need for a regulatory framework which will act as a legal validity and enforceability mechanism. Biotechnology has emerged as a top field in current developments in science, Bioethics also developed to ensure ethics is followed. Countries must make adequate laws, guidelines, and policy to cover the ever-expanding aspects of biosciences. From historical analysis to current trends in bioscience, we shall be tracing the interplay of Law and Bioscience & how they are interconnected to form an inseparable alliance, essential for the present and future.

INTRODUCTION

"I think the biggest innovations of the 21st century will be at the intersection of biology and technology. A new era is beginning"-

-Steve Jobs

We are surrounded by biosciences in every sphere of our lives. From the cold beer you drink on hot days to cheese pasta you eat; bioscience follows around you. Simple understanding of bioscience is "any form of living organism and its study relating to biological aspects, structures and behaviour of living being"² The biological science is an umbrella term which includes various forms of biological areas like humans, animals, plants. When Biology and technology combine forces, it results in creation of Biotechnology. Biotechnology utilizes biological systems, living organism

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² www.merriam-webster.com. (n.d.). Definition of BIOSCIENCE. [online] Available at: <https://www.merriam-webster.com/dictionary/bioscience>.

applications to create or develop different advanced products and services. Bioscience also includes “neuroscience, bioinformatics” as key concepts that are driving change in today’s world.

The intersection between law and bioscience, often referred to as bio-law or biotechnology law, is a multifaceted field that deals with “legal, ethical, societal aspects” of developments in various fields. This strong nexus of law and bioscience is rapidly evolving field as the advancements in biotechnology continue to grow the limits of what is scientifically possible, it becomes important for law to catch these on-going changes to provide for a comprehensive legal framework which should address all ethical dilemmas, potential risks, and also benefit associated with such advancements.

Some of the key areas where law and bioscience intertwined are-

1. Intellectual Property

“Biotechnology has made it technologically possible to build the monster; patent law is making it politically possible”-Neil Gerlach

Biotechnology often involves creations of novel inventions like “genetic engineering and pharmaceuticals.” Intellectual property laws play a crucial role in protecting these innovations. Issues like who has access to and control over these technologies is answered.

2. Bioethics

Bioethics encompasses “ethical and moral principles surrounding biological advancements especially in areas where gene editing, human cloning, stem cell research is involved”³. Legal framework is needed to address such issues.

3. Clinical trials and need of regulations

Making of new drugs, devices and therapies require extensive clinical trials. Laws are needed to ascertain how such trials will take place, ensuring patient safety and ethical use of participants.

³ National Institute of Environment health sciences Rothschild, J. (2020). Ethical considerations of gene editing and genetic selection. *Journal of General and Family Medicine*, 21(3), 37–47. <https://doi.org/10.1002/jgf2.321>

4. Biomedical Research and Human Subjects

When humans are used in scientific research purposes, it is pertinent that there should be informed consent, protection of privacy and ensuring the welfare of participants is crucial.

5. Genetic Privacy and Data Protection

Today Genetic Data can be readily accessible, laws are paramount to ensure protection of individual's genetic privacy and data.

6. Reproductive Technologies

“Invitro Fertilization, professional surrogacy, issues like parentage, custody, rights of donors, surrogates”⁴ need legal scrutiny for surveillance purposes and keeping vigil for such practices.

“Environment, food and drug, biological weapons, biosecurity and emerging technologies” used for scientific innovation all require a legal backing for its validity and hassle-free use.

HOW BIOSCIENCE INFLUENCES LEGAL AND ETHICAL DOMAIN

Bioscience plays a crucial role in shaping legal and ethical boundaries in numerous ways. Its importance cannot be ignored in influencing these landscapes and here are key reasons-

1. Advancement and innovations

Bioscience and innovation go hand in hand, it is at the forefront of scientific discoveries. While new technological breakthroughs are appreciated, it presents new challenges and opportunities. Innovations take place at a rapid pace and often law is left far behind, thus requiring the urgent need to address emerging issues.

2. Medical Ethics

Ethical dilemmas can be fruitfully utilized in shaping healthcare law policy, influencing how medical practitioners and institutions

⁴ Mudasir, A. and Bhat (n.d.). Surrogacy in India: Legal and Ethical Issues. [online] Available at: https://ir.nbu.ac.in/bitstream/123456789/3073/1/March2015_12.pdf [Accessed 22 Nov. 2023].

should operate. Research and experimentation on living beings most commonly raises such ethical quandaries.

3. Strict Control over specific information

The use and maintenance of information relating to biobanks, genetic testing, genomic research requires extra precaution on preserving such data collected, as privacy concerns are high.

4. Public Health and Safety

Bioscience is advancing and it has significant implications on public health and safety especially in food products, drug and vaccine development and disease surveillance. Laws are needed to ensure the safety and well-being in society. Potential environmental risks associated with genetically modified organisms can be mitigated with the help of legal guidelines.

5. Emerging Biotechnologies and Global Order

Emergence of new biotechnology particularly in “CRISPR gene editing, synthetic biology, lifesaving medicines, equitable distribution of resources, collaboration between nations on health and scientific research,” require International Law to maintain global balance.

HISTORICAL INTERPLAY: GENESIS OF LAW AND BIOSCIENCE

Bioscience is a dynamic field, constantly evolving the boundaries of what is possible, which require ongoing dialogue and adaption of legal principles to ensure smooth progress. But we need to trace the original roots of bioscience and how it developed its relationship with law, which can be traced through various periods and advancement in science, medicine, and legal framework.

Here is broad historical overview of Bioscience.

1. Classical Ancient Period

In ancient India, medical and ethics played a role in shaping the relationship between bioscience and law. Ayurveda, the science of life, practiced for more than five thousand years, talked about “medical malpractices, set standards for healthcare, emphasized

on ethical conduct and guidelines for practitioners”⁵. *Charak Samhita* discussed “medical negligence, importance of competence, accountability in healthcare practices”⁶. In Greece, “The **Hippocratic Oath** set ethical standards for medical practices and importance of patient welfare and confidentiality”⁷.

2. Medieval and Renaissance periods

Religious and philosophical beliefs influenced medical knowledge. Relationship between law and bioscience was intertwined by church doctrines and practices. The rise of universities and formal medical education led to structured legal oversight in medical practices. Black Death, devastating bubonic plague in Europe led to development of **Quarantine laws**⁸ to stop the spread of disease, which is still followed today.

3. Enlightenment era

This era shifted towards empirical science and rational thinking. Scientific method shaped the way bioscience was practiced and basis for evidence in legal cases. Medical Malpractices lawsuits started to come up, enforcing legal precedents in healthcare. William Harvey discovery of Blood Circulation in 1628, Edward Jenner’s Smallpox Vaccination discovered in 1796, Louis Pasteur germ theory are significant contributors that changed not just medicines but also led to change in ethical and legal practices.

4. Period of 19th and 20th century

This period is considered a golden period in relation to law and bioscience. Many major breakthroughs like “discovery of cells, development of anaesthesia, discovery of vaccines,” antibiotics etc. influenced the practice of medicine, and legal recognition of new practices and standard of care in medical research, human trials.

⁵ Code of Medical Ethics Regulations, 2002 | NMC. (n.d.). <https://www.nmc.org.in/rules-regulations/code-of-medical-ethics-regulations-2002/>.

⁶ Avinash Chandra Kavitrana, *Charak Samhita translated into English*, Calcutta 7 Miles, Steven H. *The Hippocratic Oath and the Ethics of Medicine*. Oxford; New York: Oxford University Press, 2004.

⁸ Tognotti, E. (2013). Lessons from the History of Quarantine, from Plague to Influenza A. *Emerging Infectious Diseases*, [online] 19(2), pp.254–259. doi:<https://doi.org/10.3201/eid1902.120312>.

Landmark cases like **Nuremberg Trials (1945-46)**⁹, **Declaration of Helsinki (1964)**¹⁰ established ethical and legal principles related to human experimentation. In current times, we have seen an explosion in biotechnology, genomics, medical innovation which gave rise to new legal challenges in areas like gene testing, stem cell research, and personalized medicine. IP Laws and regulations related to biotechnology and medicine have evolved significantly.

- **Roe vs Wade (1973)**

This breakthrough case granted the “right to abortion in the USA.” Better understanding of human development and fetal viability was considered which shaped this decision¹¹.

Gene Patenting and genetic sequences is a contentious issue that emerged in 20th century. The Myriad Genetics Case¹² influenced the legal landscape relating to gene patenting and access to genetic information.

- **Human Genome Project and Genetic Privacy 1990s**

This project aimed at sequencing the entire human genome, raised concern on genetic privacy¹³. This led to development of laws and regulations addressing genetic information. The Genetic Information Non-discrimination Act¹⁴ (GINA) in the USA is one such example.

- **CRISPR- Cas9 and Gene Editing 21st Century**

Development of CRISPR- Cas9 gene editing technology has raised legal and ethical questions about “editing of human germline, designer babies, and gene therapy”. These

⁹ Library of Congress, Washington, D.C. 20540 USA. (n.d.). Nurnberg military tribunals indictments [cases 1-12]. [online] Available at: <https://www.loc.gov/item/2011525463>.

¹⁰ Anon, (n.d.). WMA - The World Medical Association-Declaration of Helsinki 1964. [online] Available at: <https://www.wma.net/what-we-do/medical-ethics/declaration-of-helsinki/doh-jun1964/>.

¹¹ Roe vs Wade, 410 U.S. 113 (1973).

¹² Association for Molecular Pathology vs Myriad Genetics 569 U.S. 576 (2013)

¹³ National Human Genome Research Institute, US Collins, F. S., & Fink, L. (1995). The Human Genome Project. *Alcohol Health and Research World*, 19(3), 190–195. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6875757/>

¹⁴ The Genetic Information Nondiscrimination Act, 110-233 (USA)

questions continue to shape discussions about regulations of biotechnology and human genetics. These Historical instances demonstrate how early bioscience discoveries and advancement have not just developed medical practices but also contributed to legal and societal norms, leading to important developments that continue to shape our World Today.

The term biotechnology was coined by **Karl Ereky** in 1919¹⁵. He is referred to as “Father of biotechnology” for his contributions. In the Indian context, Dr. **Pushpa Mittra Bhargava** as “Father of Indian Biotechnology.” **Kiran Mazumdar Shaw** pioneered biotechnology in India, driven by her immense passion she emerged a leading figure in this field.

ETHICAL COMPASS: THE ROLE OF BIOETHICS IN BIOSCIENCE

Bioethics is a multidisciplinary field of study that combines principles of ethics, philosophy, laws, and life sciences to examine and address ethical questions and predicaments in various forms of biosciences. It plays a key role in guiding bioscientific research by giving a framework based on which ethical, moral, societal implications aspects are covered. Some role and responsibilities of bioethics in relation of bioscientific research-

1. Ethical Guidance

To help researchers, institutions, and policy makers to make sound decisions, which will ensure that research is done where human dignity and welfare harm if any is minimized, is ensured.

2. Informed Consent

Bioethics lay down the guidelines, specifically in cases of human trials and experiments, to ensure that individuals understand

¹⁵ Historical evolution of Biotechnology Chatterjee, S. (2021). Karl Ereky: The Father of Biotechnology. [online] YBTJ. Available at: <https://www.ybtjournal.com/post/karl-ereky-the-father-of-biotechnology>.

potential risks or benefits associated with it. “Informed consent is necessary in clinical trials, genetic or psychological research, social experiments on vulnerable populations, biomedical studies etc.”¹⁶.

Privacy and Confidentiality is ensured by protecting unauthorized access to genetic or health related data by providing policies.

Bioethics addresses the concern regarding “distributive justice, fairness, allocation of resources and funds,” which will be used in bioscientific resources. Also, bioethics strives to ensure that recent technological advanced tools which are used in research or healthcare follow the ethics.

Bioethics also covers “*environmental concerns and impact of biotechnologies on ecosystems and biodiversity.*” Bioethics also promotes global collaboration and consensus on setting ethical standards, which will be uniformly implemented.

Bioethics encourages ‘public engagement, education to promote informed ethical practices and public discourse about bioscientific research.’ Policymaking and regulations in the bioscientific field is being made by following bioethics standards.

IMPORTANT BIOETHICS PRINCIPLES

1. Autonomy

“Individual right to make informed, voluntary decisions, about their own medical care and other aspects of life. Autonomy helps in making decisions, where a person specifies their healthcare preferences on its own.

2. Beneficence

Obligation to act in the best interest of others and promotes wellbeing by providing benefits and preventing harm. Beneficence

¹⁶ IMA Code of Medical Ethics Das, N. and Chatterjee, K. (2021). Informed consent in biomedical research: Scopes and challenges. Indian Dermatology Online Journal, 12(4), p.529.

guides the healthcare professionals to provide treatments that will benefit their health.

3. Justice

fairness and equitable access to healthcare services, medical resources should be distributed. Similarly benefits of research should be distributed equally among the society.

4. Non-Maleficence

Principle of do no harm emphasizing ethical obligation to avoid causing harm to individuals. This principal guide healthcare professionals to avoid unnecessary harm to individuals in treatment, care and assess the risk and benefits of interventions”¹⁷.

These principles ensure that individual rights are respected, research is conducted responsibly, and healthcare delivered equitably.

UNRAVELING GENOMICS AND LAW: DECODING THE BLUEPRINT OF LIFE & LEGAL IMPLICATION

“Biotech and geoengineering have the same mindset, of engineering, of power, of control, of mastery of nature”

-Vandana Shiva

Human Genome Project (HGP) is an “international scientific research initiative that aims to map and sequence the entire human genome, which is a complete set of human DNAs containing all genes and genetic information”¹⁸. This project has several profound legal and ethical implications. Here is brief overview of project-

¹⁷ Beauchamp T L, Childress J F. Oxford University Press, 2001, £19.95, pp 454. ISBN 0-19-514332-9

¹⁸ National Human Genome Research Institute, US National Human Genome Research Institute (2020). The Human Genome Project. [online] Genome.gov. Available at: <https://www.genome.gov/human-genome-project>.

1. Privacy Concerns

Genetic Information Privacy- As HGP progressed, along with technology allowing rapid sequencing of individual sequences, privacy concerns emerged regarding protection of information not being leaked. To counter such privacy issues, several countries have adopted laws and regulations to ensure that such risk is kept at minimum level. Neurotechnology advancements like “neuroimaging and brain-computer interface” are also contentious issues.

2. Intellectual Property Rights

Gene Patents- HGP led to successful discovery of various genes associated with different diseases and traits. Patenting of genes became a challenging issue, as some entities began to demand patents of specific genes or genetic sequences like “Myriad Genetics patented BRCA1 & BRCA2 genes which are associated with breast cancer”¹⁹.

Legal Dispute- legal battles started to come in numbers to assert who has the right to patent and to what patent. In **Association for Molecular Pathology vs Myriad Genetics**, US Supreme Court ruled that “isolated gene sequence cannot be patented but synthetic DNA (cDNA) could be patented”²⁰.

3. Discrimination and Stigmatization

Concern arose regarding discrimination based on “genetic information in areas like insurance coverage, employment, and access to healthcare.” To counter such cases, countries have enacted laws like GINA in the USA, to prohibit discrimination and address such concerns.

4. Ethical and Regulatory oversight

The Human Genome Project was subject to Ethical review and oversight by government bodies and research institutions which was an integral part of the project. Laws and guidelines have been

¹⁹ National Institute of Health Bakshi, A.M. (2014). Gene patents at the Supreme Court: Association for Molecular Pathology v. Myriad Genetics. *Journal of Law and the Biosciences*, 1(2), pp.183–189.

²⁰ Association for Molecular Pathology vs Myriad Genetics 569 U.S. 576 (2013)

established to ensure responsible conduct and appropriate use of genetic information.

BIOTECHNOLOGY AND INTELLECTUAL PROPERTY: BALANCING INNOVATION AND ACCESS

“The rewards for biotechnology are tremendous -to solve disease, eliminate poverty, age gracefully. It sounds so much cooler than Facebook”

-George M. Church

Patents play a crucial role in biotechnological advancements by giving “legal protection and incentives for innovations in the field”. Biotechnology uses living organisms, their components, and biological processes to develop new products, technologies and solutions. We investigate how patent can contribute to biotechnological advancements-

1. Incentives for Research and development

Patents grant “exclusive rights to inventors and companies for biotechnological innovations for 20 years”. This serves as inspiration for companies, especially biotech and research, to invest their time and resources for creation of modern technologies and products.

2. Protection of Intellectual Property

Patent helps in protecting IP Biotech companies by refraining anyone from “making, using, selling or importing, patented inventions without authorization”. This exclusive right allows the companies to control commercialization of their discoveries.

3. Investment Attraction

Biotech innovations become more attractive to investors and venture capitalists, thanks to patent. Exclusive rights granted to the companies help to secure funding for R&D.

4. Disclosure of Information

In exchange for patent protection, inventors must provide information in detail about their invention to the public. This ensures the dissemination of scientific knowledge and facilitates further R&D; thus, future advancements can be based on this.

5. Collaboration and Licensing-

Patents can be licensed and sold to other companies to foster collaboration and technology transfer to accelerate progress and development of newer products.

6. Economic growth

The Biotechnology wave today is like the Information Technology wave of the 1990's. Biotech industry has potential to drive the economy by creating jobs, stimulating R&D, and generating revenue by commercial patented innovations. The motto of biotechnology is "be prepared for anything".

Thus, there are numerous advantages in Biotechnology; but regulatory approvals, ethical considerations, challenges and controversies are also in mix that check the growth of patents in biotechnology.

GENE EDITING: REWRITING THE CODE OF LIFE

Genetic testing and personalized medicines are on the rise thanks to advancement in technology. But it also brings in a host of ethical considerations that must be addressed for responsible and ethical use of genetic information for the larger benefit of society.

1. Benefit vs Harm

There are both benefits like personalized treatment, early disease detection and potential harm associated with genetic testing like psychological impacts of genetic information. efforts should be made to balance them.

2. Genetic Counselling

Genetic counselling should be provided to help the “individual understand their test result, to make informed decisions, and to better cope with the emotional or psychological impact of receiving unexpected genetic information.”

3. Research Ethics

Whenever research involves genetic data, it should adhere to ethical principles like informed consent, privacy protection and transparency in research practices.

4. Ownership and Control of genetic data

It is individuals who should have control over their genetic data, including the ability to decide how to use and share. The debate over data ownership and control is an ongoing ethical concern.

5. Paediatric and Prenatal testing

Genetic testing in children and prenatal testing raises unique ethical issues. In such cases, decisions should be made considering the best interests of the party involved.

6. Commercial Interest

Ever since private companies have started to enter genetic testing, concerns regarding commercialization remain high, since companies aim for high profit motives which conflict with the welfare and privacy of patients. Regulation and transparency are thus critical.

7. Ethical Guidelines and governance

Ethical guidelines made by the concerned authority should be properly implemented & followed, which would provide a framework for responsible genetic testing. Awareness should be made by organizing campaigns, public education is necessary to ensure accountability is maintained.

Gene testing has tremendous potential in improving healthcare, but also raises some important ethical considerations. A careful balance is needed between benefits and ethical knowhow.

A. Challenges of Gene Patenting- The BRCA Gene Patents

BRCA Genes are associated with “increased risk of hereditary breast and ovarian cancers”²¹. Myriad Genetics secured patents on isolated DNA sequences. This patent granted them the “exclusive right to conduct diagnostic testing for BRCA gene mutations”, effectively gaining monopoly in the market of hereditary breast and ovarian cancer. The challenges identified are as follows:

- **Access to testing-** ever since patent was granted, it resulted in lack of competition in BRCA gene mutations. This resulted in excessive cost of testing, patients got limited access to affordable and accessible testing services, this created huge problems for hereditary patients.
- **Inhibiting research-** challenges arose for researchers due to licensing restriction and threat of legal action deterred scientists from conducting any further research, effectively shutting the possibility of alternate test or treatment.
- **Ethical question-** critics argued that granting exclusive right to one company at the behest of others is not good for society. This led to debates on privatization of genetic information and whether gene patents fulfil public interest.
- **Legal Challenges-** several organizations like ACLU, Public Patent Foundation challenged the validity of Myriad Gene Patent. This led to the Supreme Court giving crucial judgment in 2013, where a company cannot be granted individual gene patents.
- **Impact-** it resulted in access to gene testing²¹, opened the door for competition, which led to lower costs and benefited the patients for better access. The barriers for research and development were removed, resulting in enhanced data collection.

B. CRISPR-Cas9 Technology

It is a revolutionary gene editing tool that has changed the landscape of biotechnology & genetics. It stands for “Clustered

²¹ Section 53, Indian Patents Act, 1970.

Regularly Interspaced Short Palindromic Repeats”- CRISPR associated protein nine.” Let us understand how it works and why it is considered revolutionary.

- **Working**

“CRISPR Sequences- It is a collection of DNA sequences that contains the snippets of DNA of past invaders like viruses. These sequences act as bacterial ‘memory’ of previous infection.

Cas-9 protein: It is an enzyme that acts as a ‘pair of molecular scissors. It can precisely cut DNA at specific locations.

When a bacterium is left after a virus attack, it remains stored in a CRISPR array. When the same virus attacks in future, the bacterium uses its CRISPR sequences to transcribe a piece of RNA called CRISPR RNA. The crRNA guides Cas-9 for exact location, to make the cut at its location, once it is done, the cell naturally comes into play for editing the genes”²².

- **Revolutionary Potential:**

- i. Incredibly accurate Gene Editing resulting in better accessibility and affordability.
- ii. Diverse application from basic research to potential medical treatment, for study of gene function, genetically modified organisms and developing therapies for genetic diseases.
- iii. Potential disease treatments- variety of genetic diseases, promising for conditions with known genetic causes.
- iv. **Agriculture and environmental uses-** crops can be developed that are resistant to pests, longer shelf life, more nutritious. Mosquitoes can be modified to reduce the spread of malaria.

CRISPR technology is still evolving, its full potential and implications continue to be explored. While it holds great promise, its legal, ethical and safety issues should be dealt with carefully.

²² Doudna, J. A., & Sternberg, S. H. (2017). A crack in creation: gene editing.

- **Stem Cells and Regenerative Medicine**

Stem cells have significant prospects in regenerative medicine because of their unique ability to develop into various cell types and repair or replace damaged tissues and organs in the body. Stem cells have multipotency capabilities, they have self-renewable abilities where they can divide and regenerate themselves.

- **Application of stem cell in various areas**

- a) Repair damaged tissue and organs,
- b) Organ transplants by patient own stem cells,
- c) Useful in treatment of degenerative diseases like Alzheimer, Parkinson, damaged neurons, brain tissue & also in treatment of diabetes.
- d) Cardiovascular repair after heart attack, healing of wounds, and traumatic injuries, can be achieved with the help of stem cells.

LEGAL FRAMEWORK AROUND ENVIRONMENTAL BIOSCIENCE AND ECOSYSTEMS

Countries have come together to make international agreements and conventions which play a significant role in shaping global efforts in protecting biodiversity. Here are following legal framework at national and international level.

1. The Convention on Biological Diversity (CBD)

Adopted in 1992, CBD addresses biodiversity and conservation in a comprehensive manner. Its major objectives include, “Conservation of biodiversity, sustainable use of its components and fair & equitable sharing of benefits arising from genetic resources”²³. The Nagoya Protocol, supplementary to CBD regulates “access to genetic resources, fair and equitable sharing

²³ The CITES (2019). Convention on International Trade in Endangered Species of Wild Fauna and Flora | CITES. [online] Cites.org. Available at: <https://cites.org/eng/disc/text.php>. Convention on Biological Diversity of 5 June 1992 (1760 U.N.T.S. 69).

of benefits.” It exemplifies international efforts to balance research and conservation.

2. CITES- Convention on International Trade in Endangered Species of Wild Fauna and Flora

This treaty aims to ensure that international trade in wild animals and plants does not affect their survival. It makes a list of plants and animals to categorize them based on their vulnerability to extinction²⁴.

3. The RAMSAR Convention

“It was adopted to protect and conserve the wetlands in a sustainable manner. It also recognizes the critical role played by wetlands and designates them of international importance.”²⁵.

4. The World Heritage Convention

Administered by UNESCO, it strives to identify and conserve natural and cultural sites of paramount universal appeal. Many sites are important for biodiversity conservation.

5. National Laws

India has enacted several laws from time-to-time to ensure that biodiversity is conserved at all costs. We have laws on endangered species, Protected Areas legislation, Environment Impact Assessment, Forest & Wildlife laws, Access and Benefit Sharing Laws, invasive species etc.

National Biotechnology Policy of India was made in 1980s, The Environment Protection Act²⁶ and its Rules, Biotechnology Regulatory Authority of India, Department of Biotechnology constituted by government, Genetic Engineering & Approval Committee are some of important laws and body made by government in relation to biosciences.

²⁴ CITES (2019). Convention on International Trade in Endangered Species of Wild Fauna and Flora | CITES. [online] Cites.org. Available at: <https://cites.org/eng/disc/text.php>.

²⁵ CITES (2019). Convention on International Trade in Endangered Species of Wild Fauna and Flora | CITES. [online] Cites.org. Available at: <https://cites.org/eng/disc/text.php>.

²⁶Environment Protection Act, Act no 29 of 1986.(India).

ENFORCEMENT AND COMPLIANCE

Enforcement mechanisms include government agencies responsible for protection, conservation, and judiciary. Penalties for non-compliance can include fines, imprisonment, or suspension of licenses and permits. Striking the right balance is necessary for everyone's benefit.

Challenges- despite the existence of the laws, biodiversity and conservation efforts face serious challenges like inadequate enforcement, habitat loss, climate change, lack of funds. International cooperations, strong legal enforcements are crucial to address these challenges effectively and to protect Biodiversity for future generations. Long term consequences and precautions should be kept in mind and the responsibilities of citizens to ensure better biodiversity for all. Emergence of synthetic biology raises alarm for rise of bioterrorism threats to humanity. Laws must regulate dangerous pathogens, enforce safety protocols to ensure such harm is at minimum impact.

Solutions- Make Informed Consent mandatory, maintain transparency in the process, provide genetic counselling whenever required, maintain confidentiality at all costs, have complete control over data and seek approval for sharing of data, oversight and accountability at two fold level- government and people, make research more user friendly and accessible, collaborate with various companies, governments for better laws and use of technology, make room for private-public partnership, make laws clear and uniform, public awareness and advocacy etc.

If we follow these measures, then law and bioscience will develop further and will be game changer in the future.

CONCLUSION

Law and Bioscience have developed a strong interplay and are reciprocal to each other. It is a complex and dynamic field that has a substantial impact on society. Ethical considerations, regulatory challenges, need for global collaborations, underscores the importance of a strong legal framework. As bioscience continues to expand, law must also pull up all its efforts to match scientific progress. The future of law and bioscience will depend on how we

act in the present in striking a careful balance between innovation, ethics, and law.

So is law the ultimate science, there is no uniform answer, but even nature has its own laws and there is no law which is above natural science. Science and law are mutual to one another, their coexistence and mutual relation is crucial to maintain.

ENSURING THE PLATE'S PURITY: LEGAL APPROACH TO FOOD SAFETY REGULATIONS IN INDIA

Shruti Sharma¹

ABSTRACT

Law and Food Science & Food Safety Regulations in India explores the intersection of law and food science with a focus on food safety regulations in India this multidisciplinary examination delves into the complex world of food safety and how legal mechanism is employed to ensure the well-being of consumers.

In India, Food safety regulations primarily aim to achieve three key objectives;-

- *Protection of Public Health - The foremost goal of food safety regulations is to safeguard the health of consumers by ensuring that, food products meet specified safety standards. This includes preventing contamination, adulteration, and the presence of harmful substances.*
- *Quality Assurance - These regulations seek to maintain the quality and integrity of food products. They set out criteria for labelling, packaging, and product specifications to provide consumers with accurate information about the food they purchase.*
- *Consumer Empowerment - Food safety regulations empower consumers by providing them with the right to safe and wholesome food. By forcing clear labelling, traceability, and accountability, consumers can make informed choices about the food they buy and consume.*

Through an intricate web of legislation, government agencies, and enforcement mechanisms, India strives to ensure that its vast and

¹ Shruti Sharma, 3rd Year, BA.LLB, Disha Law College, Raipur (C.G).

diverse population has access to safe and nutritious food. This Essay examines the intricate balance between specific knowledge, regularity frameworks, and the enforcement of food safety laws, shedding light on the critical role of law in maintaining the integrity of the food supply chain and, in turn, the well-being of the nation.

INTRODUCTION

“Every step in the food supply chain, from the farm to the dining table, is responsible for enhancing the food safety standards or, at the very least, ensuring they are not compromised.”

-Mike Robachi²

While perspectives on the significance of law about food science may vary, it is undeniable that the safety and quality of our food supply are of the utmost importance. Both Law and Food science are different fields, each with its principles, objectives, and areas of expertise. Law primarily deals with the legal regulations, rights, and responsibilities related to human conduct, while food science focuses on the scientific study of food production, safety, and nutrition.

However, this is a critical relationship between law and food science, particularly in the context of food safety regulations, labelling requirements, and the protection of consumers. Regarding studying food science, the questions are, Is the law the ultimate science? Why is it required to regulate the food industry? And what roles do laws and regulations play in ensuring the safety, quality, and supply chain?

² Saima Andrabi, World Food Safety Day 2023: Theme, Slogan Quotes, Posters, and celebrations ideas, The Quint, (Oct, 25, 2023, 8:23 pm), <https://www.thequint.com/lifestyle/world-day-for-safety-and-health-at-work-2023-them-history-objectives-more> .

WHY FOOD SCIENCE IS REQUIRED TO REGULATE FOOD INDUSTRY

Food science plays a vital role in regulating the food industry for several reasons. It ensures food safety by identifying potential hazards, enables quality control to maintain consistent product quality, determines shelf life, provides accurate nutritional information for labelling, drives innovation, and aids in establishing regulatory standards. Food science also helps manage allergens and facilitate product development. It is the cornerstone for informed decision-making and effective regulation in the food industry, benefiting both consumers and businesses. Thus, Food nourishment is indispensable for the existence of humanity. In India, the right to food is also considered a fundamental duty of the state as provided in Article 47 of the Indian constitution.³

Many restaurants, Food stalls, factories, etc. are opening every day in various parts of the world. These establishments must ensure proper sanitation and hygiene in their manufacturing, processing, preparation, etc. International works to ensure that customers receive high-quality and safe food. Similarly, Article 21 in its ambit extends beyond the right to life by encompassing the right to food, a point elaborated in the case of People's Union for Civil Liberties (PUCL) v. Union of India and Others (2001), by a writ petition.⁴

THEORY OF UTILITY IN FOOD SCIENCE

In today's world, where food safety is a serious concern, it is important to understand the magnitude of Jeremy Bentham's Utility theory. According to this theory, the absolute aim of legislation should be to promote and apply the principle of utility, which is to maximize as whole happiness and well-as whole happiness and well-being of society.⁵ This Theory is particularly relevant in the context of food science and law, where the safety of

³ Gopal Sankaranarayanan, Right to Freedom, The constitution of India, 38, 2022.

⁴ Mahima Sharma, Right to Hygienic food- a fundamental right in India, Ipleaders, December 18, 2020, https://blog.ipleaders.in/right-hygienc-food-fundamental-right-india/#1_Ms_Nestle_India_Limited_v_The_Food_Safety_and_Standards .

⁵ Dr. N. V. Paranjape, Jurisprudence And Legal Theory, 27, 9th edition 2022, Central Law Agency 30-D/1, Motilal Nehru Road Prayag raj (Allahabad)- 211002.

our food supply is of utmost importance. By prioritizing the principle of utility, we can make sure that our food supply is safe, healthy, and beneficial for all.

The food industry encompasses the production, preservation, covering, processing, wholesome, also allocation of foodstuffs production. Negotiating the status of these items effectively jeopardizes the well-being and protection of the nation's people. Hence, the status and standards of foodstuffs that compare the crowd must surpass a certain threshold.

The Food adulteration laws establish this criterion. Food contamination is described as the acquisition or removal of anything of significance from food, resulting in modification of the natural composition and quality of the food.⁶

LAWS RELATING TO FOOD SAFETY IN INDIA

The importance of food for human survival is evident in Article 21,⁷ which not only encompasses the right to life but also the right to food. In *Maneka Gandhi v. Union of India*⁸ the apex court further elucidates the right to food within Articles 21 has expanded leading to decisions in various cases that incorporate the right to health protection from risks and ecological contamination.⁹

CURRENT REGULATION: FEDERAL LEGISLATION

A. The Food Safety And Standards Act Of 2006

The Food Safety and Standards Act of 2006, commonly known as FSSA, was introduced by the Indian parliament to overcome the limitations of the Food Adulteration Act 1954 and consolidate regulations regarding Food Safety and Standards. This law

⁶ Saumya Sinha, Law for Prevention of food adulteration in India, Ipleaders, (Oct 28, 1:50), <https://blog.ipleaders.in/food-adulteration-laws-in-india/#:~:text=The%20Act%20empowers%20the%20State,Designated%20Officer%20for%20each%20district> .

⁷GopalSankaranarayanan, fundamental rights, The Constitution of India, 28.

⁸ AIR 1978 SC 597

⁹Mehernaz Contractor, Indian and International food laws, Ipleaders, (oct 28,02;12), <https://blog.ipleaders.in/indian-and-international-food-laws/> .

superseded all previous Legislation concerning food quality. Section 91 of the FSSA empowers the central government to create regulations governing the quality of food products.

- Ensuring the licensing and registration of food enterprises to meet food safety and Standards.
- The 2011 Regulation on Food Safety and Standards concerning packaging and labeling is about.
- The Food Safety and Standards (Food Product Standards and additives) regulation of 2011 pertains to the regulations concerning food product standards and the use of additives.¹⁰

SECTION 18 of the FSSA outlines fundamental principles of human life and health, safeguarding consumer interest, and engaging in risk management, among others. Furthermore, chapter IV of the act contains general regulations concerning food products, covering aspects like the use of activities and processing, insecticides or contaminants, residues, and veterinary drug residue. The act also addresses the packaging the labeling of food products, regulates imported food items, and prohibits unfair trade practices and deceptive advertisements.¹¹

Classification Of Clauses Within the Food Safety and Standards Act 2006

The Food Safety and Standards Act 2006 encompasses a wide array of regulations pertaining to food safety. Its provisions can be segmented into distinct sections can be segmented into distinct sections addressing various aspects of food safety regulations.

¹⁰Saumya Sinha, Laws for prevention of food adulteration in India, Ipleaders, (oct28, 02:15), <https://blog.ipleaders.in/food-adulteration-laws-in-india/#:~:text=The%20Act%20empowers%20the%20State,Designated%20Officers%20for%20each%20district> .

¹¹ Mehernaz Contractor, Indian, and International Food law, Ipleaders, (Oct 28, 02:10), <https://blog.ipleaders.in/indian-and-international-food-laws/> .

Establishment of Functions of Various Entities

The Food Safety and Standards Authority of India (FSSAI) was established in accordance with section 4 of the act. This primary authority is responsible for regulating and supervising food safety and standards. As per the act, its central office is located in New Delhi, with the provision to establish additional offices in other locations. FSSAI operates as a corporate entity with perpetual existence, a common seal, and the ability to hold a distinct legal identity. Similar to other corporate entities, it possesses the authority to initiate legal proceedings and can be subject to legal action in its own name. A chairperson and 22 members were selected through a compromise by a selection committee appointed by the central government.

Decision-Making Body

The legislation comprises specific sections addressing matters related to food safety and standards. It includes provisions for addressing issues, such as compounding offenses, and establishes a tribunal dedicated to handling appeals related to food safety.

B. Overview Of The Consumer Protection Act 2018

The Consumer Protection Act 2018 represents an updated iteration of the Consumer Protection Bill 2015 following revision recommended by the standing committee protection this bill aims to supersede. The Consumer Protection Act of 1986 was presented in the Lok Sabha in January 2018 it incorporates various novel provisions designed to address the expansion and revolution of the consumer market about regulations consumers market concerning regulations concerning food adulteration the bill introduces specific provisions including sanctions for deceptive advertising and the production and sales of adulterated or counterfeit products.¹²

¹² Saumya Sinha, laws for prevention of food Adulteration in India, Ipleaders, (Oct 28, 02:30), <https://blog.ipleaders.in/food-adulteration-laws-in-india/#:~:text=The%20Act%20empowers%20the%20State,Designated%20Officer%20for%20each%20district> .

LANDMARK JUDGEMENT

M/s Nestle India Limited v. The Food Safety and Standards¹³

The landscape of food safety in India witnessed a pivotal moment in the case involving Nestle Maggie Noodles. The Bombay High Court's landmark ruling on August 13, 2015, marked a significant turn in the regulatory structure governing food safety and standards in the country.

The case revolved around the ban imposed by the Food Safety and Standards Authority of India (FSSAI) and the Maharashtra State Food Safety Commissioner on nine variants of Nestle Maggie Noodles. This ban was challenged on the grounds of arbitrariness and a lack of adherence to principles of natural justice in its imposition.

Central to the court's decision was the directive for testing retained samples from Nestle within a specified period. The judgment mandated compliance with the Food Safety and Standards Act of 2006, requiring testing in accredited laboratories. Additionally, Nestle was directed to seek product approval and make specific alterations to its product labeling.

The genesis of this legal battle lay in reports alleging excess lead content and mislabelling in Nestle's products. Nestle vehemently contested these accusations, asserting the safety of its products based on internal reports. The case delved into multifaceted arguments, spanning the realms of the regulatory body's discretionary powers in defining standards for proprietary foods.

The legal discourse encompassed a spectrum of issues, carefully addressed and adjudicated upon by the court. These issues ranged from the maintainability of the regulations, principles of natural justice, reliance on testing reports, and the rationale behind imposing a nationwide ban.

Ultimately, the Bombay High Court's ruling allowed Nestle to resume the manufacturing and sale of Maggi Noodles. However, this permission was contingent upon the company undergoing fresh testing within a stipulated timeframe. Importantly, the

¹³ AIR 2015 SC 1688.

judgment underscored the paramount significance of public health in the realm of food safety regulations. It advocated for a fair regulatory framework that upholds standards without unduly impacting the larger packaged food market.

The Nestle Maggi Noodles case serves as a cornerstone in India's journey towards ensuring food safety and adhering to stringent regulations. It highlights the critical need for a balance between regulatory oversight and the interests of manufacturers, all while prioritizing the health and well-being of consumers across the nation.

This case stands as a testament to the evolving nature of food safety regulations in India, emphasizing the significance of transparent processes, adherence to standards, and the pursuit of justice in upholding consumer well-being.¹⁴

M/s Omkar Agency v. Food Safety and Standard Authority of India¹⁵

In the legal case of M/S Omkar Agency v. Food Safety and Standard Authority of India heard in the Patna High Court, manufacturers of smokeless tobacco challenged a directive from the Food Act. The manufacturers contended that this restriction was invalid since these products were permitted under India's Comprehensive Tobacco Control Law namely Cigarettes and Tobacco Products Act, 2003 (hereinafter 'COTPA').

They further argued that they did not fall within the definition of "Food business operators" as outlined by the Food Act, thereby claiming exemption from its requirements. The court, in invalidating the prohibition order, made several points:

1. Gutka and Tobacco, while not explicitly defined under the Food Act, were considered within the ambit of 'Food' since the Act lacked specific standards regulating their production, sale, or distribution.

¹⁴ Manupatra, https://www.manupatrafast.com/NewsletterArchives/listing/Newslex%20DHLaw/2015/Resources_%20Newslex%20-%20Agust%20-%20September%202015%20%20D.%20H.pdf, (Nov. 25, 2023).

¹⁵ 2016 SCC Online Pat 9231

2. Although pan masala was recognized as food, the commissioner's prohibition lacked substantiation based on objective evidence as mandated by the Food Act, especially for a blanket ban covering all pan masala brands, even those containing tobacco.
3. Tobacco, in itself, did not fall under the classification of 'Food', thus remaining beyond the regulation purview of the Food Act.
4. The court emphasized that since COTPA, a central law, permitted the manufacturing and sale of tobacco-based products, the prohibition of smokeless products under the Food Act was deemed contradictory to the allowances made by COTPA.

Academy of Nutrition Improvement v. Union of India¹⁶

In the case of the Academy of Nutrition Improvement and ORS versus the Union of India, non-governmental organizations representing experts and academics challenged the mandatory iodization of salt for human consumption. The court ruled that if a food item, in its natural and unadulterated form, poses no harm to health, regulations cannot be imposed on it. There was no evidence suggesting that universal salt iodization would harm the majority of the population without iodine deficiency. However, the court deemed that a specific rule, Rule 44, exceeded the Act's scope and was thus invalid.

Consequently, the ban on the sale of non-iodized salt for human consumption was lifted. This decision may not be in the public's best health interest. Therefore, the court recommended that the central government take at least six months to thoroughly reconsider mandatory iodization based on the latest information and research. If, after this review, the government still supports the universal iodization scheme, it should introduce appropriate legislation or measures to sustain the program within the confines of the law.

CENTRAL INITIATIVES

¹⁶ AIR 2006 SC 80.

- Food and Nutrition Security- Nutrition security is being addressed through several national initiatives, including the Integrated Child Development Services (ICDS), the Kishori Shakti Yojana targeting adolescent girls, and the Pradhan Mantri Gramodaya Yojana.
- The Mid-day Meal program- India's largest school feeding initiative, the Mid-day Meal program, serves over 120 million children across 1.265 million school and EGS centres nationwide. Its primary goal is to enhance enrolment break.¹⁷

STATE INITIATIVES

Chhattisgarh state food initiative Chhattisgarh state has many policies related to food:-

- Antyodayannayojna- This program has been in effect in the state since March 2001 and is aimed at assisting the most economically disadvantaged individuals under this initiative every family receives 35 kilograms of rice at the rate of Rs 1 per kilogram every month. Currently, 14.58 lakh ration cards are operating under this program with 7.19 lakh aay families approved by the central government and an additional 7.66 lakh aay families approved by the state government.
- Annapoorna scheme - The government of India initiated this program in the state starting in October 2001. this initiative offers 10 kilograms of rice at no charge to elderly and impoverished individuals according to the Chhattisgarh Food and Nutrition Security Act of 2012 individuals holding ration cards under the Annapurna scheme receive a special Antyodaya ration card. With the special today ration card beneficiaries are entitled to receive 10 kg of rice for free and an additional 25 kg of rice at the

¹⁷Vikaspedia, <https://vikaspedia.in/social-welfare/social-security/right-to-food#:~:test=Antyodaya%20Anna%20Yojana-.Food%20and%20Nutrition%20Security.and%20Pradhan%20Mantri%20Gramodaya%20Yojana> , Oct 28,2023.

subsidized rate of 1 Rs. 1 per kg each month. currently, this program is benefiting 7,916 eligible ration card holders.

- Computerization of fair-price shops- The Indian government has been actively working on computerizing the public distribution system (PDS) across the country. The final stage of this endeavour involves the digitalization of fair price shops, which was initiated by the core ODS in March 2012.¹⁸

FAILURE AND CRITICISMS OF VARIOUS FOOD SYSTEMS IN INDIA:-

Indian Food System has big problems. More and more people around 821 million in 2017 are going hungry, while a staggering 1.9 billion adults and 340 million kids struggled with obesity. It's a deadly cycle, kids who don't get good nutrition early on are more likely to become obese later when they eat high-fat, sugary, and salty foods.

Five main issues make this a crisis:-

- Not enough food- Farms aren't producing enough to feed everyone.
- Food doesn't get where it needs to go- A lot of food is lost on its way from the farm to your plate because of bad transport and storage.
- Not everyone can get healthy food- Some people don't have access to good, diverse food choices.
- Healthy food costs too much- It's often way more expensive to eat healthy than to buy processed junk food.
- Bad for the planet- The way we make food damages the environment, using too much land and water, hurting wildlife, and producing lots of greenhouse gases.

¹⁸ Department of Food Civil Supplies & Consumer Protection Government of Chhattisgarh,

https://khadya.cg.nic/PlanScheme_En.aspx#:~:text=Under%20Chhattisgarh%20Food%20and%20Nutrition,1%2Fkg%20every%20month , Oct. 28, 2023.

Fixing these problems means changing how we grow, and distribute, and buy food. It's about making sure everyone can afford and access good, healthy meals while also taking care of our planet.¹⁹

India Demands Strategies To Focus On Five Key Areas:-

1. Improvement Access and Availability- This involved enhancing the efficiency of the supply chain to make healthier food options more accessible while reducing the costs associated with quality diets.
2. Enhancing Agri-Food Value Chains- Designing systems that account for the perishable nature of fresh foods, minimizing quality degradation, and reducing food losses in the process.
3. Merging Technology and Behavioural Shifts- Encouraging behavioural changes in both consumers and products through innovative technologies and incentives, nudging them toward safer and healthier food choices.
4. Empowering Public and Private Sectors- Collaborating between government entities such as agro-logistics and food safety departments, and private stakeholders including traders, processors, and retailers, to drive innovation in food businesses.
5. Balanced Approach- Supporting actions that improve the food environment (supply side) while also influencing consumer food choices and preferences (demand side).

These suggestions should be implemented effectively, it can help ensure that the food we consume is safe and free from contamination, protecting public health and well-being.

A comprehensive approach entails understanding the trade-offs and synergies between aspects of healthy, inclusive, and sustainable diets. Implementing effective food safety laws necessitates recognizing that changes in the food system can be

¹⁹ CGIAR, <https://a4nh.cgiar.org/2019/02/01/repairing-food-systems-failures-policies-innovations-and-partnerships/>, (Nov. 25, 2023).

influenced by incentives at various stages. Therefore, interventions must consider the interactions and connections between different stakeholders, seeking solutions that transcend the initial problem in areas, aiming for long-term, impactful changes in ensuring the purity and safety of plates used in the food industry across India.²⁰

CONCLUSION

In conclusion, the intersection of law and food science is crucial for ensuring food safety in India. Food safety regulations aim to protect public health, ensure quality, and empower consumers. The Right to food is fundamental, and utility theory plays a significant role in this context. The food industry is heavily regulated through various laws and acts, including the Food Safety Standards Act 2006. Landmark judgments have set important precedents, emphasizing the need for accurate labeling and consumer protection.

Central and state policies in India address food and nutrition security, but challenges and criticism exist, including concerns about the quality of meals in mid-day programs and limited coverage.

To enhance food safety, proper handling, storage, regular inspection, education, accurate labelling, strict regulations, and advancement these measures effectively can protect public health and ensure the safety of the food supply in India.

²⁰ Ibid.

AN ESSAY ON NASCENT FOOD LAWS AND THE HOAX OF NUTRITION IN EVER-EVOLVING FOOD SYSTEMS

Madhura Banerjee¹

ABSTRACT

As human society constantly undergoes changes, it isn't rational to assume that existent laws shall stand the test of time. While the growth of food science has fortunately aided us in various ways, its misuse in furtherance of capitalist interests must be paused. Given the rapid technological advancements that the 21st century stands witness to, the elected representatives of people, with sovereignty bestowed upon them, must realize the urgency with which laws must catch up to these unprecedented scientific upgrades. This essay aims to discuss the multi-faceted relation between science and law, that has also been the focus of much jurisprudential debate, and this particular project shall analyse how effective the food laws are at present. This doctrinal study thereby seeks to examine how the laws and the regulatory mechanisms accompanying them are yet to develop sufficiently to combat pertinent issues in our food system, at the global as well as national levels. Stringent laws are prerequisites to prevent those in control of production, manufacturing and supply chains, from circumventing legal rules with profits in mind. Ethical aspects of endangering public health must not be neglected and the improvement of regulatory frameworks is of foremost significance in making societal transformation seamless in nature.

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THE SCIENCE OF LAW AND THE LAWS OF SCIENCE

Science is a systematic study of the world with the view of gaining knowledge that is empirically verifiable. It is governed by laws formulated by stalwarts who have made their mark on the sands of time, with their unparalleled contributions to the dynamic fields of sciences. The term “law” which can be understood as the command of the sovereign, entails description as well as prescription. One is the science of law while the other is the normative approach. The science of law, concerned about positive law is a study of what the law is. The legal positivist studies law through social facts. Hereby, one’s value-judgements are kept aside and this is hence reflective of purely fact-based law. Normativism on the other hand is reflective of value-orientation. The normativism studies what the law should be or ought to be and takes morality into account. Speaking of varied approaches, while analytical jurisprudence focuses upon what legal concepts mean and evaluates their logical consistencies, sociological jurisprudence assembles facts in relation to contents, impacts and origins of legal norms as well as the usage of social science methods in estimating cause and effect.² Laws have a predictive value and can be equated to testable hypotheses.

Coming back to the topic of transformation, sociologists such as Auguste Comte state that the society rests upon social statics and social dynamics. Consensus universalis, meaning the universal agreement among people about the ideas of social order and social progress, maintains social harmony and that is the aim of the “law” which wishes for people to have a good life. Population increases, coupled with developments in the cognitive abilities of humans, fuels social change in societies that pass through successive stages of growth, better known as evolution.

IS LAW THE ULTIMATE SCIENCE?

The answer to this question is inevitably in the affirmative, especially owing to the manner in which the law governing human

² Conant, Michael, *The Science Of Law: A Structural Outline*, vol. 25, no. 2, JSTOR, Malaya Law Review, pp. 368–85, (1983), <http://www.jstor.org/stable/24863971>

conduct employs a rational outlook to regulate worldly affairs, exactly how science uses logic to observe phenomena and employs reason to regulate. In the current techno-legal context, it can be ascertained that societal transition is a result of scientific innovation in a world order which is based upon the growth of technology but the legal domain must be given due credit as what gets outlawed cannot be practised even if technological apparatus permits its practice. With special reference to principles of natural justice and legal fundamentals, of, for instance, equality, it is ideal for the law to have the same objectivity and neutrality that science boasts and boasts of.

REGULATING THE FOOD SYSTEMS

The legal structures established at the national level play a fundamental role in the efficacy of a comprehensive food control system. Within every sovereign jurisdiction, a web of intricate statutes and regulations governs the various aspects of food, delineating the stipulations imposed by the government upon participants in the food supply chain, all aimed at safeguarding the integrity and safety of food. The nomenclature "food law" encompasses legislation that presides over the cultivation, distribution, and management of food, thereby encompassing the oversight of food control, food safety, quality assurance, and pertinent facets of food commerce throughout the entirety of the food supply chain, from animal feed production to the ultimate consumer.

The Food and Agriculture Organization of the United Nations (FAO), provides legal assistance to governments. This involves aiding in the drafting, modification, or revision of national legislation concerning food safety and quality, as well as the implementation of regulatory frameworks aimed at enhancing the food control and surveillance system in accordance with both international legal standards and best practices. Such legal support is offered through collaborative efforts between teams of legal advisors and food safety experts, tailored to suit the particular requirements and legal structures of member states. Several key considerations include:

- Alignment of national legal frameworks with the Codex Alimentarius standards, guidelines, and associated texts, which serve as the global reference point for food safety and quality.
- Advocating for the incorporation of a risk analysis approach to enhance food control systems.
- Assisting countries in the establishment of science and evidence-based food control systems that not only safeguard the health of consumers but also facilitate market access and food trade, while pre-empting food safety crises.
- Strengthening national capacities and fostering comprehension of international food safety legislation among domestic stakeholders through direct collaboration with local legal professionals and government officials.
- The development of tools and guides addressing a range of technical and managerial facets related to food control.³

It is vital to know that, goods seen to be unfit for the market can be recalled for protection of public health. In this context, traceability, as defined by the Codex Alimentarius Commission, refers to the capacity to track the movement of a food item as it progresses through specific phases of production, processing, and distribution. This concept of traceability, when integrated into food control systems, serves as a critical instrument for managing food-related hazards, ensuring the provision of accurate product information, and verifying the authenticity of food products. Recall, or more formally Product Recall, is characterized as the action taken to withdraw food items from the marketplace, at any point along the food supply chain, which includes products in the possession of consumers. Food recall plays a crucial role in the management of risks when addressing food safety incidents and emergencies. It serves as an indispensable tool for promptly responding to and mitigating potential hazards.

³ Food and Agriculture Organization of the United Nations, <https://www.fao.org/food-safety/food-control-systems/policy-and-legal-frameworks/food-laws-and-regulations/en/> (last visited Oct. 20, 2023).

Speaking from the constitutional perspective, Article 21 of the Indian Constitution encompasses not only the Right to Life but also includes the Right to Food. The Right to Food received attention in the case of People's Union for Civil Liberties v. Union of India and Others (PUCL) (2001) through a writ petition, where its importance was briefly discussed. Additionally, the Right to Food is recognized as a fundamental duty of the state, as articulated in Article 47 of the Indian Constitution.⁴

In India, food businesses must comply with provisions of the Food Safety and Standards Act, 2006 (FSSA) to handle manufacturing or processing or the supply of food products. This legislation governs the production, storage, distribution, sale, and import of food items with the aim of guaranteeing the accessibility of safe and nourishing food for human consumption. Additionally, it establishes the Food Safety and Standards Authority of India (FSSAI) and outlines the obligations of individuals and entities involved in the food industry, including food operators, manufacturers, packers, wholesalers, distributors, and sellers.

The Indian food industry is subject to regulation not only under the Food Safety and Standards Act but also by international organizations dedicated to monitoring food safety and hygiene. These organizations include:

World Health Organization (WHO): The Nutrition and Food Safety Team of WHO is responsible for overseeing food safety and providing guidelines to prevent diseases arising from unhygienic food. The Standards and Scientific Advice on Food and Nutrition (SSA) Unit of WHO formulates policies related to food nutrition.

Food and Agriculture Organization (FAO): FAO's mission is to combat hunger by promoting sustainable policies. It encourages sectors like agriculture, forestry, and fisheries to contribute to their goals and objectives.

Codex Alimentarius Commission (CAC): Implemented by the Joint FAO/WHO Food Standards Programme, CAC convenes sessions to publish the Codex Alimentarius, a compilation of

⁴ Indian and International Food Laws, <https://blog.ipleaders.in/indian-and-international-food-laws/> (last visited Oct. 20, 2023).

internationally adopted Food Standards. These standards encompass various aspects, including food labelling, food hygiene, food additives, pesticide residues, and more. The Codex Alimentarius is published in six official languages of the United Nations and includes General Standards, Commodity Standards, and Regional Standards.

International Organization for Standardization (ISO): ISO standards for the food industry cover a range of topics, such as food products, food safety management, microbiology, fisheries, essential oils, and starch and its by-products. Specific ISO standards like ISO/TC 34, ISO/TC 34/SC 5, ISO 20633, ISO/TC 34/SC 4, ISO 22000, and ISO 16140 are utilized in the food sector.

World Trade Organization (WTO): In addition to its trade-related activities, the WTO also addresses food standards. Food security is a global concern, and the WTO imposes certain restrictions on food management to ensure that food standards and regulations are upheld.

THE HOAX OF NUTRITION

While the pivotal role of artificial intelligence in making agrifood systems become climate resilient and the growth of genetic engineering, among other eminent advancements, deserve our praise, the circumvention of rules by profit-driven enterprises cannot be ignored due to the imminent threats posed to public safety. New technologies help farmers manage crops and livestock, detect pests and diseases and optimize the use of labour, fertilizers, pesticides, feed and water but they also help food engineers in creation of food that hypnotizes humans to the extent of consuming thousands of calories in addition to the per day energy (calorie) requirement of each individual.

It is rather unfortunate to note that business-minded people, for the manifold increase of their revenue, have mastered the art of making their consumers addicted to their products. As absurd as the aforementioned claims might seem to the common man, an ingredient as common as sugar essentially activates the same

neural pathways or dopamine circuits that are activated by narcotic substances.

In leading scientific studies, when rats were presented with a mutually exclusive choice between water sweetened with saccharin, an intensely sweet but calorie-free substance, and intravenous cocaine, a highly addictive and harmful drug, a significant majority of the animals (94%) exhibited a preference for the sweet taste of saccharin. This preference for saccharin was not solely due to its unusual ability to deliver sweetness without calories, as a similar preference was also observed when using sucrose, a natural sugar. Moreover, this preference for saccharin was not overcome by increasing doses of cocaine and persisted even in the presence of cocaine intoxication, sensitization, or an escalation in cocaine intake—this latter behaviour being a characteristic of drug addiction. ⁵

The findings of these studies unequivocally demonstrate that the allure of intense sweetness can surpass the reward associated with cocaine, even in individuals who are sensitized to and addicted to the drug. It is hypothesized that the addictive potential of intense sweetness arises from an inherent hypersensitivity to sweet tastes. In most mammals, including rats and humans, sweet receptors have evolved in environments where sugars were scarce, and therefore, they are not adapted to handle high concentrations of sweet substances. The excessive stimulation of these receptors by sugar-rich diets, which are now prevalent in modern societies, has the potential to trigger an abnormally high reward signal in the brain. This heightened reward signal may have the capacity to override self-control mechanisms, ultimately leading to addiction.

The globally skyrocketing obesity rates that have multiplied manifold in the past few decades of human civilization can be attributed to corporate greed that has used food science to comprehend how and why our taste buds crave certain combinations of salt, sugar and fat.

⁵ Intense Sweetness Surpasses Cocaine Reward, <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1931610/> (last visited Oct. 20, 2023).

In the modern era, our relationship with food has evolved significantly from the way it existed centuries ago. Today, we no longer view tomatoes and potatoes as potentially poisonous, and carrots are conveniently packaged in bite-sized, brightly coloured bags. For a considerable portion of our lives, we tend to take the origin and production of our food for granted. We consume it without much thought. Chips will remain chips, mac & cheese is simply mac & cheese, and eggplants are still eggplants, even if they bear no resemblance to an egg. However, when it comes to our food, we often fail to give due credit to the food industry and opt for blissful ignorance over conscious awareness. Consequently, we are often taken aback when we witness a substantial increase in the prevalence of conditions like diabetes, heart disease, and obesity. This isn't a personal critique but rather an observation of a collective societal trend that we are all complicit in.

In Michael Moss's book "Salt, Sugar, Fat," he provides an exposé of sorts, delving into the meticulous engineering that goes into the food we consume. From the kettle-cooked chips that accompany your sandwich to the cookie you enjoy during afternoon tea, scientists have dedicated years, and sometimes decades, to conducting precise mathematical tests and regression analyses to determine the exact "bliss point" of customer satisfaction. The bliss point is that precise combination of salt, sugar, and fat that, as Moss describes it, makes us "unable to stop at just one."⁶

For certain products, it is not even the taste of them that draws the purchasers to them, but the seemingly magical powders alias masalas added to them that allure people.

Even outwardly healthy products like fruit juices are not free from problems due to lack of fibre and the presence of concentrated sugar syrups. The packs of orange juice that unsuspecting mothers hand over to their infants, give us, through their skilful packaging, an illusion of being "natural". Home-made orange juice, that is in fact natural, would in no way have lasted for months on its own so food, going stale is a part of whose ordinary nature, lasting for

⁶ Food Engineering- An Addictive Science? <https://sqonline.ucsd.edu/2020/12/food-engineering-an-addictive-science/>, (last visited Oct. 20, 2023).

months should ring a cautionary bell in the minds of the consumers.

As for the preservatives- they serve the essential function of extending the shelf life of various products, including food, cosmetics, and pharmaceuticals, by preventing their deterioration. Antimicrobial preservatives like nitrites, nitrates, benzoates, and sulphur dioxide are effective at inhibiting or delaying the growth of bacteria, yeast, and Molds. Antioxidants such as butylated hydroxy toluene (BHT), butylated hydroxy anisole (BHA), and propyl gallate work to slow down or halt the degradation of fats and oils. Anti-enzymatic preservatives like citric and erythorbic acids are employed to impede enzymatic processes, such as ripening, even after the harvest of food items.

Natural substances such as salt, sugar, vinegar, and spices have been employed as preservatives for centuries. However, the majority of preservatives used in contemporary times are artificial rather than natural. Many of these artificial preservatives are toxic, and some carry potentially life-threatening side effects. Research has indicated that artificial preservatives like nitrates, benzoates, sulphites, sorbates, parabens, formaldehyde, BHT, BHA, and others can pose serious health risks, including hypersensitivity, allergies, asthma, hyperactivity, neurological damage, and cancer.

Studies have shown that several natural preservatives derived from plants, animals, microbes, and minerals possess antioxidant, antimicrobial, and anti-enzymatic properties. Extracts from sources such as basil, clove, neem, and rosemary show promise as alternatives to their artificial counterparts. It is hence best to advocate for the use of natural preservatives, not only for improved preservation and therapeutic efficacy but also for enhanced overall health and safety.⁷

⁷ Artificial Preservatives And Their Harmful Effects: Looking Toward Nature For Safer Alternatives, <https://ijpsr.com/bft-article/artificial-preservatives-and-their-harmful-effects-looking-toward-nature-for-safer-alternatives/>, (last visited Oct. 20, 2023).

POLICIES FOR THE FUTURE THAT LIES AHEAD

To begin with, the loopholes of the laws must be looked into. For instance, the Food Safety And Standards (Packaging And Labelling) Regulations, 2011, or any other legislative instrument for that matter, has not yet addressed the action of using more than 50 different names for the simple word “sugar”.⁸ A consumer who has been medically advised to avoid sugar, can take a look at the list of ingredients, on the product purchased by him, to check his sugar consumption but being a layman his chances of knowing what “agave nectar” stands for are very little to none. In providing this list of ingredients used to manufacture this product, there has been no actual deception but the purchase of this product still takes place due to lack of consumer awareness regarding the nomenclature so used as the consumer isn’t able to comprehend the actual amount of sugar mixed into the product. Mandating the usage of the most commonly known and easily identifiable names for ingredients could have helped take care of such an issue. Advertisements can be publicly shown on a large scale for increasing awareness regarding a multiplicity of issues such as those mentioned earlier and for people to know the long-term health hazards of continual consumption of food that has been handled incorrectly.

A vast majority of illnesses can be prevented if appropriate measures are taken at each stage along the farm-to-table journey to avoid, reduce, and eliminate harmful contamination. No single action at any specific point in this process can suffice on its own, but the cumulative and cooperative efforts of food producers, processors, distributors, retailers, and consumers can almost entirely eradicate foodborne diseases. It's crucial to acknowledge that the ultimate responsibility for ensuring food safety lies with private entities, but the government also bears a responsibility, and it should prioritize reducing foodborne diseases to the greatest extent possible through research, regulation, and education.

The second vital objective is to uphold public confidence in food safety and the food supply, which directly stems from successfully

⁸ Learn to recognize the 56 different names for sugar, <https://robertlustig.com/56-names-of-sugar/>, (last visited Oct. 20, 2023).

mitigating the risk of illness. Public confidence in food safety is a public good that serves several purposes. It empowers consumers to make varied and nutritious dietary choices, unrestricted by concerns about food safety. It fosters an environment conducive to embracing new food technologies. Moreover, it aligns with the desires of the public, who seek the reassurance that their food is safe. This peace of mind is derived from knowing that both the government and the commercial participants in the food system have made every reasonable effort to ensure food safety.⁹

Accountability stands as a fundamental pillar within all regulatory frameworks. In the context of consumer protection regulation, the primary justification for such regulation lies in the recognition that the market often falls short in delivering the desired level of a public good, in this case, food safety, which consumers value and are willing to support financially. Regulatory standards are established to provide this public good, and they serve as a mechanism by which companies can be held accountable. Regulatory accountability steps in where the market's own mechanisms fail to sufficiently ensure the provision of the public good.

The achievement of integration in the food safety system is impeded by the presence of a disjointed collection of food safety laws that regulate the system, leading to a fragmented organizational structure. This organizational fragmentation divides both the responsibility and accountability for the government's program's effectiveness. Public confidence, in today's age of instantaneous communication and extensive scrutiny of government initiatives, particularly those aimed at ensuring public safety, is exceedingly delicate. European food safety agencies, for instance, experienced a swift erosion of credibility and public trust following revelations of both scientific and institutional shortcomings in adequately safeguarding the public or meeting their expectations in certain instances of health crises caused by bacteria.

Food safety systems are, in conclusion, in immediate need of improved regulations and supervision as well as governmental funding. Keeping the public interest in mind, it is the need of the

⁹ Reforming Food Safety: A Model for the Future, <https://media.rff.org/documents/RFF-IB-02-02.pdf>, (last visited Oct. 20, 2023).

hour for legislative action to reduce the amount of white poison, alias sugar, and other questionable substances including certain preservatives, that multi-national corporations pour into junk food whose affordability draws consumers towards them. In conclusion, state machinery that oversees our food systems is still far behind its expected position in the current scenario and the same must be changed as fast as possible for the benefit of people left at the mercy of profit-hungry companies

LAW AND FORENSIC SCIENCE

Arunita Roy Chowdhury¹

ABSTRACT

This essay aims to disseminate ideas on the Law and Forensic Science theme. The objective caters to elucidate upon the concept behind the association of Law with Forensic Science by illustrating various aspects that combine the two domains in an intricate fashion.

Accounting for certain cases pertaining to the accessibility and applicability of forensic science to Law, the methodology will portray a rough sketch of the pointers. It will also showcase the various developments and the places in need of developments, necessary for the field of forensic science to make it a pre-requisite in the field of law.

As crimes tend to follow a steep rise with advancements in technology in the circulating global actions, justice needs to be on a parallel rise, therefore for heinous crimes such as murders, rape, poisoning to death, the identification of the suspects, the bullets, the poison, producing them as exhibits for evidence in the court of law to provide justice to the victims are all an integrated part of forensic science that aids as an important tool in the court of law.

The essay will also analyse certain landmark cases to acknowledge the contribution of forensic science to law.

INTRODUCTION

According to Salmond from the idealistic school of thought, he defined law as “law may be defined as the body of principles recognized and applied by the state in the administration of

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justice.” On the other hand, Austin from the positive school of jurisprudence defined law as “the aggregate of rules set by men as politically superior, or sovereign to men as politically subject.” The purpose of illustrating these two definitions was to show how different viewpoints perceive law, nonetheless from both these definitions it is deciphered that law has been defined as a set of rules applied by an authority.

Shifting our focus from the definitions of law to definitions of forensic science, we observe that the term ‘Forensic’ is derived from the Latin word ‘*forensis*’ which means belonging to courts of justice or to public discussion or debate².

Forensic science is the discipline of science that implements methods and strategies of natural sciences in the identification, recognition, collection, and examination of evidence (exhibits) in the administration of justice. Therefore, with the rise in global circumstances, forensic science is an integrated law component.

AMALGAMATION OF LAW AND FORENSIC SCIENCE: A NARRATIVE

The integration of forensics into law was not instantaneous. It went through cycles of development.

Tracing back to the history of Forensic Science in India, it emerged from having a few rudimentary scientific labs and facilities by means of a fingerprint bureau and laboratories to examine the questioned documents and ammunition, specifically firearms.

In the 19th century, a bulk of deaths were reportedly reported to be caused due to poisoning, thus that grew the concern for the need for a chemical examination laboratory well equipped to examine the human viscera to identify the toxic substances and biological analysis of the body fluids like blood, semen, saliva, tissue fluids, plasma.

Progress was eventually recorded in the establishment and development of the Chemical Examination Laboratories, however

² B.S. NABAR, FORENSIC SCIENCE IN CRIME INVESTIGATION 1 (3rd ed. 2002).

identifying the criminals was based on the traditional methods of witnesses' perspectives, hence another need was fulfilled when the first Anthropometric Bureau was instituted in Calcutta in the year 1892. It aided the investigators and the police officials to identify the criminals and suspects based on the biological means of anthropometric measurements like observing the body heights and other adjacent measurements. However, this means of identification was not absolutely reliable.

Studying the papillary ridges on the fingerprints minutely, William Herschel, created a recording system to record the thumbprints of the suspects and victims. The affirmation to this creation was positive as the thumbprints biologically differ from one individual to another even in the same species. Sir Francis Galton, a scientist from the U.K. undertook the first systematic study of fingerprints and in the year 1892, he published a book on 'Fingerprints' giving a record of statistical proof of how personal identification is unique. "It was then that Sir Edward Richard Henry, the Inspector General of Police, Lower Bengal with the able assistance of two Indian officers namely, Khan Bahadur Azizul Haque and Rai Bahadur Hemchandra Bose, developed a system of classification of fingerprints, thereby discarding the anthropometric system of identification. The first ever Finger Print Bureau in the world was established at the Writer's Building at Calcutta (now Kolkata) in the year 1897."³

Gradually India expanded with the establishment of the Government Examiner of Questioned Documents in the year 1906 at Simla. The Serologist and Chemical Examiner to the Government of India in the year 1910 in the city of Calcutta⁴. These establishments were prior to independence. Post-independence, modifications were suggested and therefore India embarked on the journey of establishing the first State Forensic Science Laboratory at Calcutta, in 1952. Presently there are around 18 forensic science laboratories. The other laboratories were subsequently established. Today what is known as the Bureau of Police Research and Development acts as the nodal

³ *Central Finger Print Bureau*, CENTRAL FINGER PRINT BUREAU, <http://164.100.44.112:8888/English.aspx> (last visited Oct. 30, 2023).

⁴ Supra note 2.

agency of the Government of India aiding in the development of forensic science in India⁵.

Before concluding this piece of narrative, an attempt has been made to illustrate the landmark case of forensic science that initiated the identity of forensic science to be carved into the globe of law.

The first case to introduce forensic science to law and justice was the Tandoor Murder Case⁶:

CASE: State v. Sushil Sharma 2007 CriLJ 4008

FACTS

Sushil Sharma, the prime convict was the owner of a restaurant where he murdered his wife Naina Shani by shooting her out of rage for his wife engaging in a phone call with a man, alleged to be one of her mates, chopping her body into pieces and putting it over the tandoor grill of the restaurant to burn it off.

APPLICATION OF FORENSIC SCIENCE IN INVESTIGATION

The autopsy report of the corpse ruled out that bullets were discovered stuck in the head and the neck areas, when the ballistic department was referred to for determining the type of weapon possessed by the suspect, it found out that the bullets were fired from 32 Arminius revolver in possession of that suspect⁷.

When the revolver was examined for other micro-evidences, it was determined that the blood sample on the body of the revolver matched the prototype of DNA in the blood samples of the victims on other objects seized at the crime scene.

INFERENCE

Forensic science was therefore introduced to the courtroom, the case in its entirety relied greatly on the application of ballistics and

⁵ Supra note 2.

⁶ State v. Sushil Sharma, 2007 CriLJ 4008.

⁷ Sourabh Batar, *Review of Tandoor Murder Case*, 10 AJMR 78, 1 (2021), https://www.researchgate.net/publication/358385538_Review_of_Tandoor_Murder_Case

DNA analysis. Therefore, forensic science proved to be a prerequisite in solving criminal cases majorly owing to its ballpark accuracy.

UNITS OF FORENSIC SCIENCE: THEIR ROLE ANALYSIS IN EVIDENCE PRODUCTION

Forensic science has been segmented into multiple units that possess an individuality over the type of evidence they examine. The segmentation helps in the accurate analysis of the pieces of evidence.

The units and their individuality are discussed below:

a. Unit of Ballistics

- Examination of bullets, cartridges, and ammunitions with the samples to distinguish the specific firearm or weapon used in the crime.
- Study the trajectory of the bullets in cases of gun-shot murders and determine the time and manner of firing.
- Nature of the gun-shot murders and other associations with firearms.⁸

b. Unit of Biology

- Study of microorganisms in the samples if present (typically a bacteriological study)
- Examination of the anatomical remains of the evidence like human teeth, and skull.
- Examination of morphological structures which are microscopic like hair, seeds, and pollen-grains (typically in cases of outdoor crimes)

⁸ Supra note 8.

c. Unit of Chemistry

- Examination of narcotics and in cases where drugs have been used.
- Determination of the quantity of alcohol present in cases of illicit alcohol poisoning and further criminal offense.

d. Unit of Documents

- Analysis of questioned documents and age of the documents found from the scene of evidence.

e. Unit of Physics

- Examination of glass, trace elements, torn fabrics, and machines present in a crime scene.

f. Unit of Serology

- Examination of body fluids like semen, sweat, saliva, and blood stains and their patterns.
- Aids in the determination of paternity, thus serving as an important requisite in cases involving paternity disputes. It is done through means of DNA profiling, which accounts for an important aspect of forensics as forensics plays a primary role in cases of paternity disputes which is common in India.

g. Unit of Toxicology

- Examination of toxic substances like powders, pills, and other substances used in cases of poisoning.
- Accounts for cases involving drunken driving.⁹

PRINCIPLES OF FORENSIC SCIENCE

Forensic Science being a discipline of science, like natural sciences is based on certain principles, that aid in the admissibility to the

⁹ Supra note 2.

courtroom. The most important principle is **Locard's Principle of Exchange** asserted by the famous criminologist hailing from France- Sir Edmond Locard. According to the principle, it states that 'every object leaves traces.

The principle draws the picture that when a suspect has committed the crime, the suspect has left some marks by taking away some stuff from the scene of the crime. The evidence of DNA makes the well-grounded use of this principle that the substances from where the DNA samples were collected were in direct contact with the perpetrator.

Another important principle is the **Principle of Individuality** which asserts that every object is unique, they possess individuality. Fingerprints at a crime scene of no two individuals will be the same.

The **Principle of Comparison** states that when a substance is collected from a crime scene whose identity is not known, the nature of the substance must be studied by comparing it to another substance of the same nature to detect the accuracy. This principle is quite relevant to the process of measurement in Physical Science, where the definition of measurement states that it is the process of measuring a present physical quantity of unknown value with that of a known standardized quantity of the same nature.

These principles hold greater weightage for the establishment of a chain of custody by forensic science to enhance admissibility to the courtrooms.

The **Principle of Progressive Change** asserts that every living organism progressively changes with changes in natural conditions.

CRIMINAL LAW AND FORENSIC SCIENCE

Under this heading, the essay will elaborate on the applicability of forensic science to Criminal Law with specifications to DNA Analysis, which is applicable as a tool in most criminal cases. When forensic science was not well grounded in the legal field, the majority of identification and subsequent proceedings were based

on witnesses' accounts of the crime scene and victim portraits. Paternal disputes were not resolved as effectively as they are now because the primary goal pertaining to them is DNA analysis, which is the true test to confirm the biological relation. As technology evolved, so did the desire to identify criminals using technological assistance. Proved that DNA has 99% accuracy, making it infallible evidence, it is a highly useful tool for both forensics and the legal domain.

In the case of Priyadarshani Matoo¹⁰, the connection between the accused and the crime was established with the help of DNA analysis using the evidence from the crime scene. It was observed that the semen sample collected from the deceased victim matched the accused's, according to the results of the DNA test the CBI performed at Hyderabad CDFD. The blood sample taken from the deceased victim matched the blood spots found on the helmet visor, which was alleged to be of the accused.

The 2012 Delhi Gang-Rape Case¹¹ (commonly known as the Nirbhaya Case) also found the utility of DNA application as an important tool to identify suspects. It was examined that the DNA on the iron rods matched upon carrying out a DNA profiling with that of the victims and the entire profiling was consistent.

Under the Criminal Law, the accused were convicted. It was allegedly reported that Ram Singh, the bus driver of the bus where the crime took place committed suicide while in custody. The trial court in September 2013 awarded death sentences to four of the accused except for the juvenile. One among the four accused, appealed for a review of the judgment, however the same was dismissed by the apex court of India on December 18, 2019. Hence, they were sentenced to death, awarding justice to the deceased victim after years of waiting¹². The Trial Court convicted the accused under various sections of IPC (Indian Penal Code) for the commission of the illegal act.

¹⁰ Santosh Kumar Singh v. State, (2007) 3 SCC Cri 90.

¹¹ Mukesh & Anr v. State for NCT of Delhi & Ors, (2017) 6 SCC 1.

¹² *The Times of India* (2019) 'What is Nirbhaya Case?' 18 December, <https://timesofindia.indiatimes.com/india/what-is-nirbhaya-case/articleshow/72868430.cms>

The most important aspect of Forensic Science under criminal law lies in establishing the chain of custody. The elaboration highlights how to establish the chain of custody.

1. It begins with the collection of the proper sample of evidence from the crime scene, undisturbed. The collection of samples (questioned documents, DNA samples, broken glasses) must be collected by an authorized investigator from the departments assigned.
2. Post collection, proper packaging of the samples and sealing them is essential to prevent tampering, contamination of the samples.
3. The samples packaged must be documented with the proper date and time when it is collected, inclusive of the nature of the sample (whether biological, physical, or chemical).
4. The scientific measure to be followed post documentation refers to proper means of storage to prevent damage, contamination, and degradation of the sample (biological or serological) by subjecting them to the necessary degree of temperature, amount of pressure, and level of humidity.
6. The Chain of custody is finally established when the samples and exhibits collected are successfully analyzed and presented in the courtroom (the Principle of Analysis is implemented) to be used as evidence.

In order to protect the integrity of the evidence and to guarantee a fair and reasonable legal procedure throughout investigations and trials (criminal cases), a safe chain of custody must be established and maintained. It is a cornerstone of the criminal justice structure.

CONCLUSION

Law and Forensic Science are intricately knit to deliver justice to the people who deserve it. As we dig thoroughly into this complex relationship, we visualize the enormous influence that forensic

science has on the legal domain and how it may serve as a sign of both accountability and hope.

Forensic science and its spectrum of disciplines have committed deeply to the delivery of justice to the victims by unearthing the minute details and micro-data from the scenes of crime, unlike the traditional methods that relied on the witnesses' perspective.

With Forensic Science proving to be one of the prerequisites in law, it also helps to establish expert testimony by applying an expert to elucidate on the exhibits produced before the court in order to maintain accuracy.

Today Forensic Science is gradually expanding like a water body to enter into the field of cyber-crimes. Cyber forensics studies the identification, collection, documentation, preservation, and examination of electronic evidence to recover digital data, to prevent cyberbullying, cyber trafficking, and the very common cyber-hacking. Owing to the advancements in the field of digital technology, cyber forensics is coming into play as it becomes very critically applicable.

The blend of forensic science and law is another example of how legal systems can adapt to accommodate new methods and technologies. The legal system must adapt to the changing nature of investigation methods in the new era of digital forensics and developing technology by resolving complex concerns about privacy, admissibility, and ethics. The frontiers of justice will continue to be shaped by the opportunities and challenges presented by this digital frontier

RIPPLE EFFECT - TRANSBOUNDARY HARM IN A NUCLEAR ENERGY PERSPECTIVE

Ananiasri R¹

ABSTRACT

It is widely accepted that nuclear power plants in one country may cause very serious damage in other countries.² While nuclear science and nuclear energy activities were limited to the country's jurisdiction and maintenance, the idea that mismanagement or disasters in the nuclear power plants of one state would affect another state was an idea that was not contemplated before but dawned when the infamous Chernobyl incident occurred. Until then, the safety aspects of constructing, siting, and operating national nuclear power reactors were considered matters of domestic concern, with neighbouring countries possessing only legal interest if they had investments in the country. However, after Chernobyl, it was realized that the hazards of nuclear power operations were intrinsically international in dimension and that borders did not hold much significance in the age of nuclear production. What was the domestic state's liability towards the other states which were affected by its decisions, actions and aftermath was the issue to be tackled.

This topic was not discussed by the customary international lawmakers and regulators as it involved consideration of the conditions of different countries which have different issues and different priorities. However, after the Chernobyl incident, a need came to define and discuss transboundary harms in length. The objective of this essay is to trace the evolution of transboundary harm, its interpretation, elements constituting the harm, general and

¹ The author is a 3rd year student pursuing her bachelors in Law and Business Administration in SASTRA University.

² Volume III, Norbert Pelzer, 'Nuclear Accidents: Models for Reparation,' at 355, Nuclear Non-Proliferation in International Law (T.M.C. Asser Press the Hague 2016).

substantive guidelines, and the strength of the established international customary law via various commentaries, essays, research papers, digests, guidelines, draft articles, and other primary and secondary sources.

INTRODUCTION

Chernobyl was the first concrete example of the potential global environmental, health, economic, and political effects of nuclear power plant accidents. In addition, the different degrees of national sensitivity to nuclear energy manifested by individual countries reflect each country's national environmental, and public health priorities, not just the states to externalize the risk of nuclear activities.³ This section will relate the facts of the Chernobyl incident and the definition of transboundary harm by customary international law to understand the nuances of this concept which led to the introduction of the draft principles. Clause (e) of Principle 2 of the Draft Articles on the allocation of loss in the case of transboundary harm arising out of hazardous activities (hereinafter referred to as Draft Articles) defines transboundary damage as follows- *“transboundary damage” means damage caused to persons, property or the environment in the territory or other places under the jurisdiction or control of a State other than the State of origin;*⁴

It clearly states that the damage should have occurred in the territory/jurisdiction of one state and should have an impact or caused damage in the territory/ jurisdiction of another state to consider a particular incident, transboundary harm. In the Chernobyl incident, a power plant exploded in the USSR, and the impact of this explosion was detected at high levels throughout Europe and even far away in North America.

While the USSR accepted the responsibility for the incident, it did not assume any legal liability towards the countries which were

³ Vol.7, Handl, Gunther, An International Legal Perspective on the Conduct of Abnormally Dangerous Activities in Frontier Areas: The Case of Nuclear Power Plant Siting, (Ecology Law Quarter 1978).

⁴ Principle 2., clause (e), ILC Draft Principles on the allocation of loss in the case of transboundary harm arising out from Hazardous Activities, 2006.

affected by the explosion of the power plant and after separation, Ukraine even tried to gain financial assistance from the other countries affected. However, the Preamble of the Draft Article clearly states that those who suffer harm or loss because of such incidents involving hazardous activities are not left to fend for their financial losses and can obtain prompt and adequate compensation.⁵

Article 1 of the Draft Article provides that the articles are to apply to activities not prohibited by international law which involve a 'risk of causing significant transboundary harm through their physical consequences'.⁶ Draft Articles, when Article I provide that the risk of causing significant transboundary harm' is to be defined as including, a high probability of causing significant transboundary harm and a low probability of causing disastrous transboundary harm'. The level of the harm needs to be categorized as being "serious" or "severe" and it is enough to be considered significant if it is detectable.⁷ In the Chernobyl incident, the nuclear power plants exploded leading to the introduction and spread of radioactive elements into the environment and this was a physical consequence of the damage.

Article 3 provides that the state of origin (defined as the state, where the activities are taking place or are to take place) 'shall take all appropriate measures to prevent significant transboundary harm or at any event to minimize the risk thereof. The states should perform their duty of due diligence and ensure they eliminate all the risks that would lead to transboundary harm. In the Chernobyl explosion, the team should have ensured that safety precautions were taken before conducting the test, and in case of problems, the system should have been able to minimize the damage. However, the USSR did not take the test of due diligence.

⁵ Ibid.

⁶ Article 1, Draft Articles on Prevention of Transboundary Harm from Hazardous Activities, 2001.

⁷Ibid.

ELEMENTS OF A TRANSBOUNDARY HARM

For an incident to be categorized and dealt with as transboundary harm, it should constitute a few elements to differentiate between the type of damage that occurred.

1. Physical relationship with the harm and its consequence

In transboundary harm, there should be a physical nexus between the incident and its consequence. The Semipalatinsk Nuclear Test Site in Kazakhstan was used by the Soviet Union for testing nuclear weapons between 1949 and 1991. It resulted in widespread environmental contamination and had a devastating impact on the health of people living in the area. In this case, there is a physical nexus as the nuclear weapons test led to the pollution of the environment rendering it inhabitable. Presently, therefore, the term transboundary harm which requires a physical element, denotes 'bodily, materially or environmentally' harmful consequences wherein the aspect of bodily harm also includes factors injurious to human senses e.g., nuisance caused by noise, odour etc.⁸

2. Caused by Human Actions

For an incident to be considered an occurrence of “transboundary harm” it should be the consequence of the actions taken by humans. An incident whose cause is natural factors such as earthquakes, floods, volcanoes etc., cannot be considered as actionable transboundary harm. The harm caused to natural resources by industrial and agricultural activities is thus typically encompassed by the obligation, while for example economic consequences caused by an

increase in commodity prices due to environmental interferences are excluded.⁹ The harm caused by factors covered under the *force majeure* clause also will not be considered transboundary harm. In the case of the Fukushima incident, an earthquake and tsunami led to the cut of power supply in the Daiichi power plant resulting

⁸Xue, Hanqin, *Transboundary Damage in International Law*, (Cambridge 2003).

⁹ Vol,44, Schachter, Oscar, *The Emergence of International Environmental Law*, *Journal of International Affairs*, p.464, (1991).

in the disaster.¹⁰ Though the incident was a nuclear disaster, it cannot be considered a transboundary harm.

3. A Certain Threshold of Severity that Calls for Legal Action

For an event to be considered transboundary harm, there should have been a relative degree of damage that would have occurred. This is because not every transboundary harm would cause international liability.¹¹ In 1977 weather caused a short-circuit of high-voltage power lines and rapid shutdown of the reactor in the Gundremmingen Nuclear Power Plant in Germany but due to a relatively lesser degree of damage, it was not considered a transboundary harm.¹² International law will apply only to cases which have had a severe degree of damage. However, the degree of harm will be calculated on a fact-to-fact basis. The International Nuclear and Radiological Event Scale (INES) was introduced in 1990 by the International Atomic Energy Agency (IAEA) to decide the severity of nuclear disasters.

4. Transboundary Movement of Harmful Effects

More than one state should have been affected by the activity in question to consider it transboundary harm. However, it is not essential that only one state should have been affected by the activity. In the cases of long-range air pollution, or acid rains owing to industrial pollution numerous states can be affected and have been affected. Taking the example of Chernobyl, as stated above, it affected not only the USSR but also impacted many countries in Europe and North America. It even led to contamination of a large portion of the Ukraine making it inhabitable. The explosion resulted in various economic losses including the cessation of dairy production in the United Kingdom, a ban on the sale of leafy vegetables in Italy, and a prohibition on the consumption of reindeer in Sweden.¹³

¹⁰ Fukushima Daiichi Nuclear Accident (2021) IAEA. Available at: <https://www.iaea.org/topics/response/fukushima-daiichi-nuclear-accident>

¹¹ Supra note 8, p. 457.

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<https://inis.iaea.org/search/searchsinglerecord.aspx?recordsFor=SingleRecord&RN=10441799>

¹³ Devereaux F. McClatchey, *Chernobyl and Sandoz One Decade Later: The Evolution of State Responsibility for International Disasters, 1986-1996*, (G.A. J. INT'L & COMP. L. 1996).

GENESIS AND GUIDELINES

While the Draft articles were framed to deal with the concept of transboundary harm and other related aspects of nuclear law, definitions and guidelines were being drafted in commentaries and other legislations. In his book “Transboundary Damage in International Laws,” the author defined that “transboundary damage or harm is environmental damage which is caused by or originates in one state and affects the territory of another.”¹⁴ It was an aspect of nuclear disaster which impacted not only the domestic state but also affected other states.

1. Declarations and Legislations

Principle 21 of the Stockholm Declaration states the duty not to cause transboundary harm: “States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their resources pursuant to their environmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or areas beyond the limits of national jurisdiction.”¹⁵

The origins of the obligation lie in the old principle of international law that states are obliged not to inflict damage on or violate the rights of other states, which is often expressed by reference to the principle of *sic utere tuo ut alienum non laedas* which expressly states that one should control and make use of their property without affecting or injuring the property of other people.

In ***United States V Canada***, it was adjudged that “*no State has the right to use or permit the use of its territory in such a manner as to cause injury by fumes in or to the territory of another or the properties or persons therein, when the case is of serious consequence and the injury is established by clear and convincing evidence*”¹⁶ This depicts how even before the Draft Articles, the concept of transboundary harm was interpreted and dealt to prevent any ambiguity for further cases.

¹⁴supra note 7, at 1.

¹⁵ Principle 21, Declaration on Human Environment adopted 16 June 1972 by the United Nations Conference on the Human Environment, (1972).

¹⁶ The United States v. Canada, RIAA vol. 3, pp. 1905-1982 (1938 and 1941).

2. State sovereignty and territorial sovereignty

State sovereignty is a founding principle and a prerequisite for the system of international

law.¹⁷ The essence of international law is derived from the states and their exclusive authority over their land. One principal corollary of sovereignty is that states have jurisdiction, *prima facie* exclusive, over a territory and a permanent population living there.¹⁸ A state has supreme control over its territory and can perform all lawful acts within its jurisdiction.

A traditional view in international law is that states are by their sovereignty, initially free to wield authority over and exploit the natural resources within this geographical area that constitutes its territory, and to pass laws and make decisions regarding its environment and management of the natural resources.¹⁹ This right of states to manage the environment within their territory is reflected in the principle of Permanent Sovereignty over Natural Resources.

While the power of state sovereignty guarantees power to control and rule their territory, it is an obligatory duty of all states to ensure that they follow the tenets of customary international law and ensure that while exercising their power concerning their state, they do not violate any powers and rights of other states and ensure that they fulfil their duty towards the other states. This was also expressly pointed out in the ***Island of Palmas*** arbitration, where the Permanent Court of Arbitration stated that “Territorial sovereignty ... involves the exclusive right to display the activities of a State. This right has as a corollary a duty: the obligation to protect within the territory the rights of other States, in particular, their right to integrity and inviolability in peace and in war, together with the rights which each State may claim for its nationals in foreign territory.”²⁰

¹⁷ Perrez, Franz Xaver, the relationship between Permanent Sovereignty and the obligation not to cause transboundary environmental damage, *Environmental Law*, pp. 1187-1212 (1996).

¹⁸ 3rd edition, Sands, Philippe and Jacqueline Peel *Principles of International Environmental Law*. 11, (Cambridge 2012).

¹⁹ *Ibid.*

²⁰ *Netherlands v. the United Kingdom*, RIAA vol. 2, at p. 839, (1928).

NO – HARM RULE

The no-harm rule is a widely recognised principle of customary international law whereby a State is duty-bound to prevent, reduce and control the risk of environmental harm to other states. This is the obligation each state has towards others to ensure peace and unity.²¹ Under current international law, the no-harm rule is expanded to also include harm to areas beyond national control.²² The rule thus protects not only the territories under state control but also the “global commons,” i.e., the high seas, outer space, the atmosphere, and the Polar Regions. These are regions which are covered by boundaries of different states, however, do not belong to one state and neither will they come under the jurisdiction of the states it passes through. As a modern rule of environmental law, the no-harm rule comprises two partly opposing objectives: that states have sovereign rights over their natural resources, and that states must refrain from causing environmental harm. International texts that include the no-harm rule, therefore also often include a confirmation of the sovereign right of states to exploit their resources.²³ While the objectives may seem to be contradictory to each other, the objectives have been framed to ensure that states are not arbitrarily abusing their powers without consideration for the other states.

1. Substantive Guidelines

As expressed by the no-harm rule, states are under a general obligation not to cause damage to the environment of other states or areas beyond national jurisdiction. Damage and injury to property and persons are also covered under the purview of a general obligation to prevent causation of transboundary harm.²⁴ However, while it is understandable that the general obligation is imposed on all states as per international law, a more difficult

²¹ 7th edition, Ian Brownlie, *Principles of Public International Law*, (2008).

²² *Legality of the threat or use of nuclear weapons*. Advisory opinion, p. 226, 8 July 1996. ICJ Rep. (1996).

²³ *supra* note 14, Principle 2, Declaration on Environment and Development adopted 12 August 1992 by The United Nations Conference on Environment and Development (1992).

²⁴ Article 21, Convention on Long-range Transboundary Air Pollution, Geneva, 13 November 1979. comparison with Article 1(1), United Nations Framework Convention on Climate Change, New York, 9 May 1992.

question is to what extent environmental protection is encompassed by the obligation.²⁵ *Birnie, Boyle and Redgwell* point out that treaty law does not provide any precise uniform definition of what is meant by the “environment,” and thus “environmental harm”; the definitions vary depending on the purpose of the treaty, and a generic definition of harm may thus not be given.²⁶ They argue that while prospective material injury is an essential element of the no-harm rule, it seems tenable that the obligation does not apply only to the loss of resources of an economic value, but also to the impact certain actions of the states have on entities of intrinsic value, say for example natural ecosystems, biodiversity and areas of wilderness and aesthetic significance.

2. Threshold of severity

Application of the no-harm rule would not be possible for all transboundary harms and it is a necessity that the harm must be of a certain degree of severity. The need for a threshold criterion arises because of the two parallel objectives of the no-harm rule namely that states have the responsibility not to cause damage outside their territory, but also, by virtue of their sovereignty, the right to exploit the natural resources within their jurisdiction are disputing each other and that there is a need to strike an equitable balance between both the objectives to ensure that the rule is being applied appropriately.

Often, the principles of the Stockholm and Rio Declarations have been used to interpret relevant meanings and standards mainly principles of Rio 2 and Stockholm 21. "States ... have a duty 'to ensure that activities within their jurisdiction and control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction.'"²⁷ First, in response to States claiming that either they were not parties to the treaties or that the declarations were not binding, the Court declared that the

²⁵ 3rd edition, *Birnie, Patricia, et al., International Law and the Environment*. 184, (Oxford 2009). p. 184.

²⁶ *Ibid.*

²⁷ *supra* note 22.

duty not to cause transboundary harm was customary international law.²⁸

Explicit thresholds of harm cannot be derived from the respective principles of the Stockholm and Rio Declarations. The second part of Principle 21/2 expressly convenes that “damage to the environment” must be prevented, regardless of the severity of the damage. However, to understand the proper interpretation, the principle should be read with the sovereign right of states “to exploit their resources,” which is expressed in the first part of the principle. The two competing objectives must be balanced against each other, which in turn requires the determination of a certain *qualification* of harm or a measure to quantify the harm. Due to these considerations of territorial sovereignty, a threshold must also be interpreted into other international law instruments prohibiting environmental harm that does not contain an explicit threshold.

Although there seems to be consensus on the requirement of “significant harm” to consider a particular act as transboundary harm, a definite answer as to what is meant or considered “significant” has not been found and would be ignorant if a particular standard would be set to decide which action should be considered as “significant.” The degree of severity changes with circumstances, and therefore its degree must be determined in relation to the specific context of each instance and on a case-to-case basis.²⁹ However, an unset standard and degree of severity does not mean that it is up to the states to determine whether their actions have had a significant transboundary impact. Reiterating the statement made above, according to the commentaries to the Articles on Prevention the threshold shall be measured by “factual and objective standards.”³⁰

The first approach towards determining the threshold of harm is that it should be determined by balancing the socioeconomic utility of an activity against its detrimental effects on the environment;

²⁸ Legality of the threat or use of nuclear weapons. Advisory opinion, 8 July 1996. ICJ Rep.(1996).

²⁹ Report of the International Law Commission on the Work of its Fifty-third Session, p. 388 (2001).

³⁰Ibid.

thus, the level of tolerance of harm increases as the economic and developmental advantages of the activity increase³¹ According to the second approach, a *de minimis* test must be applied to the harm, a test which indicates that if the harm is not minor, i.e. insignificant or trivial, the threshold has been crossed. This approach is taken by the ILC in the Articles on Prevention, which defines the degree of the term “significant” as something more than “detectable.”³²

Principle 21/2 of the Stockholm and Rio Declarations is often interpreted to encompass an obligation to prevent and control harm.³³ In the *Legality of nuclear weapons*, the ICJ slightly changed the verbatim of the principle from “a responsibility on states to ensure that the activities within their jurisdiction and control do not cause damage to the environment”, to an “obligation to ensure that such activities ‘respect’ the environment.” It is uncertain whether the Court meant to make any material changes to the principle, however, the use of the general phrase “respect” may indicate that the principle is extended to instances where no damage is caused. The ICJ in later states recognized the principles in the declarations which state that “states are obliged to prevent harm.” In *Gabčíkovo-Nagymaros*, it was confirmed that “in the field of environmental protection, vigilance and prevention are required on account of the often-irreversible character of damage to the environment and the limitations inherent in the very mechanism of reparation of this type of damage.”³⁴

3. The required level of prevention

A significant question pondered upon is as to what degree /level of prevention is required under the obligation, i.e., what standard of care is required with respect to the application of the no-harm rule. Two general approaches have emerged on this issue. The first approach is that states are generally obliged to achieve actual prevention of harm. The other approach is that states are under an obligation to act with due care in implementing measures of

³¹Lefeber, René *Transboundary Environmental Interference and the Origin of State Liability*, The Hague (1996).

³² *supra* note 28.

³³ *supra* note 28, para 3.

³⁴ *Botswana v. Namibia*, para.140, ICJ Rep. (1999)

prevention. Another way to conceptualize this issue is to ask whether the no-harm rule is one of result or conduct.³⁵ That is, should it be a way of performing their duty, or should it be the result of the series of actions to be taken by each state? Following the discussion in the previous sections, it seems tenable to conclude that under the no-harm rule, states are obliged to prevent and control transboundary harm and minimize the risk thereof, and this is rather a duty to oblige and is not considered a preventive measure.

The next significant question is how the due diligence standard is to be determined, Due diligence is a “framework concept,” which means that it can be interpreted and understood only by the specific risks and activities in question and cannot be generalized.³⁶ In the context of the no-harm rule, there seems to be a growing consensus on the basic elements of the standard. It has been agreed by various authorities that good standards should be tested wherein the conduct of the state must be compared to what a “good government” would do in a particular situation of transboundary pollution.³⁷

ENVIRONMENTAL IMPACT ASSESSMENT

Environmental Impact Assessment (EIA) is a prominent and established procedure in the current international environmental law regime and a mechanism frequently used by states to gain knowledge of the environmental consequences of actions they authorize or participate in. The Espoo Convention on Environmental Impact Assessment describes its functioning as “a national procedure for evaluating the likely impact of a proposed

³⁵ Plakokefalos, Ilias Prevention Obligations in International Environmental Law, p. 37, ACIL Research Paper (2013-12) and Vol.10, Dupuy, Pierre-Marie Reviewing the difficulties of codification: on Ago's classification of obligations of means and obligations of result in relation to state responsibility, pp. 378.382, (European Journal of International Law, 1999).

³⁶ Vol.77, Voigt, Christina State Responsibility for Climate Change Damages, p. 10 (Nordic Journal of International Law, 2008).

³⁷ Ibid, p. 11, Koivurova, Timo Due Diligence, pp. 1 -3, (Max Planck Encyclopaedia of Public International Law, 2013).

activity on the environment.”³⁸ The procedure aims to provide information to national authorities when deciding whether to authorize an activity, and the procedure is a useful tool for operationalizing the precautionary principle because through conducting prior EIAs states may inform themselves of potential environmental impacts before they make decisions.³⁹ The procedure plays an indispensable role in implementing environmental protection guidelines and regulations into development projects and thus promoting sustainable development.⁴⁰

Duties to conduct transboundary EIAs have been enshrined in several international conventions in non-binding instruments such as the Rio Declaration, and are also entrenched in the Articles on Prevention where it is stated that “any decision in respect of the authorization of an activity ... shall be based on an assessment of the possible transboundary harm caused by that activity, including any environmental impact assessment.”⁴¹

Monitoring may be Defined as a duty “to observe, measure, evaluate and analyse, by recognized scientific methods, the risks or effects of pollution.”⁴² Monitoring is synonymous with the EIA’s work as it provides additional support in ensuring that the actions of the states do not unintentionally lead to transboundary harm. Articles on Prevention emphasize the importance of monitoring and state that “the duty of prevention based on the concept of due diligence is not a one-time effort but requires continuous effort ... it continues in respect of monitoring the implementation of the activity as long as the activity continues”.⁴³ The commentary hints that monitoring and EIA are complementary in nature and are equally important in ensuring that the states oblige their duty towards each other as per customary international law.

³⁸ Article 1 (vi), Convention on Environmental Impact Assessment in a Transboundary Context, 25 February 1991.

³⁹ *New Zealand v. France*, pp. 342-245, ICJ Rep. (1995).

⁴⁰ *Supra* note 24, p. 165.

⁴¹ *supra* note 4, Article 7.

⁴² Article 204(1), Convention on the Law of the Sea, Dec. 10, 1982, 1833 U.N.T.S. 397. (1982).

⁴³ *supra* note 28, p. 420 para. 2.

CONCLUSION

Transboundary harm, though a relatively new concept, has evolved into a niche of its own, supported by various guidelines, draft articles, commentaries, and awards. Once an ignored aspect, it has now been established as a paramount part of customary international law divulging into various branches of international law, predominantly international environment law and nuclear energy law. However, proper legislation and conventions should be drafted and states all over the world should be extended an invitation to ratify these legal documents to ensure that all states conform to basic regulations concerning international environmental and nuclear energy and oblige their duties properly. It would also ensure that a basic framework would be drafted for all the states to legislate their laws with respect to this niche tailoring it to the existential conditions of their countries, and at the same time ensure uniformity and clarity in the laws to be abided by.

THE SCIENCE IN JURISPRUDENCE: A HISTORICO-PHILOSOPHICAL PERSPECTIVE

Debjani Mukhopadhyay¹

ABSTRACT

Both law and science were the outcome of philosophical deliberations that lasted centuries. The historical trajectories of law and science have been conflated in several ways since the Ancient Greek Period. While science vividly started taking shape with Pythagoras in the pre-Socrates era, natural law developed simultaneously with Heraclitus's Law of Nature. In fact, the development of natural law during the Classic Greek Period with the dialogues of Socrates, Plato and Aristotle also shaped the concept of the State and individuals as its subjects while Aristotle's Theory of Causality became the cardinal foundation of Western Scientists, which continues to remain to this day.

It would be quite right to say that the founding pillars of both law and science today are the three essential concepts: Empiricism, Rationalism and Ethics. All three concepts have developed and been made applicable both in science and in jurisprudence. This begs the question: What are the similarities between law and science? And most importantly, is law a superior science?

We find some of these answers in the study of epistemology, the theory of knowledge. The cardinal concepts in epistemology such as a priori and a posteriori knowledge and the verifiability of such sources of knowledge lead the way in answering questions on the scientific basis of law. Understanding the fundamental concepts of science and finding its applicability in jurisprudence can answer such questions for us.

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INTRODUCTION

In this essay, we shall primarily inspect the questions of where ideas come from and what makes these ideas “scientific.” We shall also make deliberations on the fundamentals of science to answer the question of what can be considered scientific. We shall discuss the prevalence of Empiricism, Rationalism and Ethics in both law and science, following which we can embark on the understanding of epistemology through the dissection of a priori and a posterior knowledge in the field of law and science. We shall also see the development of legal concepts through a scientific lens along the following points:

- a. The understanding of empiricism in both science and law and the development of perceptual knowledge
- b. Application of rationalism to empiricism or evidentiary knowledge and the formation of rational knowledge
- c. The extrapolation of thesis, hypothesis and synthesis from existing knowledge in both law and science

Lastly, we shall deal with the questions of applicability of the fundamental principles of science in substantive law. The question of whether law is superior to science shall be dealt with conclusively.

BACKGROUND

Both the origin of scientific thinking and legal reasoning can evidently be traced back to the Classical Greek philosophers, Plato and Aristotle. Plato, in one of his dialogues - *Theaetetus*, states that there is no knowledge without the application of the mind. In his concept of sense perception and knowledge, Plato is convinced that the act of sensing or observing through over five senses cannot be the only source of real knowledge². Observation of the material reality, as per Plato, cannot in itself result in knowledge. He argues that empirical observations only result in knowledge when

² John M Cooper, Plato on Sense-Perception and Knowledge ("Theaetetus" 184-186), 15, *Phronesis*, 123, 123-126 (1970)

judgment is applied to the perception. Plato's approach to understanding where knowledge stems from was one of the first explanations of scientific knowledge. The descent of modern science as well as modern law can be traced back to his concept of the application of rationality and judgement on perceptual knowledge to derive scientific knowledge.

METAPHYSICS AND RELIGIOUS MORALITY IN LAW AND SCIENCE

Much before we arrived at the applicability of sciences and laws, both science and law were metaphysical pursuits, mostly intertwined with the concept of religious morality. For instance, the renowned pre-Socrates era mathematician, Pythagoras fostered the belief that science is not distinct from mysticism. He held that his discoveries in mathematics were God-given and often regarded them as an impact of divine revelation³. Perhaps, the conflicting relationship between science and religious morality did not change before Galileo's discovery came starkly in contradiction with the Church. Similarly, Aristotle conceptualized law as the order of God in his articulation of the ideal rule of law. He stated:

“He who asks law to rule is asking God and intelligence and no others to rule, while he who asks for the rule of a human being is importing a wild beast.”

Neither science nor law found objectivity as a material basis, entirely free from religious morality before the Age of Enlightenment. The phenomenal changes that occurred during the Age of Enlightenment were the reformation of laws and science based on objective observations and rational synthesis from such objectivity.

Things started taking turns towards the development of modern science and law when the emphasis on man and society as an object was made amply clear. One of the fundamental characteristics of the Age of Enlightenment was that empiricism was widely accepted as the primary foundation of scientific

³ WILL BUCKINGHAM Et al, THE PHILOSOPHY BOOK, 28, (DK Publishing 2011)

thinking. Rationalism, the application of mind to the empirical foundations was the very next step that eventually led to the formation of a hypothesis. The verification of the hypothesis formed a thesis. In the Middle Ages, while the very early shift of science and law from metaphysical philosophy to materialism and rationalism was seen, neither law nor science was free from the censorship of the Church. Thus, the basis of both science and law was subordinated to the theological worldview promoted by the Church. However, there were some distinct breaches in the era of feudal law and science which were quite the exception.

The formation of the Great Charter of 1215, known as the Magna Carta, the early charter of human rights, was one. For the very first time in history, a Charter in the form of the Magna Carta set out limitations on the powers that the King could exercise. It was the time in history when the law of the land and the rights of the commons were superior to the command of the King. The Charter, quite ahead of its time, laid down rules which apply even to this day. For instance, it laid down provisions for protection from imprisonment, placed limitations on the feudal payments to the crown, and provisions for access to justice. Although the Charter was not a breakaway from the influence of the Church, it was quite free from the existing custom and moral theory in its ventures to set out a common law which applied equally to all subjects of the King. For instance, clause 39 of the 1215 Charter laid down that:

“No free man shall be arrested or imprisoned or disseized or outlawed or exiled or in any way victimized, neither will we attack him or send anyone to attack him, except by the lawful judgment of his peers or by the law of the land.”

Subsequent amendments were made to The Magna Carta in the 17th century including the Petition of Right and the Habeas Corpus Act which established law as a bouquet of the rights of man based on material and objective circumstances rather than a command of the Sovereign or as the instrument of the Church.

Similarly, science had also had a breakaway towards an objectivity-based, inductive approach in the feudal era. One of the first propagators of an inductive approach to science, as opposed to a deductive or Aristotelian outlook, was Francis Bacon. Also known

as the father of empiricism, Bacon theorized that scientific knowledge must come from careful observation of nature and through inductive reasoning. However, as objectivity or empiricism was not a primary foundation of scientific thinking in the feudal era, these ideas were quite alien. Therefore, both science and law were confined within the prisms of customs, and moral and religious righteousness with certain exceptions in the feudal era.

THE BREAKAWAY: EMERGE OF EMPIRICISM AND RATIONALISM

Although the emergence of science and law based on empirical observations, free from religious morality, started way back in the 13th and 14th Centuries, the censorship of the Church prevented these ideas from flourishing. In the year 1546, the book written by Nicholas Copernicus, "On Revolution of the Celestial Spheres" was published which presented the theory that the earth revolved around the sun.

Even at the turn of the 17th Century, the politics of science was dominated by the Catholic Church which resulted in the banning of the book in the year 1616. Later, Galileo Galilei was also made to be a martyr of modern science by the Church.

The beginning of the 17th Century also witnessed the emergence of empirical observations coupled with rational thinking as the basis of all scientific thinking. Francis Bacon, in his book *Novum Organum*, published in 1620 remarked:

"There remains simple experience; which, if taken as it comes, is called an accident, if sought for, an experiment. The true method of experience first lights the candle [hypothesis], and then by means of the candle shows the way [arranges and delimits the experiment]; commencing as it does with experience duly ordered and digested, not bungling or erratic, and from it deducing axioms [theories], and from established axioms again new experiment."

Thus, begins the foundation of an inductive approach to research and experiments.

Empiricism was also found to be the primordial characteristic of the 17th Century in jurisprudence. Montesquieu, the French philosopher and the father of the historical school of jurisprudence believed that the actions of the State must conform to publicly known standards. In *The Spirit of the Laws* published in the year 1748, Montesquieu argues that positive laws and social institutions, unlike physical laws, are created by human beings which makes them prone to “ignorance”, “errors” and “impetuous passions.” Montesquieu’s philosophy of law was different from how law has been defined in the past. He refused to promulgate the argument that law is a command of the sovereign. In fact, he argued for making empirical data the basis for the framing of laws which coupled with the rationales of lawmaking shall result in legislation. As per Montesquieu, laws should be adopted:

*“to the climate of each country, to the quality of its soil, to its situation and extent, to the principal occupation of the natives, whether husbandmen, huntsmen or shepherds: they should have relation to the degree of liberty which the constitution will bear; to the religion of the inhabitants, to their inclinations, riches, numbers, commerce, manners, and customs.”*⁴

Perhaps, the science of law, for the first time, was taking shape towards building on an empirical foundation when Montesquieu, in *The Spirit of Laws*, attempted to study the varieties of societies in comparison to one another and classify them to study the inter-functioning of institutions. Similarly, Kant, in his book *Critique of Pure Reason*, lays down the idea that empiricism or perceptual knowledge is the basis of all knowledge and that reason can’t give us answers to what is beyond or in contradiction to perception. Through Kant, we find that rational knowledge solely applies to empirical knowledge and forms the basis of any scientific enquiry.

Around the same time, the influential German jurist, Savigny came up with *Volkgeist*, the theory that law flows from the will of the people. Savigny considered the necessity for the uniqueness of the experience of people to be a part of lawmaking. Although Savigny was against the codification of laws since the “will of the people”

⁴ Hilary Bok, "Baron de Montesquieu, Charles-Louis de Secondat", *The Stanford Encyclopedia of Philosophy*, sec 4, (2003).

was considered to be dynamic, the principle of *Volkgeist* was instrumental in inducing an inductive method of lawmaking, rather than a deductive one.

The development of modern constitutions roots back to the principles of the Rule of Law as described by Dicey in his book “The Law of the Constitution” in the year 1885. In his book, Dicey advocated for the establishment of the Rule of Law, generally used as the Thumb Rule in the domain of Constitutional and Administrative Law today.

The concept of the Rule of Law was characterized by three aspects: The absence of arbitrary power, equality before law and the predominance of legal spirit⁵. It is notable that Dicey’s Rule of Law seeks to establish a system of checks and balances for the abuse of power which can be recounted as a re-evaluative or corrective approach to jurisprudence. In such ways, Dicey’s Rule of Law considered the abuse of administrative or Constitutional powers and laid down rules to restrict such abuse. Therefore, all three essentials of scientific enquiry: empiricism, rationalism and ethics were applied.

The Age of Enlightenment was significant in establishing the parameters of scientific thinking based on which both science and law furthered themselves. Freed from religious morality, metaphysics and censorship of the Church, both science and law thrived. However, with the advent of the Industrial Revolution, the scope for applicability of science was enhanced. Science was now seen as an apparent solution for woes that plagued mankind for thousands of years.

Through scientific enquiry, one could now resort to resolving issues of mankind and reduce the requirement for hard labor. Besides, facilitating convenience, efficiency and safety through the use of innovations was proof that scientific inquiry was now premised upon objective realities of the society. Science, therefore, became the mirror that reflected the past and yet foretold the future. Regardless, there was no such dynamic change in law or

⁵ Richard H Fallon Jr, The Rule of Law As a Concept in Constitutional Discourse, 97, Columbia Law Review, 1, 1-5, (1997).

jurisprudence. In the Age of Enlightenment, natural law sourced from moral or legal norms prevailed.

The scientific enquiry into reform trailed quite behind. Regardless, there was no such dynamic change in law or jurisprudence. In the Age of Enlightenment, natural law sourced from moral or legal norms prevailed. The scientific enquiry into reform trailed quite behind.

THE SCIENCE OF SUBSTANTIVE LAW

The application of scientific enquiry in the domain of substantive law deals with questions that centrally involve theories of punishment. Shifts in attitude towards punishment vary from one State to another as per their political and customary nature. For instance, around the year 1700 in the United States, organizations pushed for the abolition of the death penalty and other retributive forms of punishment. However, the shift in the substantive law of the State was not a result of scientific inquiry into the impact of punishments on the deterrence of offence or the prevalent social inequality which made socially vulnerable groups more prone to receiving a death penalty. The shift was rather driven by the concept of utilitarianism that the Government must seek the greatest good for all its citizens in great numbers. Cesare Bonesana di Beccaria, the Italian jurist, was an ardent advocate of this approach. In 1764, in his pamphlets on Crime and Punishments, he writes:

“If it can only be proved, that the severity of punishments, though not immediately contrary to the public good, or to the end for which they were intended, viz., to prevent crimes, be useless; then such severity would be contrary to those beneficent virtues, which are the consequence of enlightened reason, which instructs the sovereign to wish rather to govern men in a state of freedom and happiness, than of slavery. It would also be contrary to justice, and the social compact.”⁶

⁶ Francis A Allen, An Essay On Crimes and Punishment, BRITANNICA, (Nov. 23, 2023, 3.00 PM).

By the beginning of the 20th Century, however, the inquiry into theories of punishments was purely data-backed and was backed by well-researched claims. It was, therefore, easier to venture into the aspects of effective law and the consequences of laws and policies for socially vulnerable groups to be able to comprehend reform. The demand for the abolition of the death penalty today is way more scientifically validated than it was in the 1700s. That capital punishment does not deter perpetrators has been clearly established today.

If we take a look at the data from 2004 in the USA, we would empirically find that the average murder rate in the States that did not abolish capital punishment was higher than in the States which did, falsifying the deterrence theory⁷.

By the end of the 20th Century, the science of substantive law flourished not only to impose punishments for distinct breaches of law but also to rehabilitate these offenders back into society while also taking necessary precautions based on empirical observations and rational expectations. One example of the same can be Megan's Law, a Federal Law passed in 1994 that mandated sex offenders to register themselves with a local law enforcement agency so that communities are notified when a sex offender lives or works nearby. The law also puts common restrictions including residency restrictions requiring sex offenders to not live within a certain distance of a park or school⁸. The greater concern today is the protection and privacy of such data and the privacy of such convicts in their integration back into society, we certainly find such substantive measures well-researched and data-backed to be able to contribute positively to the prevention and deterrence of crime.

Since legal systems depend heavily on the social, moral and customary fabric of a society, the applicability of law varies from one country to another. Framing of penal laws heavily relies on a scientific outlook but they vary from one country to another depending on its political economy or political regime.

⁷ John J Donohue and Justin Wolfers, Uses and Abuses of Empirical Evidence in Death Penalty Debates, 58, *Stan.L.Rev.*, 791, 803, (2005)

⁸ Rose Corrigan, Making Meaning of Meghan's Law, 31, *Law and Social Inquiry*, 267, 284 (2006)

For instance, countries that rank high on the democratic index globally have abolished the death penalty while countries which have some forms of authoritarian political regime have failed to take the abolitionist approach.

Authoritarian regimes use capital punishment as a form of repression that is less costly and more effective than extra-judicial killings and severe violations of human rights. This is beside the point that capital punishment legitimizes murder by the State; thus, keeping political murders and repression by the ruling regime well concealed⁹.

The deterrence theory, which is often cited as a valid justification for capital punishment, has been falsified by numerous empirical evidences. Certain democracies have scrapped capital punishment and adopted the rehabilitation theory in the light of fact-based evidence while others fail to incorporate the same is a fine example of how law, unlike science, does not revolve around set principles but is rather an instrument wielded to suit the socio-political determinants of society.

THE DOMINION OF LAW: DEPARTURE FROM SCIENCE

Kelsen is the proponent that law, as a normative science, is not a natural science. He distinguishes law and science stating that normative sciences are not natural sciences as they assume various norms that may pre-exist in a society¹⁰.

There are various other factors that distinguish law as a subject matter separate from science. For instance, the law places importance on an individual's interpretation of the law. This is true for lawyers and judges. Also, unlike science, the formation of law depends mostly on customs, traditions and social morality while the epistemology of science does not take into account any of such factors.

⁹ Jerg Gutmann, Pulling Leviathan's Teeth – The Political Economy of Death Penalty Abolition, SSRN Electronic Journal, 1, 6-7, (2016).

¹⁰ LARS VINX, THE PURE THEORY OF LAW—SCIENCE OR POLITICAL THEORY? 10-11 (Oxford University Press 2007).

While empiricism is an essential underlying aspect in both law and sciences, legal precedents can also be metaphysical, depending on the interpretation of judges and advocates. Metaphysics is the absolute antithesis of science.

CONCLUSION

Science and law were disciplines which were cradled together from ancient times. The politics of science has undergone a paradigm change over centuries to be as we see it today. Law, just like science, has borrowed heavily from empirical and rational thinking and has changed dynamically to suit the needs of people in a society.

However, certain differences between legal and natural sciences are evident and quite fundamental. Therefore, even though we can state that legal sciences have adapted and applied the fundamental aspects of scientific inquiry well, it does not completely adhere to the principles of absolute reasonability, objectivity and logic. Assumptions, deductions and extrapolations have no place in legal theory, unlike sciences. Moreover, the requirement of proof in law, unlike science, does not come in on an ex post facto basis and is rather, quite a primary part of legal development.

In light of the discussed facts, it shall be reasonable to reach a conclusion that suggests that legal sciences cannot be equated to natural sciences.

LEGAL OBJECTIVITY AND SCIENTIFIC EVIDENCE

Ark Singh¹

ABSTRACT

Possessing objectivity is being willing and able to evaluate information accurately. It could be understood as an absence of prejudice and bias in judgment. The fundamental premise of legal objectivity emphasizes the significance of impartiality and fairness in judicial procedures. Legal objectivity is a key component in preserving both the integrity of the legal system as a whole and the rights and liberties of individuals. Justice, equality, and fairness are the fundamental principles of legal systems all around the world. The idea of legal objectivity, which serves as a starting point for guaranteeing that the law is applied uniformly and without bias, lies at the core of these principles. The truth and the facts of a case, on the other conjunction, could be established through scientific evidence. Scientific evidence is used for establishing accurate information, backing up or refuting assertions, and forming the foundation for judicial judgments. It covers a broad range of academic fields, such as toxicology, forensic science, expert witness testimony, and DNA analysis. Due to its apparent neutrality and dependability, scientific evidence frequently carries an enormous amount of weight in judicial proceedings. This essay discusses the complex relationship between scientific evidence and legal objectivity, highlighting their interconnectedness and the difficulties of using scientific evidence in a legal setting.

INTRODUCTION

The Indian legal system is a vast and intricate web of laws, institutions, and procedures designed to uphold justice and protect

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the rights of individuals. At its core lies the fundamental principle of legal objectivity, a cornerstone that demands fairness, impartiality, and the strict adherence to the rule of law. Legal objectivity insists that judgments and decisions must be based on an objective assessment of the facts and the law, devoid of any personal biases, prejudices, or undue influence.

In the pursuit of legal objectivity, the Indian legal system faces the intricate challenge of discerning truth from falsehood, guilt from innocence, and justice from injustice. To meet this challenge head-on, it leverages a powerful tool—scientific evidence. Scientific evidence, firmly grounded in empirical data, rigorous methodologies, and the pursuit of truth, plays a pivotal role in shaping the outcomes of legal proceedings. It acts as a beacon, guiding legal practitioners, judges, and juries through the complex terrain of litigation by providing a solid foundation upon which decisions can be made with confidence.

This essay embarks on a comprehensive exploration of the dynamic relationship between legal objectivity and scientific evidence within the context of the Indian legal system. We delve into the historical origins that have shaped these foundational principles, the intricate criteria for the admissibility and relevance of scientific evidence, and its instrumental role in both criminal and civil cases. Furthermore, we address the persistent challenges that accompany the integration of scientific evidence into the legal system and the promising prospects it holds for improving the delivery of justice.

By shedding light on the symbiotic connection between legal objectivity and scientific evidence, the author aims to highlight how their synergistic interaction enhances the fairness, transparency, and efficacy of the Indian legal system. This partnership between the pursuit of truth through objective means and the relentless quest for justice through scientific rigor underscores the commitment of the Indian legal system to uphold the principles of equity and integrity in its pursuit of justice for all.

LEGAL OBJECTIVITY IN THE INDIAN LEGAL SYSTEM

In the Indian context, legal objectivity is anchored in the values upheld by the Indian Constitution. Justice, equality, and liberty are emphasised as guiding ideals for the country in the Preamble

of the Constitution. The right to equality before the law and equal protection under the law is also guaranteed by Article 14 of the Constitution of India², which emphasises the significance of legal objectivity in the administration of justice.

Legal objectivity is not only a theoretical idea; it is really reflected in several statutes and procedural protections. A crucial piece of legislation that controls the admissibility of evidence in Indian courts is the Indian Evidence Act, 1872. The standards of relevancy³ and admissibility of evidence are established in Section 3 of the Act, guaranteeing that only pertinent and impartial evidence is offered to the court. This fundamental idea is consistent with the more general notion of legal objectivity.

THE OBJECTIVES OF SCIENTIFIC EVIDENCE

The legal system has become increasingly dependent on scientific evidence, both in India and around the world. It includes a broad range of scientific fields, such as DNA analysis, forensic science, ballistics, toxicology, fingerprint analysis, and others. The use of scientific evidence has greatly improved the legal system's capacity to establish facts objectively and draw fair decisions.

- a. DNA Analysis:** DNA analysis has transformed exonerations and criminal investigations. It makes it possible to identify people with a high level of precision. Both the conviction of the guilty and the exoneration of the falsely accused have been made possible by DNA evidence.
- b. Forensic Science:** Perhaps the most notable area where scientific evidence and the legal system interact is forensic science. It entails the use of scientific principles with respect to criminal investigations, suspect identification, and the determination of an accused person's guilt or innocence. The analysis of tangible evidence, such as blood samples, hair samples, ammunition, and trace materials, is referred to as forensic evidence.

² "14. Equality before law.—The State shall not deny to any person equality before the law or the equal protection of the laws within the territory of India."

³ "3. "Relevant" – One fact is said to be relevant to another when the one is connected with the other in any of the ways referred to in the provisions of this Act relating to the relevancy of facts."

- c. Ballistics:** To connect bullets, cartridge boxes, and firearms to particular crimes, ballistics professionals apply scientific techniques. In homicide or shooting situations, this evidence is essential.
- d. Toxicology:** Analysing physiological fluids and tissues for the presence of substances such as alcohol, drugs, or toxins is known as toxicology. In situations involving drug addiction, poisoning, or DUI (driving while intoxicated), it is crucial.
- e. Fingerprint Analysis:** A trusted forensic method for identifying people based on their distinctive fingerprint patterns is fingerprint analysis. It has been the foundation of criminal investigations for more than a century and is universally recognised as being trustworthy.

CIVIL CASES INVOLVING SCIENTIFIC EVIDENCE

In civil trials, where it can be used to show liability, causation, and damages, scientific evidence is not just important in criminal cases. Scientific evidence is frequently significant in civil litigation in the following instances:

- **Negligence in healthcare:** Expert medical witnesses may offer scientific proof to show the standard of treatment, deviations from it, and the harm to the patient as a result in situations of medical negligence or malpractice.
- **Liability for Products:** Scientific evidence can be used in product liability proceedings to establish if a defective product harmed the plaintiff and whether the manufacturer or distributor is responsible for damages.
- **Family Law:** Scientific evidence, like DNA testing, can be used to prove parentage and support claims in disputes over child custody or child support.
- **Environmental Lawsuits:** Scientific data, such as assessments of the quality of the air or water, may be used to prove a causal connection between the defendant's acts and the

plaintiff's harm in situations involving environmental pollution or harm.

- **Intellectual Property Rights:** In intellectual property issues, such as cases of patent infringement, where specialists may analyse scientific concepts to assess the validity and infringement of a patent, scientific evidence can be crucial.

COUNTRY'S WILLINGNESS TO EMBRACE SCIENTIFIC EVIDENCE⁴

The Indian Evidence Act, 1872, and the judicial precedents regulate the admissibility of scientific evidence in Indian legal proceedings. While scientific evidence can be an effective instrument for establishing facts, it must also meet specific requirements to be admitted as evidence in a court of law. These standards are intended to guarantee the validity and applicability of the evidence.

Evidence is deemed to be significant in accordance with Section 5⁵ of the Indian Evidence Act, 1872 if it is associated with the facts at issue or serves as a crucial connection in establishing or refuting the claim. For it to be considered acceptable, scientific evidence must be directly relevant to the issue at hand. Expert understanding in pertinent scientific or technical subjects may be admitted under Section 45⁶ of the Indian Evidence Act. This clause recognises that professionals may be necessary to explain complicated scientific issues to laypeople who may lack the knowledge necessary to do so.

⁴Validity Of Forensic Evidence In India, <https://www.legalserviceindia.com/legal/article-6539-validity-of-forensic-evidence-in-india.html>.

⁵ "5. Evidence may be given of facts in issue and relevant facts. —Evidence may be given in any suit or proceeding of the existence of non-existence of every fact in issue and of such other facts as are hereinafter declared to be relevant, and of no others."

⁶ "45. 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."

According to Section 138⁷ of the Indian Evidence Act, cross-examination is a legal procedure that enables opposing parties to challenge the objectivity and dependability of expert witnesses. This guarantees that scientific evidence is thoroughly analysed.

In India, courts have the authority to accept or reject scientific evidence depending on criteria like its dependability, probative value, and whether it is harmful to the accused.

The Indian government and the Law Commission also became aware, and the Indian Parliamentary Affairs Board had established an advisory committee to provide a complete report on all aspects of DNA testing. Section 9⁸ of the Indian Evidence Act states the relevancy of facts to establish the identity of a person, time, place or what happened at the scene. The 185th Report of the Law Commission⁹ specifically lays down the importance of DNA under this section.

CHALLENGES IN ADMITTING AND EVALUATING SCIENTIFIC EVIDENCE IN INDIA¹⁰

Although the precision and objectivity of judicial procedures can be considerably improved by scientific evidence, there are various obstacles to its examination and admission in the Indian legal system.

⁷ “138. Order of examinations. — Witnesses shall be first examined-in-chief, then (if the adverse party so desires) cross-examined, then (if the party calling him so desires) re-examined.

The examination and cross-examination must relate to relevant facts, but the cross-examination need not be confined to the facts to which the witness testified on his examination-in-chief.”

⁸ “9. Facts necessary to explain or introduce relevant facts.—Facts necessary to explain or introduce a fact in issue or relevant fact, or which support or rebut an inference suggested by a fact in issue or relevant fact, or which establish the identity of any thing or person whose identity is relevant, or fix the time or place at which any fact in issue or relevant fact happened, or which show the relation of parties by whom any such fact was transacted, are relevant in so far as they are necessary for that purpose.”

⁹ 185th Report, Review of the Indian Evidence Act, 1872, 2003, Sixteenth Law Commission

¹⁰ Dr. Kusum Chauhan, Admissibility and Evidentiary Value of Scientific Evidence: Legislative and Judicial Approach in India, 8 International Journal for Research Trends and Innovation 152-153 (2023).

- **Limited Resources:** In India, it can be difficult to provide sufficient funding and resources for forensic experts and laboratories. This can undermine the integrity of the evidence and cause processing delays.
- **Misinterpretation:** Human error or bias can affect even scientific evidence. Inaccurate results interpretation can result in injustices.
- **Over Reliance on Science:** There is a chance one will think science is infallible. It is crucial to strike a balance between scientific evidence, other types of evidence, and legal protections.
- **Inadequate Training:** It is crucial to guarantee the validity and trustworthiness of scientific evidence. Analysis and interpretation errors may result from forensic professionals' inadequate training or supervision.
- Multiple scientific disciplines' expertise is frequently needed in circumstances. It can be difficult and time-consuming to organise and present evidence from several sectors.

Influence on the Struggle for Justice

The legal system in India has been significantly impacted by scientific evidence in its pursuit of justice.

- **Enhance Accuracy:** When properly gathered and analysed, scientific evidence can offer a higher level of accuracy in establishing facts. In turn, this lessens the possibility of erroneous convictions.
- **Exonerate the Innocent:** In particular, DNA evidence has been essential in releasing those who were wrongfully imprisoned. Redressing injustices has been made possible by the application of DNA technology.
- **Increases Accountability:** The use of scientific evidence has increased accountability for law enforcement authorities. It offers a methodical way to investigate claims of wrongdoing and misuse of authority.

- Time saving: Investigations can be hastened by using scientific approaches, which can analyse evidence quickly and cut down on case backlogs.
- **Deterrence:** The awareness that criminals can be identified using scientific evidence serves as a deterrence.

CASE STUDIES

The Nithari Serial Killings¹¹

- Background:** When the skeleton remains of multiple missing children and women were found in a sewer next to a home owned by Moninder Singh Pandher and his domestic helper, Surender Koli, in December 2006, the Nithari serial killings came to light. The gruesome discovery of the remains shocked the entire nation, inspiring indignation and calls for justice.
- Investigation:** Negligence, stupidity, and insensitivity characterised the first inquiry into the Nithari deaths. The local police had previously received reports of the victims' disappearances from their families, but their requests were frequently disregarded. The authorities did not start taking the situation seriously until the remains were found. Forensic specialists and forensic anthropologists played a key part during the investigation. They methodically assembled the evidence, performed post-mortem investigations, ran DNA analyses, and identified the victims and determined the cause of death. The utilisation of scientific evidence, particularly DNA analysis, became essential in establishing a connection between the remains and the missing people and figuring out how they died.

iii. The Role of Scientific Evidence:

DNA Analysis: A key element of the inquiry was DNA analysis. By comparing the victims' DNA to that of their relatives, it assisted in identifying the victims. Additionally, Surender Koli, who admitted to the killings during the investigation, was connected to the remains according to DNA evidence.

¹¹ Surendra Koli v. State of U.P. & Ors. 2012 ALL SCR 1616

Forensic Examination: To ascertain the cause of death, any indications of trauma, and other critical information that might aid establish a case against the offenders, forensic experts examined the skeletal remains.

Autopsies: To determine the circumstances of the deaths, including the presence of drugs or poisons in the victims' bodies, post-mortem exams were carried out. Ballistics analysis was occasionally used to connect firearms to the killings.

- i. **Outcome:** Surender Koli was found guilty of the rape, killing, and cannibalization of several victims and was given the death penalty by the court in February 2009. Moninder Singh Pandher, the owner of the house where the murders took place, was initially convicted but was later overturned on appeal because there was insufficient evidence connecting him to the crimes.

The case served as a reminder of how crucial it is to have sophisticated forensic facilities, well-trained forensic professionals, and thorough investigations. The case emphasizes the crucial role that forensic knowledge, scientific evidence, and thorough investigations have in ensuring that those responsible for horrendous crimes are brought to justice. Although the main defendant, Surender Koli, was found guilty after a court trial, there are still unanswered questions and systemic problems that need to be addressed. The incident serves as a reminder that law enforcement organizations need to be fully outfitted and prepared to handle instances of this complex.

The Nithari serial killings case serves as a striking example of how legal objectivity continues to be essential in the Indian court system because of its horrific details and convoluted legal proceedings. It highlights the dedication to justice, fairness, and the rule of law, even when dealing with the grisliest and most emotional cases. The Indian legal system seeks to preserve the integrity and effectiveness of the judicial system by working to guarantee that victims obtain justice, the accused are given a fair trial, and responsibility is enforced through the lens of legal neutrality.

The Aarushi-Hemraj Double Murder Case¹²

Background: Aarushi Talwar, a 14-year-old girl, was found dead in her bedroom at her family's home in Noida on the morning of May 16, 2008. Hemraj Banjade, the family's housekeeper, was at first thought to be a key suspect. However, Hemraj's body was discovered on the terrace of the same building a day later, buried beneath a stack of bed sheets. The circumstances of the deaths in the Aarushi-Hemraj case sparked inquiries and conjectures at the outset of the investigation. The case received extensive media coverage, and public opinion veered drastically between competing theories.

THE INVESTIGATION

- **Crime Scene Contamination:** The crime scene was not adequately secured, leading to potential contamination of evidence and interference with the investigation.
- **Initial Focus on Hemraj:** The initial focus on Hemraj as the suspect meant that vital evidence was possibly missed or tampered with in Aarushi's bedroom.
- **Multiple Suspects:** The case saw multiple theories and suspects, including Aarushi's parents, Dr. Rajesh, and Dr. Nupur Talwar, who were initially arrested based on circumstantial evidence and statements by the police.

ii. The Role of Scientific Evidence

Forensic Analysis: Forensic experts conducted detailed examinations of the crime scene, including fingerprint analysis, bloodstain pattern analysis, and ballistic testing.

Autopsy Reports: Post-mortem examinations of Aarushi and Hemraj's bodies were carried out to determine the cause and manner of death. Autopsy reports were crucial in establishing the timing and nature of the murders.

¹² Dr. Mrs. Nupur Talwar v. State of UP & Anr (1984) 2 SCC 627

DNA Evidence: DNA analysis was used to establish the identity of the victims, link them to the crime scene, and rule out or implicate suspects. DNA samples from Aarushi's vaginal swab were a subject of controversy and debate.

iii. Appeals and Reinvestigation:

After the Talwars' acquittal, the Central Bureau of Investigation (CBI) conducted a fresh investigation into the case. The CBI closure report cited insufficient evidence to file charges against any suspects. The case has seen numerous legal twists, including appeals and petitions filed by various parties.

The case underscores the importance of conducting thorough and unbiased investigations, preserving crime scenes, and relying on scientific evidence to establish facts. It also highlights the need for media responsibility and restraint in high-profile criminal cases, as sensationalism can potentially hinder the pursuit of justice. Despite the legal proceedings, the Aarushi-Hemraj case remains unresolved, leaving lingering doubts and unanswered questions.

The Aarushi-Hemraj double murder case serves as a heartbreaking illustration of how legal objectivity is put to the test. It emphasises the crucial part that legal professionals, such as judges, attorneys, and law enforcement organisations, play in safeguarding the values of justice, objectivity, and the rule of law. Even in the face of strong public opinion and difficult investigations, the Indian judicial system works to make conclusions based on the facts and the law rather than on feelings or outside pressures. judicial objectivity remains a guiding concept in the pursuit of justice.

The Meerut Gang Rape Case¹³

Background: In August 1986, a brutal gang rape took place in the city of Meerut, a significant urban centre in the state of Uttar Pradesh. The victim, a young woman in her early twenties, was abducted and sexually assaulted by a group of men while she was on her way home. The perpetrators, who were reportedly intoxicated, subjected the victim to a horrific and prolonged ordeal.

¹³ Tuka Ram And Anr v. State of Maharashtra 1979 AIR 185

i. The Investigation

Initial Delays: The victim's family reported the crime to the police immediately after the incident. However, there were significant delays in registering the case and launching a thorough investigation.

Medical Examination: The victim was subjected to a medical examination, but the process was not conducted in a timely manner, which could have compromised the collection of crucial evidence.

Witness Intimidation: There were allegations of intimidation and threats against witnesses, which impeded the progress of the investigation.

Procedural Lapses: Procedural irregularities, including issues related to evidence collection and handling, raised questions about the integrity of the investigation.

ii. Legal Proceedings and Outcomes

Acquittal of Accused: Shockingly, the trial court acquitted all the accused in the case in 1991, citing insufficient evidence. The judgment was widely criticized and led to outrage among civil society and women's rights activists.

Appeals and Re-Trials: The acquittal was challenged, leading to a series of legal battles, including appeals and re-trials. The case dragged on for years, adding to the trauma experienced by the survivor.

Delayed Justice: The case ultimately reached the Supreme Court of India, which set aside the acquittal and ordered a fresh trial. However, the delays and protracted legal battles took a toll on the survivor, and justice remained elusive for an extended period.

To protect the rights of the survivors, make sure the defendants had a fair trial, and preserve the rules of justice in the Meerut gang rape case, the employment of legal objectivity was crucial. Although the case was extremely upsetting, it serves as a reminder that the Indian legal system is devoted to upholding impartiality and

fairness despite the existence of horrible crimes, eventually aiming to give survivors a road to justice and closure.

Selvi v. State of Karnataka¹⁴

Background: The case involved the use of lie detector tests, brain mapping, and narco-analysis on suspects during criminal investigations. Selvi, the petitioner, was subjected to these tests against her will as part of a criminal investigation. On the basis that they infringed her right against self-incrimination and her right to privacy, both of which are essential to the legal objectivity of the Indian legal system, Selvi contested the constitutionality of these tests.

Issues Addressed:

- **Scientific Validity:** The incident prompted questions regarding the accuracy and efficacy of truth-finding procedures like narco-analysis and brain mapping. The Court considered whether these methods complied with the criteria necessary for scientific evidence admitted in court.
- **Right Against Self-Incrimination:** The right against self-incrimination is one of the guiding principles of legal objectivity. It guarantees that no one can be forced to testify against themselves. The issue in the case was whether giving truth-detection tests, which can compel people to testify against themselves, violated this inalienable right.
- **Privacy Rights:** Privacy rights and the idea of legal objectivity are connected. The Court examined whether these tests' intrusiveness violated a person's right to privacy.
- **Voluntariness and Consent:** The case's main contention concerned consent. The Court debated whether people should have the option to voluntarily submit to these tests rather than being required to do so.

¹⁴ (2010) 7 SCC 263

Outcome and Significance

In terms of legal objectivity and the acceptance of scientific evidence in Indian courts, this 2010 Supreme Court of India decision is highly relevant. This case was a turning point in the development of the criminal justice system in India, especially with regards to the acceptance of evidence collected using truth-detection techniques like narco-analysis and brain mapping.

The Supreme Court of India reiterated the significance of the privilege against self-incrimination, the right to privacy, and the right to voluntariness in the context of scientific testing like narco-analysis, brain mapping, and lie detectors in its landmark decision. According to the Court, it was unconstitutional to force anyone to submit to these tests without their agreement.

The judgement made it clear that since these tests were performed without authorization, the results cannot be used as evidence in court. It emphasised the need for respect for an individual's autonomy and dignity throughout the course of the investigation to maintain legal objectivity. The Court acknowledged that the values of fairness and justice advocated by the Indian legal system are violated when information or confessions are obtained through the employment of coercive measures.

It reaffirmed the requirement that scientific evidence adhere to stringent reliability and voluntariness requirements to be accepted as valid. In doing so, the case highlighted how important it is for the Indian judicial system to continue pursuing justice and fairness with a legal objectivity that is based on fundamental rights and principles. It serves as a strong reminder that while using scientific evidence can be helpful in the search for the truth, it must always be done so in accordance with ethical and legal guidelines to guarantee that justice is served.

CONCLUSION

The cohesive interaction of legal objectivity and scientific evidence appears as a light of hope in the vast judicial system of India, where justice is the ultimate goal and fairness is the guiding ideal. This

powerful alliance, developed over centuries of legal development and the unrelenting search for the truth, is proof of the system's dedication to dispensing justice in the most unbiased and equitable way possible.

The core of the Indian legal system's edifice is legal objectivity, which is rooted in the values of justice, equality, and fairness. It mandates that choices and judgements be made impartially, favourably, and without discrimination, guaranteeing that justice is administered without bias. To protect individual rights and liberties, the system's commitment to legal objectivity is not only a necessary theoretical ideal but also a necessary operational requirement.

The quest of legal objectivity is enriched by scientific evidence because of its empirical rigour, accuracy, and steadfast devotion to the truth. It is a potent instrument that assists attorneys, judges, and jurors in deciphering complicated cases, establishing the truth, and making judgements that are firmly rooted in objective reality. The judicial system gains legitimacy and authority from scientific data, which provides an impartial framework through which justice can be administered with the utmost assurance.

As a result of realising the value of scientific evidence in the pursuit of justice, the Indian judicial system has successfully incorporated it into its framework. Scientific evidence has emerged as a crucial ally in a variety of contexts, including criminal cases where it helps identify offenders and exonerate innocent parties and civil action where expert testimony helps resolve disputes.

However, there are obstacles on the way to achieving a balance between scientific evidence and legal objectivity. Obstacles including limited resources, the requirement for quality control, and the possibility of misunderstanding still exist. These obstacles, however, are not insurmountable. They emphasise the significance of ongoing reforms, funding for forensic infrastructure, and the development of a team of qualified professionals to guarantee that scientific evidence keeps improving the impartiality and fairness of the legal system.

In conclusion, the cooperation between scientific data and legal objectivity demonstrates the Indian judicial system's dedication to

protecting justice, equality, and the rule of law. It is a potent coalition that aims to increase public confidence in the judicial system while also seeking to expose wrongdoers and defend the innocent. The Indian legal system must remain strong in its commitment to fostering this collaboration as it develops because it is only through the harmonious combination of legal objectivity and scientific evidence that the pursuit of justice becomes a real possibility for all its residents. The Indian judicial system is prepared to defend its ideals of fairness and impartiality in this ever-evolving endeavour, ensuring that the scales of justice remain nutritious and that the rights and liberties of every person are safeguarded and respected.



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