SCIENTIFIC ART OF UNCOVERING THE TRUTH BY BRIDGING JUSTICE AND SCIENCE-SHINE THE TRUTH

Abstract

Forensic science, untapped history, occupies a unique niche between law enforcement and the courts. Interpret the nature of evidence is analyzed through investigation in the reconstruction of the context of one way street criminal evidence. Fingerprint and DNA analysis(bloodstain patterns, firearms, ballistics, and toxicology) to the “ologies”-anthropology, entomology, and pathology, wildlife forensic compile in forensic science. The universal symbol of forensic science, “microscope” which is strongly modified to explore the depth of crime, reasons of criminal motivation and legal address to investigative questions study is the aim of criminal justice. Both ultraviolet (visible light),Ramman and infrared (IR) lights which help to promote absorption light of higher energy label and atomic bond of molecule are important sources of beam of light in forensic criminology. During autopsies study diseases, the interpretation taphonomic of information and trauma by the forensic odontologists and anthropologists know biological profile of skeleton which leads to identify of victim. Forensic entomologist is identified insects associate death and time of death and crime intersect (drugs, poisons, and location of stolen goods like paint, glass, hair, fiber, soil, impression). Biological evident through DNA fingerprint or 10 million profiling DNA (Combined DNA Indexing System) which is visualized by radio labeling or chemilunescence identify by restriction fragment length polymorphism (RFLP).The major effect of stimulants, depressant, narcotics, hallucinogen are represent by Illicit drugs (cocaine, heroin etc), alcohol are separate of

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stationary and mobile phase of molecule by both electrophoresis and chromatography by toxicologist to find cause of death.

Keywords: bloodstain patterns, firearms, ballistics, CODIS, radio labeling, RFLP, hallucinogen.

"In reality, those rare few cases with good forensic evidence are the ones that make it to court".

-Pat Brown.

I. INTRODUCTION

Beside both fingerprints and DNA analyses, In a variety of fields of study, including forensics, engineering (mechanical, electrical, and chemical), and fire science, hyperspectral imaging (HSI) has tremendous potential for detecting, visualizing, identifying, and estimating age at the identification of crime victims or the perpetrators. Criminal investigation, dating back to 1700 BCE, is rooted in the Code of Hammurabi, which allows both the accuser and the accused to present their collected evidence. [1]. Mass spectroscopy (MS) plays a crucial role in detecting, determining, and structurally analyzing samples in analytical chemistry and biochemistry.

Forensic electrochemistry, specifically potentiometric and potentiostatic methods, extends the field of electroanalytical chemistry by focusing on the identification of chemical substances associated with crime scenes. In the context of forensic investigations involving firearms, the collection of data related to gunshot residue (GSR) serves multiple purposes, including estimating firing distances, identifying bullet entry points, and, most importantly, determining whether a suspect discharged a firearm. This development has amplified the significance of forensic science in criminal investigations, particularly in cases involving homicides and violent crimes.

The analysis of GSR aims to identify inorganic and organic constituents such as barium, lead, and antimony, with chemometric techniques that involve the use of square wave voltammetry (SWV), scanning electron microscopy (SEM), and energy dispersion X-ray (EDX) for the treatment of analytical data. Furthermore, the application of cyborg technology represents the fusion of human cognition and technological advancements.

The criminal justice system based on Forensic chemical/biochemical analysis tool that are based subarea of forensic analysis, forensic serology (combine of immunoassays and DNA/RNA analysis), which identify on the type of sample, age, origin, or sex from biological fluids found at a crime scene. A mixture of endogenous and exogenous DNA analysis and PCR inhibitor from durable tissues of bone identify of individuals in crime scenes. The detection of DNA polymorphisms through molecular genetics techniques involves several key pathways for repairing DNA damage. These pathways include base excision repair (BER), nucleotide excision repair (NER), single strand break repair (SSBR), mismatch repair (MMR), direct reversal utilizing photolyases' photoreactivation activity, recombination and rejoining pathways, as well as tolerance via translesion synthesis (TLS). Various tools, such as scanning electron microscopes (SEM), Fourier transform infrared (FTIR), UV/visible micro spectrophotometry (MSP), Pyrolysis Gas Chromatography/Mass Spectrometry (PGC), Raman spectroscopy, X-ray diffraction (XRD), and other instruments, are employed to evaluate forensic trace elements. Additionally, there is a focus on biometric indicator spoofing, which pertains to attacks on automated biometric recognition systems utilizing live scan technology, with an emphasis on the development of anti-spoofing or liveness detection mechanisms that are operationally feasible.

II. ORIGIN OF CRIMINOLOGY

Criminology represents an interdisciplinary exploration of crime and deviant behavior, with its roots extending over 200 years ago, originating from the realms of criminal justice and penal systems. Cesare Beccaria, as exemplified by the National Criminal Justice Reference Service, authored "On Crime and Punishments" in 1764, advocating for punishments commensurate with the gravity of the offense.

Throughout the 20th century, criminology evolved, focusing on comprehending the causes of crime through the analysis of sociological, psychological, and economic factors. In "New Criminology," J. Rank introduced the perspective of conflicts between social and economic classes as catalysts for societal unrest.

Criminologists employ a multidisciplinary approach to understand the motives behind criminal behavior, encompassing factors such as greed, anger, jealousy, pride, emotions, a desire for control, revenge, power, and materialistic gains, among others. Potential contributors to criminal activity include aspects like parental relationships, heredity, brain function, hormonal influences, education, peer pressure, substance abuse, and the presence of easy opportunities.

Figure 1: Criminal Justice.

Figure 2: Criminology VS Criminalistics

1. **Criminology and the Legal Perspective:** Criminologists primarily concentrate on understanding the underlying factors contributing to illegal actions that are subject to legal sanctions within a society. This focus includes both the prevention and correction of criminal behavior. In contrast, Criminalists, as per J. Rank's report, do not partake in activities that are illicit, such as economic exploitation, racial discrimination, or creating unsafe working conditions. The field of criminology largely relies on sociological and psychological theories for its foundation. The Classical, Positivist and Chicago schools are three predominate theories are bases on Bentham’s Utilitarianism theory, applies scientific theory of criminology and social disorganization.

2. **Criminology and Criminal Justice:** Criminal justice develop by criminologists which is the application of enforcing of laws and investigating crimes to punish and rehabilitation of criminals. Criminology and Criminal justice are working together to against the crime. The goal of the Criminologists to addressing crime, victimization and relate governmental agendas and generate information.

In general difference between Detective and FBI (Federal Bureau of Investigation) Agent. [Sources: Pay Scale, U.S Bureau of Labor Statistics.]

Detective	FBI
Collect and analyze evidence in criminal investigations.	Investigate terrorism, organized crime, and other major crimes.
Interview suspects and witnesses.	Work with officials in local, state, and federal agencies.
Analyze archival records.	Analyze criminal data and maintain it in databases.

In general difference between Criminologist and Forensic Scientist.[Sources: Pay Scale, U.S Bureau of Labor Statistics.]

Criminologist	Forensic Scientist
Conduct research on crimes and criminals.	Collect analyze physical evidence of crimes.
Identify causes of and solutions to crime.	Work at crime sites and criminal labs.
Predict crimes and suggest preventive measures.	Testify as an expert withness.

III. DIFFERENT KINDS OF WEAPONS AND/OR TOOLS IN CRIME

The most common weapons used for homicides include a range of items, such as ballistics, projectiles, slings, bows, catapults, rockets, and tools for forensic examination like fingerprint and serial number recovery. In addition to these, there are various firearms like handguns, rifles, shotguns, and knives, as well as the use of body parts such as fists or feet. Moreover, certain toxic substances, including nitroaromatic explosives like TNT(2,4,6-trinitrotoluene) and tetryl,(2,4,6, N-tetranitro-N-methyl aniline) nitrate esters such as ethylene glycol dinitrate (EGDN), glycerol trinitrate (nitroglycerin, NG), and pentaerythritol tetranitrate (PETN). nitramine explosives, such as 1,3,5- trinitro-1,3,5-triazacyclohexane, (RDX) and 1,3,5,7-tetranitro-1,3,5,7- tetrazacyclooctane (HMX), as well as mixtures containing one or more of these explosives. Triacetone triperoxide (TATP) and ammonium nitrate (AN) $NH_4 NO_3$ [2] are further explosives. All explosives are toxic in nature.

1. **Ballistics:** Ballistic means "**to throw**". Ballistics encompasses the field of mechanics that addresses the launching, flight characteristics, and impact consequences of projectiles, particularly in the context of ranged weapon munitions such as bullets, unguided bombs, rockets, and similar items. It also involves the science and art of crafting and propelling projectiles to attain specific objectives. [3]. A ballistic object is a freely moving entity possessing momentum, subject to various forces, including those generated by rifling, compressed gases discharged from a firearm's barrel or a propulsion nozzle, the influence of gravity, and aerodynamic resistance during its flight.. [3]. Only ballistic missiles are used for trajectory guidance during the very brief initial phase of powered flight, after which the trajectory is controlled by the principles of classical physics.

Around 64,000 years ago, in Sibudu Cave, located in modern-day South Africa, stones, spears, and thrown sticks served as ballistic projectiles. Subsequently, in 1000 AD in China, missile technology began to emerge, with the 12th century marking the discovery of the first missiles, followed by the spread of this technology across Asia by the 13th century. [4].

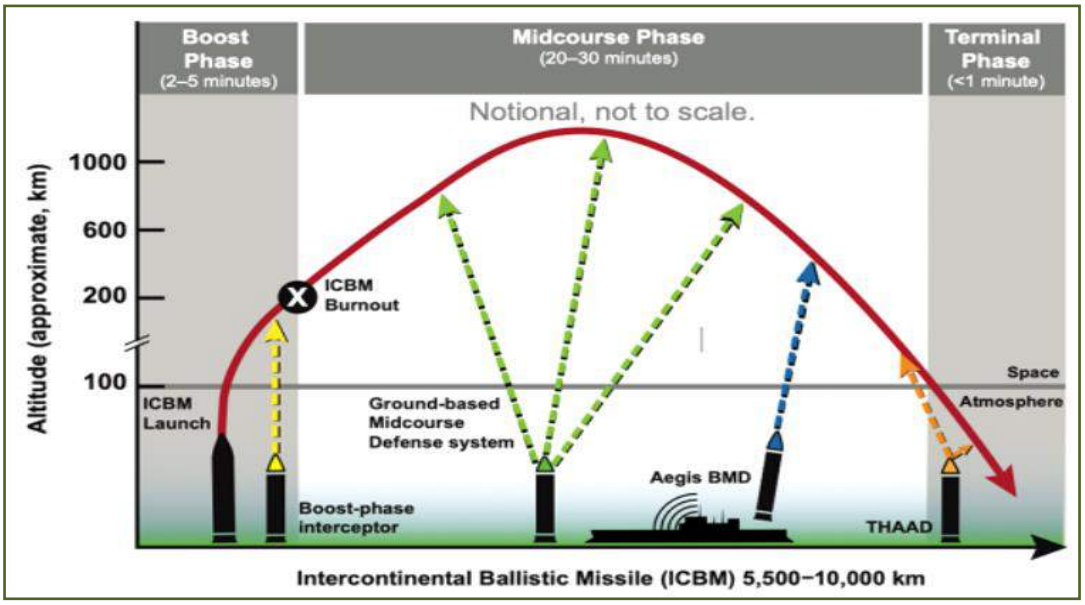
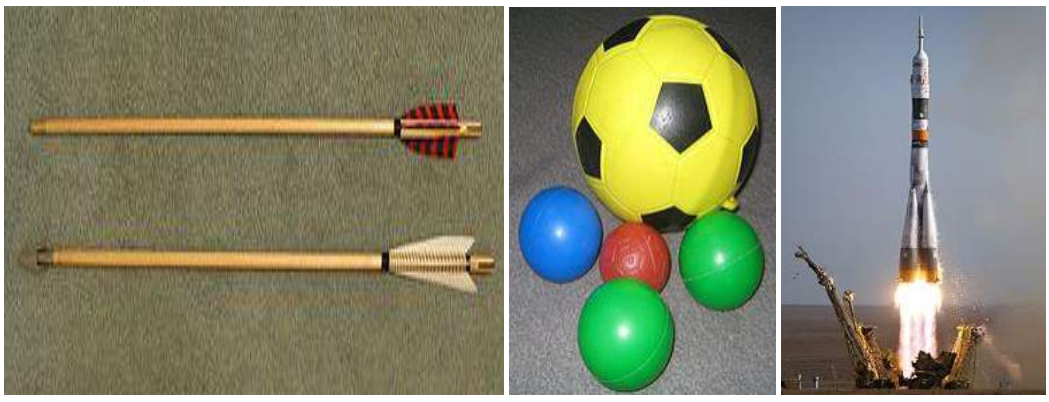


Figure 3: U-M Physics Researcher Co-Chairs Ballistic Missile Defense Report.

Ballistics was throwing on solid equipment which acts in scientific and mathematic basis discovered by Sir Isaac Newton, which was published of famous book "Phikosophiae Naturalis Mathematica" on 1687. It is fully depend on laws of motion and gravity.

2. **Projectiles:** Any object that is launched into space by applying force, whether the space is empty or not, is considered a projectile. Although any object traveling through space (such as a baseball thrown) qualifies as a projectile, the phrase is most frequently used to describe a ranged weapon. Projectile trajectory is examined using mathematical equations of motion. e.g. arrows, bullets, artillery shells, balls, wingless rockets etc [5].



(i) **(ii)** **(iii)**

(iv) **(v)**

Figure 4: Projectiles- (i)Arrows, (ii)Balls, (iii)Wingless rockets, (iv)Artillery shells, (v)Bullets.

Figure 5: Types of Projectile Launcher.

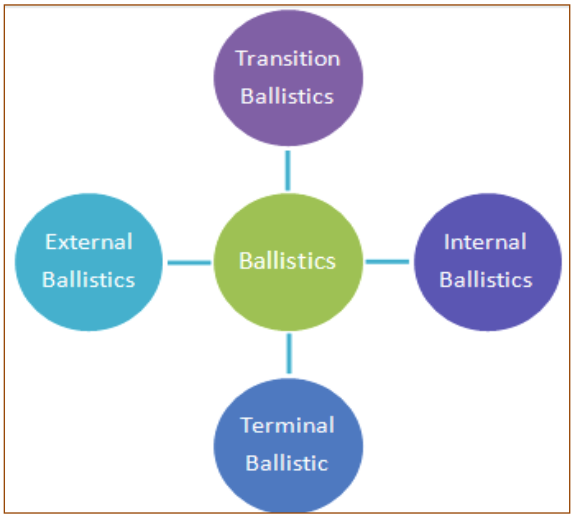


Figure 6: Categories of Ballistics.

Projectiles Launcher:

- **Throwing:** One of the projectile launchers by hand is throwing. When comparing projectile throwing speeds between athletes and chimps, athletes can reach speeds of up to 90 mph, whereas chimpanzees can only reach speeds of 20 mph [6]. This proficiency could indicate the capacity of human shoulder muscles and tendons to retain flexibility until the moment when they are needed to manipulate an object. . [6].

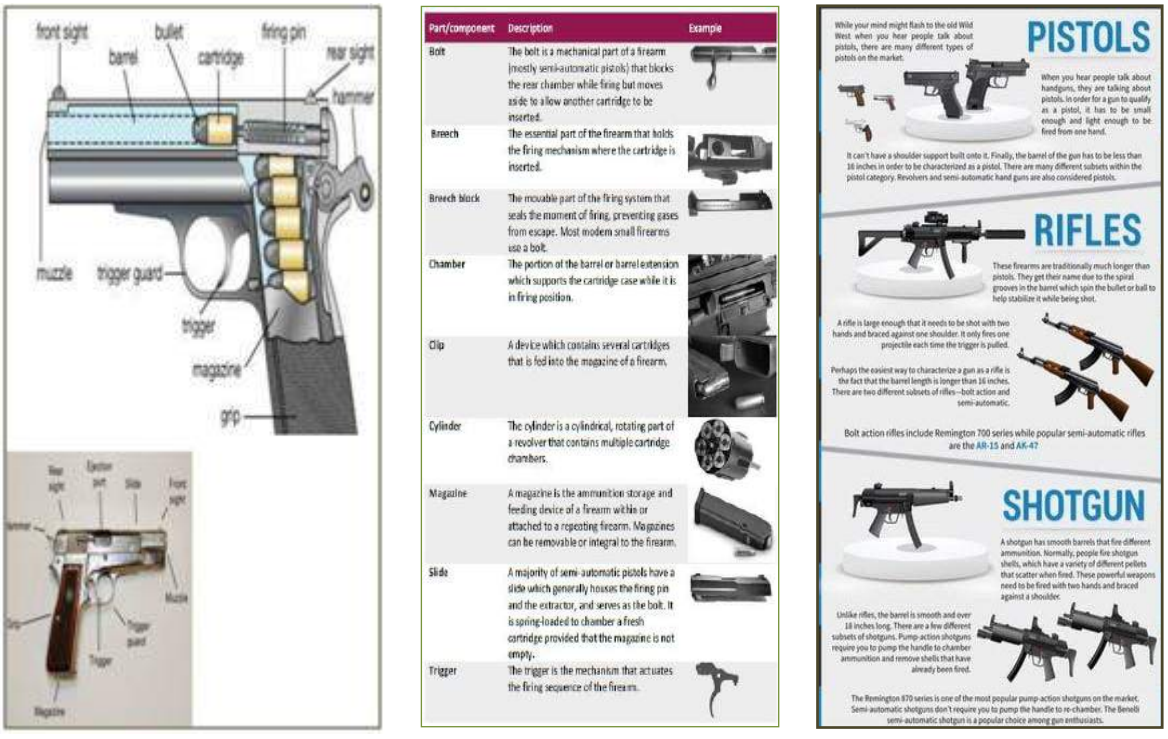
- **Sling:** A sling, a projectile weapon, involves launching a stone or another object using a small, blunt cradle or pouch suspended between two lengths of cord. The "sling bullet," typically made of stone, clay, or lead, is positioned with the middle finger or thumb. The sling is swung in an arc, releasing the projectile to travel toward the target.

- **Bow and Arrow:** A flexible piece of material called a bow is used to launch arrows, which are aerodynamic projectiles. A string connects the two extremities of the stick, and as the string is drawn back, the stick's ends bend. The potential energy stored in the bent bow is transformed into the arrow's speed upon releasing the string. This activity of shooting arrows using bows is referred to as archery. [7].

- **Catapult:** Without the use of explosives, a projectile can be launched a long distance with the use of a catapult, which was very useful for numerous ancient and medieval siege engines. Due to its exceptional effectiveness in warfare, the catapult has been utilized since ancient times. [3]. The word “catapult” means 'Kata' means "against," and 'pallō' means "to throw or hurl."

- **Gun:** This firearm projection varies according to design but is usually affected by the action of gas pressure. The projection of this firearm is influenced by the design, typically by the action of gas pressure. Often identified as a ballistician, a weapon engineer or armorer who designs cartridges using the scientific principles of ballistics [8].

There are three categories of firearms. These are (i)Handguns – includes pistols, revolvers and derringers,(ii) Long Guns – includes rifles and shotguns, and (iii) Mounted Guns – includes cannons and anti-aircraft gun.



(i) (ii) (iii)

Figure 7: (i) Up=Pistol; Down=Rifle. (ii) Parts of Firearm. (iii)Different types of Guns.

When experts examine guns, they look for important clues like the special number on the gun and fingerprints that might be on it.

3. **Rocket:** A rocket refers to any vehicle, be it a missile, spacecraft, airplane, or any other type of conveyance that utilizes a rocket engine for propulsion. Propellers carried by the rocket before use are used to make all of the rocket engine exhaust [9]. Rocket engines propel light and powerful rockets forward by simply hurling their exhaust backwards at a high rate of speed. At least since the 13th century in China, rockets have been used for both military and civilian purposes. Although rocket are used for fireworks, weaponry, launch vehicles, satellite, human spaceflight but rocket engineer needs to make sure being safe and avoiding any dangers when they take the time to plan, try things out, build things carefully, and use them accurately.

Figure 8: (i) Throwing (ii) Sling (iii) Catapult (iv)Gun

Subfields of Ballistics: There are several distinct times in the journey of the Ballistics is further classified into four subfields. These are:- (a) Internal Ballistics, (b) Transitional Ballistics, (c) External Ballistics, (d)Terminal Ballistics.

- **Internal Ballistics:** Internal ballistics (also Interior ballistics encompasses the period from when the firing pin strikes the primer to the point when the bullet exits the barrel.), Internal ballistics is a type of science that looks at how things are shot out of guns. It focuses on what happens from when the gunpowder is lit to when the bullet leaves the gun [11] .e.g. From small-caliber rifles and handguns to advanced high-tech artillery.

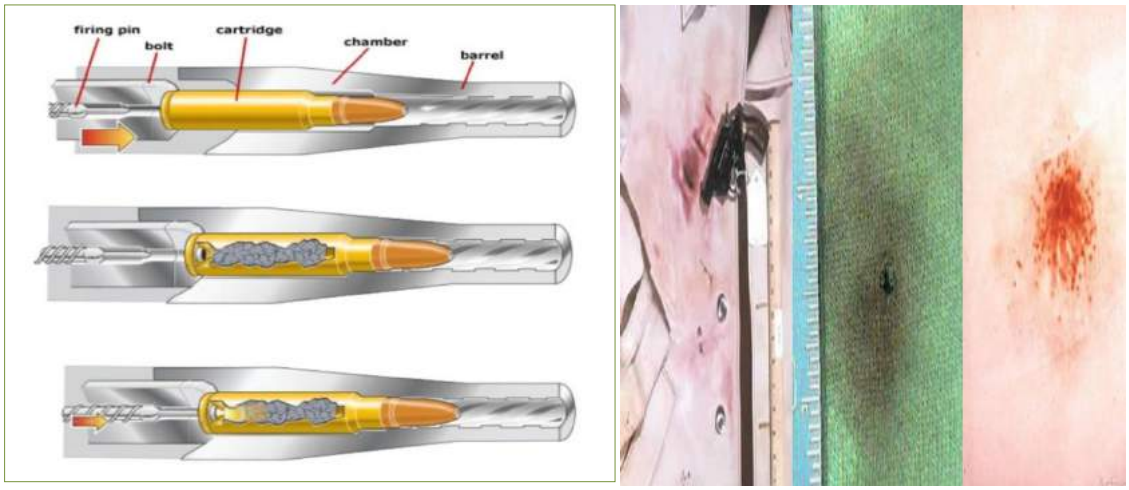


Figure 9: (i) Mechanism of firing process. (ii) Residue on clothing.

Mechanism of Firing Process: The firing pin is released when the trigger is pulled rearward, causing it to forcefully move forward. As the firing pin comes into contact with it, the primer initiates ignition. The gunpowder within the cartridge rapidly expands upon being ignited by the primer's spark. The expanding gas swiftly propels the bullet out of the cartridge and down the barrel. As the bullet exits the barrel, it acquires a spin from the rifling. The bullet's velocity and the discharge of gases generate a characteristic "bang" sound.

From the National Integrated Ballistics Information Network (NIBIN), the Data Base of Firearm Information is formed with combine of the FBI and the ATF&E are two systems on 1999. NIBIN system has over 800,000 computerized images.

The spread of a shot pattern (shotgun) or the distribution of powder patterns, which are reciprocal of distance and gunpowder residue, determines the distance between weapons and their target. Victim’s cloth is chemically tested for gunshot residue to confirm of determine the distance by the ‘Griess Test’ or using Barium and Antimny components. Ganshot residue (GSR) is the strong evidence of victim stay for approximately 2 hours by washing or wiping the hands on the thumb web and the back of the firing hand. Collection and preservation of firearms evidence keep safely for forensic experiment.

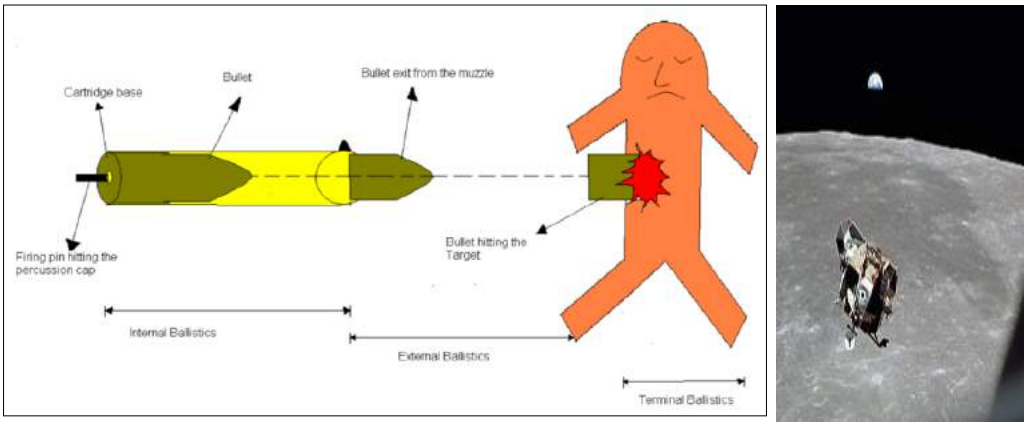
- **Transitional Ballistics:** Intermediate ballistics, also known as transitional ballistics [12], involves examining how a projectile behaves from the moment it exits the muzzle until the pressure behind the projectile is balanced. [13]. Therefore, it occupies a position between internal ballistics and external ballistics.

- **External Ballistics:** The study of external ballistics focuses on the flight behavior of unpowered projectiles. It is a firearm designed to manage the bullet's unassisted trajectory after exiting the barrel but before hitting the target.

- **Terminal Ballistics:** Terminal ballistics pertains to the actions and consequences of a projectile upon striking its intended target, especially in cases involving extremely high-velocity impacts.

IV. APPLICATION

1. **Forensic Ballistic:** Forensic ballistics refers to the examination of bullets and gunshot impacts to gather pertinent information for use in legal proceedings, such as court cases. Separate from ballistics data, firearm and tool mark exams (also known as "ballistic fingerprinting") entail examining ammunition, tool, and firearm marks to determine whether a certain weapon or tool was used to commit a crime [14].



(i) (ii)

Figure10: (i) Forensic Ballistic. (ii) Astrodynamics

2. **Astrodynamics:** The practical issues pertaining to the motion of rockets and other spacecraft are addressed by the astrodynamics, which applies celestial mechanics and ballistics to these issues. Newton's equations of motion and his universal law of gravitation are commonly employed for calculating the movement of these objectives.. It is a fundamental field in the design and management of space missions.

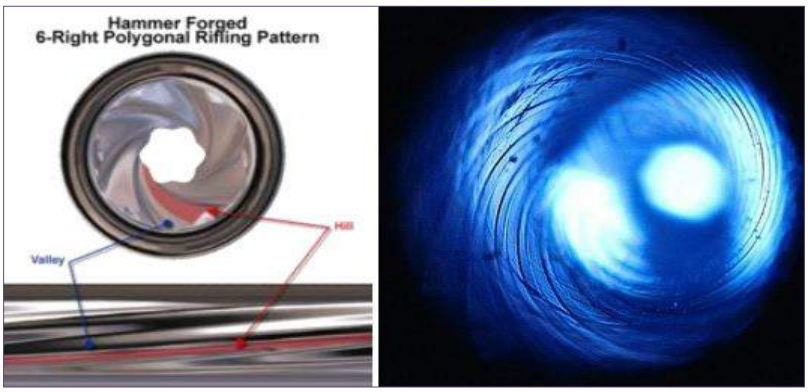
3. **Fingerprint Recovery:** Cyanoacrylate commonly name superglue is used to recover fingerprint from the surface of firearms which is placed spirally designed fume hood without touch any think. As long as liquid superglue transitions into a gaseous state, the fumes in circulation bond with the oils remaining from the fingerprint. This results in the fingerprint appearing white, and it can be improved with fingerprint powder to create a sharp contrast against the weapon's surface.

   Gathering evidence from firearms can be challenging due to the textured grip and overall shape, making it difficult to trace fingerprints on the surfaces of weapons. .It also processes the Striate databases, e.g. Integrated Automated Fingerprint Identification System(IAFIS). By the southern blotting DNA is analyzed and reache to victim.

4. **Serial Number Recovery or Restoration:** In cases where the manufacturer's recognition has been obscured, forensic science employs both physical (electrolytic, ultrasonic cavitation etching, magnetic particle, and heat treatment) and chemical scientific techniques for serial number restoration (= determining out how to conceal the identity of the numbered item). The recovery of a serial number can supply law enforcement agencies with valuable details regarding a firearm or another item, potentially providing a crucial lead in an investigation. During the magnetic particle inspection process, ultraviolet (UV) light may be employed to enhance the visibility of any retrieved serial number, particularly when fluorescent particles are introduced into the ferrous solution. [15]. Only when the serial number has been only slightly concealed in depth may chemical restoration be successful. Fry's Reagent, comprising hydrochloric acid, cupric chloride, and distilled water, is employed for magnetic metals and is utilized by the examiner to methodically reveal the concealed number on the surface. For non-magnetic, non-aluminum substances, the examiner can choose an acidic ferric chloride solution.

5. **Examination of Cartridges:** The examination of the cartridge relies on the unique tool marks imprinted by various components of the firearm, such as the ejector and firing pin found in semi-automatic and fully automatic firearms. By utilizing identical components, it is possible to inspect and align these markings with fired exemplars from the same firearm.. To identify potentially usable fingerprints for comparison with known exemplars in fingerprint databases like IAFIS, fingerprint samples are obtained by fume-treating cartridges with cyanoacrylate, followed by examination and photography [16].

(i)



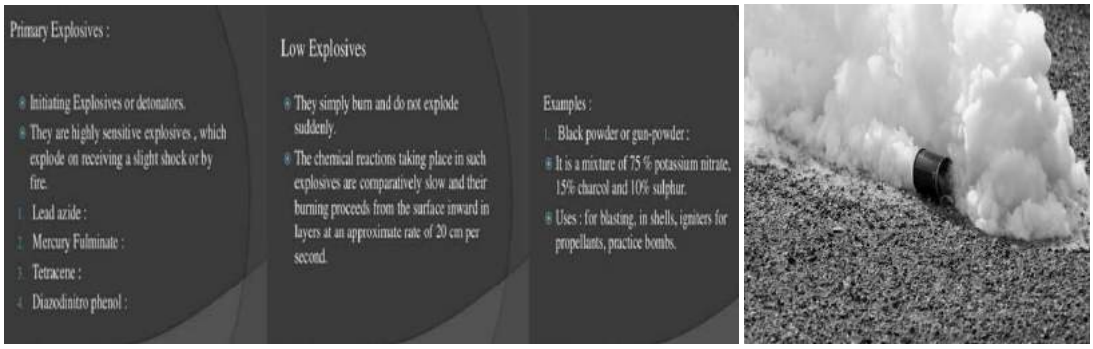
(ii)

Figure 11: (i) Illustration of microstamping. In the insert, a close-up of the cartridge's serial number is displayed. (ii) Remington rifle rifling pattern with a right-handed (clockwise) twist.

6. **Qualities of a Class and an Individual:** The make and model of the weapon is different into class characteristic and it classified into three, (a) The lands and grooves in the barrel, which consist of raised areas and indentations formed during the rifling process,(b) the bullet caliber, and (iii) the rifling twist. All three can be tied directly and used in bullet. The twist denotes the spinning direction of the rifling within the barrel, which may be either in a clockwise direction (for right-handed shooters) or counterclockwise (for left-handed shooters).To compare accurate striations, examiners must use the confiscated weapon to take a known sample. Shooting the weapon into a water tank produces known bullet exemplars, which are used for slower-moving bullets like those from revolvers or pistols. [17].

7. **Chemical Warfare and Nerve Agents:** The most powerful synthetic organophosphorus compounds with extreme toxicity are employed as nerve agent gases. Exposure often occurs through contact with the skin. since nerve agents are liquids at room temperature that easily permeate the skin and reach the bloodstream [18]. Inhaling highly toxic nerve agent vapors and aerosol droplets is an alternate route of exposure, and the onset of effects can vary from seconds to hours or days, contingent on the exposure level and method. When a nerve agent disrupts the nervous system, triggering a cholinergic crisis, it activates the enzyme acetyl cholinesterase, responsible for breaking down acetylcholine (Ach) in the synapses that control muscle tissue.

During World War I, chemical weapons were primarily employed to debilitate, injure, and fatally affect well-entrenched defenders, for whom the indiscriminate and often static characteristics of gas clouds would be most efficient [18] .Tear gas, mustard gas, lethal agent like phosgene and chlorine etc. are using in chemical warfare widely.



(i) (ii)

Figure 12: (i) Primary Explosive. (ii) Tear Gas.

After releasing of explosive material has great potential energy, which produces light, heat, sound, and pressure. Some chemicals, like dust, powders, gases, or volatile organic liquids, may not exhibit explosive properties under particular conditions or in specific states, such as when adequately protected, when dispersed as airborne clouds, or when rapidly released.. [19].

- **Primary Explosive:** Within blasting caps and percussion caps, primary explosives are frequently utilized to transmit a physical shock signal [20]. To start a larger explosive charge that is typically safer to handle, only a little amount, typically milligrams, is required. [21]. Example: Compounds such as benzoyl peroxide, benzvalene, 3,5-bis(trinitromethyl)tetrazole, acetone peroxide, alkali metal ozonide, ammonium chlorate, ammonium permanganate, azoclathrates, azidotetrazolates, chlorine in its oxidized form, copper(I) acetylide, copper(II) azide, hydrogen peroxide cumene, various halogen azoles (including fluorine, chlorine, bromine, and iodine azides), triamethylene hexamethylene diamine, hypofluorous acid, hydrazoic acid, lead picrate, lead styphnate, and lead azide, heptoxide of manganese, and xenon oxides, including tetroxide, oxytetrafluoride, and dioxide.

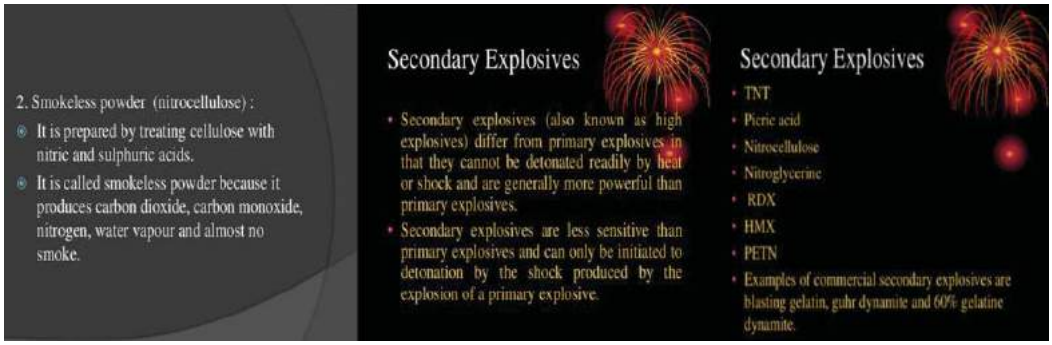


Figure 13: Secondary Explosives.

- **Secondary Explosives:** In comparison with primary explosive, secondary explosive is less sensitive. It is commonly initiated with a smaller quantity of a primary explosive and is used in larger amounts within an explosive sequence [22]. TNT and RDX, which can be expanded as "Research Department explosive" or "Royal Demolition eXplosive," serve as instances of secondary explosives.

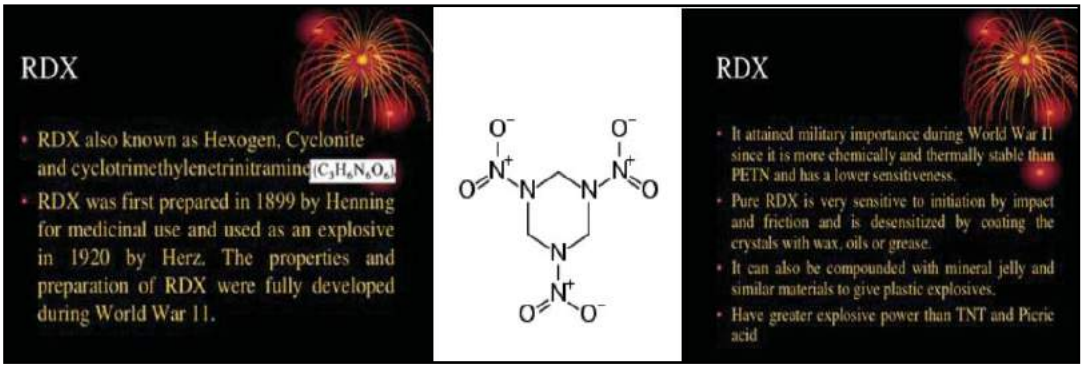
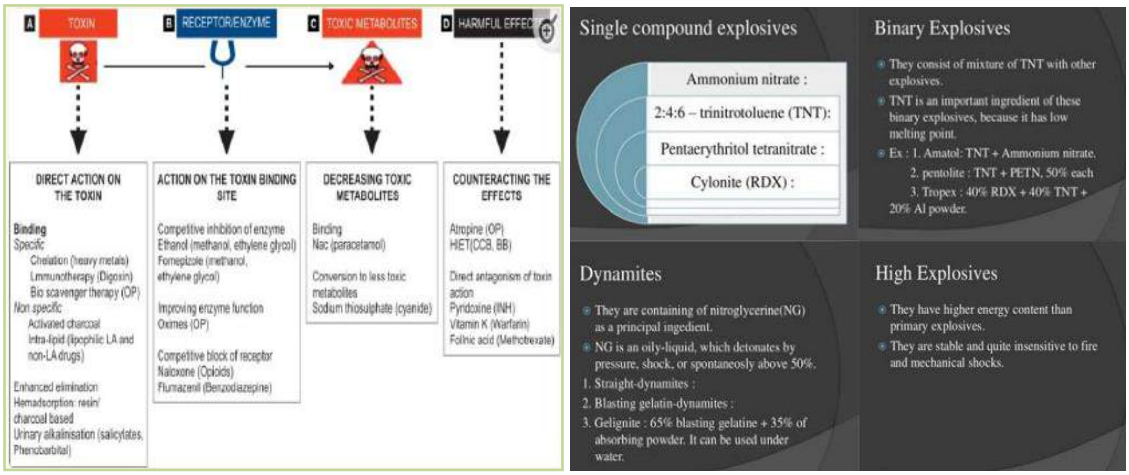


Figure 14: RDX (Secondary Explosive).

- **Tertiary Explosives:** Tertiary explosives are blasting agents, intermediate secondary explosive boosters that are less sensitive, frequently utilized for safety, and have typically cheaper material and handling costs. As an example, ANFO (pronounced as "AN-foh" or AN/FO for ammonium nitrate/fuel oil) is a frequently utilized industrial explosive in bulk to mitigate the risk of landslides. [23].

- **Cyanide Gas:** An apparatus like a gas chamber, employed for the purpose of suffocating or poisoning individuals or animals.It comprises a hermetically sealed enclousere where gas is introduced. Hydrogen cyanide is the most frequently employed poison, although carbon dixide and carbon monoxide have also been utilized. Tear gas, often known as a lachrymator agent or lachrymator (derived from the Latin word "lacrima," meaning "tear"), encompasses various substances that have been historically and presently employed. These substances include Mace (a proprietary blend), pepper spray (OC gas), PAVA spray (nonivamide), CS gas, CR gas, CN gas (phenacyl chloride), bromoacetone, and xylyl bromide [24]. Lethal gases,

Mustard gas, G-series nerve agent gases such as GA (tabun), GB (sarin), GD (soman) and GF (cyclosarin), etc are toxic gases for human health.



(i) (ii)

Figure 15: (i) Mechanism of Antidotes. (ii) Tertiary Explosives

- **Antidotes:** A medicine, chelating agent, or chemical that offsets (neutralizes) the effects of another toxin or drug that is toxic in nature is known as an antidote. Antidotes function through various mechanisms to alleviate the impact of a toxin: they can impede its absorption, bind and render the poison inert, counteract its effects on target organs, or hinder the conversion of the toxin into more harmful metabolites. [25]. The type of toxin ingested, the estimated dose to which the patient has been exposed, the exposure route, clinical aspects of toxicity, half-life, and pharmacokinetics, as well as the risk vs benefit of using the antidote, all influence how long antidotal therapy lasts. [25]. Examples include sodium bicarbonate, acetylcysteine, naloxone, atropine, flumazenil, therapeutic antibodies, and a variety of vitamins etc.

- **Narcotics:** These substances induce psychological addiction, alleviate or eliminate discomfort to facilitate sleep, and reduce vital signs such as blood pressure, heart rate, and respiration rate. [26]. Opium narcotics extract from poppies (Morphine, Heroin, Codeine etc.) is produces ‘high’ drowsiness and Hallucinogens (psychedelics, dissociatives and deliriants).

Figure 16: Drug addiction.

- **Hair Analysis:** Hair analysis results can frequently serve as significant, even conclusive evidence in courtrooms months after drug use. [27]. Following blood and urine, hair analysis has risen to become the third most critical biological matrix employed in forensic toxicology for drug testing. This is due to the growing interest in hair analysis over the years [27].

8. **Investigative Techniques:** Comprehensive criminal investigations encompass a range of investigative techniques, evidence gathering and preservation, questioning, interviews, and searches. [1]

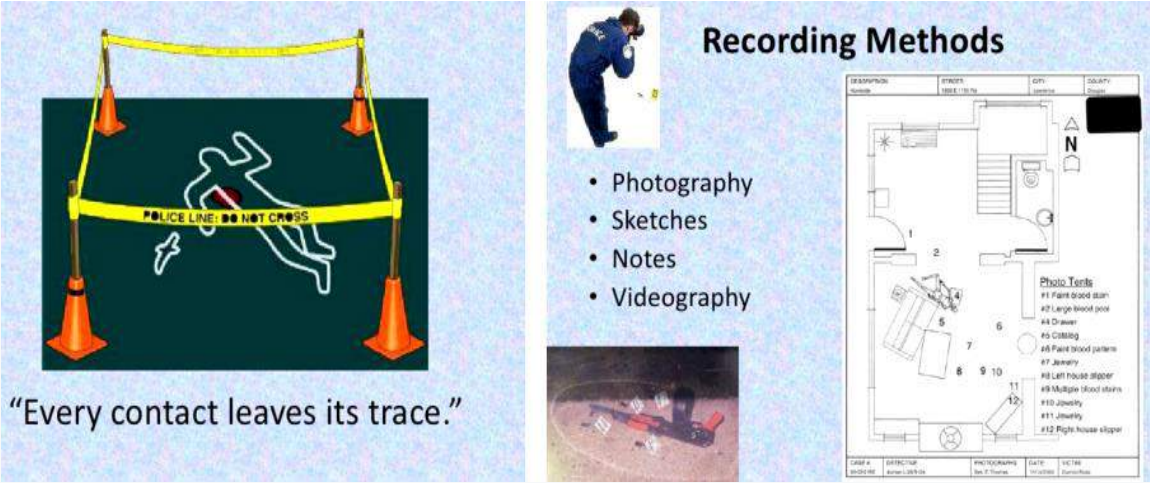


Figure 16: Investigation at crime place.

Priority bias issues are investigated, along with suggested remedies, by looking at signs of suspicion, a criminal's motive, a chance to commit the crime, and any connections between the victim and possible offenders.

- **Toxicology:** Apart from assessing any visible physical manifestations, a forensic toxicologist must take into account the investigative context and any potential clues uncovered at the crime scene, such as pill containers, powdered substances, residual traces, and accessible drugs [28].Armed with this data and the provided samples, the forensic toxicologist faces the task of identifying the presence of toxic compounds, quantifying their concentrations, and predicting their anticipated effects on the individual [28]. Vital components of the field of forensic toxicology encompass human performance toxicology, post-mortem toxicology, and forensic drug testing (FDT).

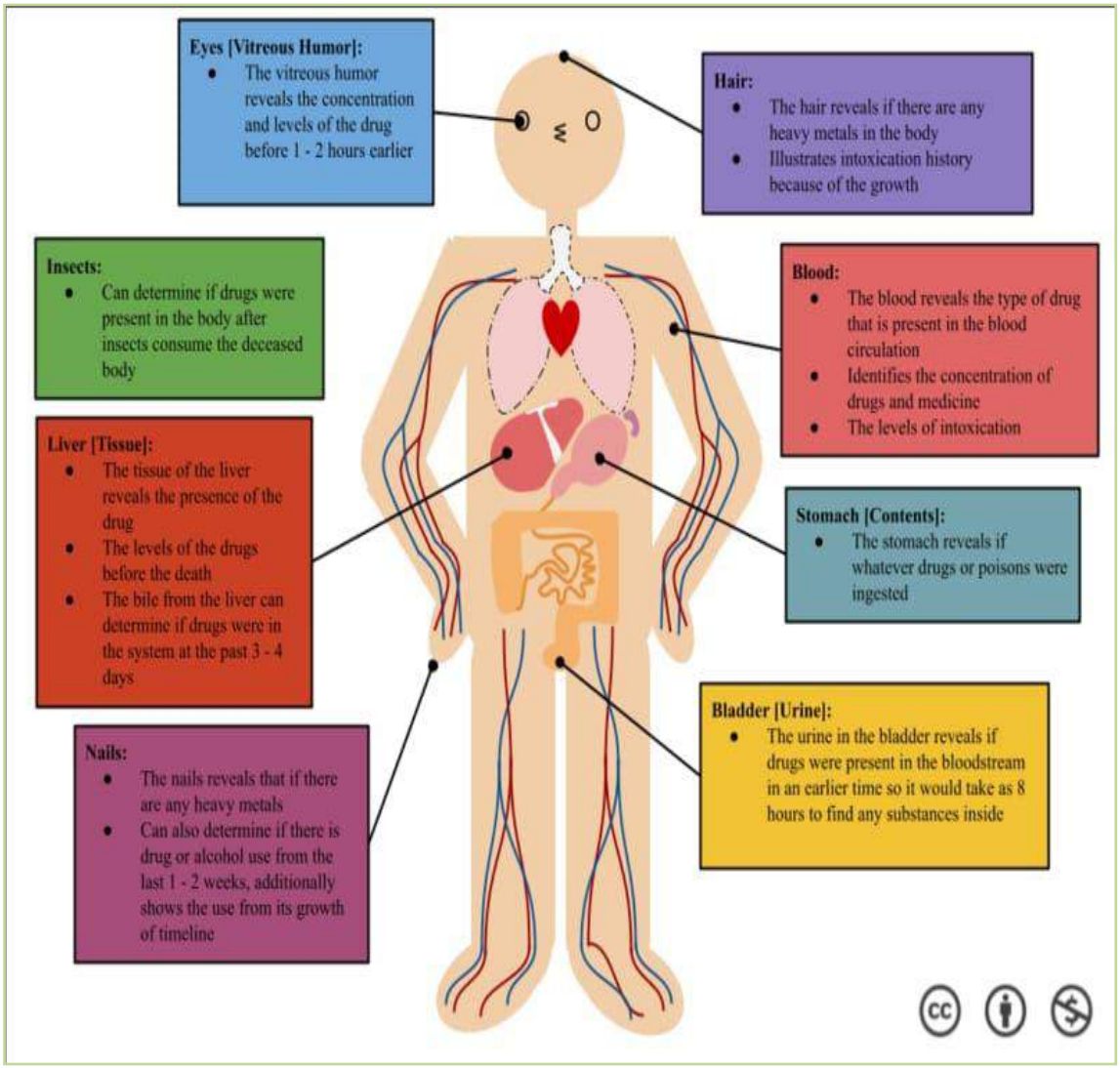


Figure 17: Drug location of the body.

V. CONCLUSION

Important design of biomedical implantable systems with a focus on implanted telemetry electronics for telemetry and closed loop control of design methodologies and significant milestones**.** Future technological developments will bring up new hurdles for innovative implanted systems as the science and technology of electronics and materials progress and human aspirations grow in response to medical needs.

REFERENCE

[1] CSI (CRIME SCENE INVESTIGATION): FIRST STEP TO UNFOLD THE NETWORK OF CRIME Dhabal Sampa , Nandi Kushal , Chakraborty Amrita , Sen Jyoti Dhrubo , Bera Khokan , Biswas Arpita , Mandal Suprodip and Saha Dhananjoy, International Journal of Forensic Science and Legal Medicine. It is followed under these reference.

- Herschel, William James (1880). “Skin furrows of the hand”. Nature. 23 (578): 76.
- Faulds, Henry (1880). “On the skin–furrows of the hand”. Nature. 22 (574): 605.

- Tewari, RK; Ravikumar, KV (2000). “History and development of forensic science in India”. J Postgrad Med. 46 (46): 303–308.
- Sodhi, J.S.; Kaur, asjeed (2005). “The forgotten Indian pioneers of finger print science”. Current Science. 88 (1): 185–191.
- Ruffell, A; McKinley, J (2014). “Forensic geomorphology”. Geomorphology. 206: 14–22.
- Farrar, Andrew; Porter, Glenn; Renshaw, Adrian(2012). “Detection of Latent Bloodstains Beneath Painted Surfaces using Reflected Infrared Photography”. Journal of Forensic Sciences. 57 (5): 1190–1198.
- Pringle, JK; Ruffell, A; Jervis, JR; Donnelly, L;McKinley, J; Hansen, J; Morgan, R; Pirrie, D; Harrison, M (2012). “The use of geoscience methods for terrestrial forensic searches”. Earth–Science Reviews. 114 (1–2): 108–123.
- Saks, Michael J.; Faigman, David L. (2008).“Failed forensics: how forensic science lost its way and how it might yHerschel, William James (1880). “Skin furrows of the hand”. Nature. 23 (578): 76.

[2] Saha, D., Dhabal, S., & Sen, D. J. (2022). Forensic science deals with safety armour during warfare explosives. *Journal of Forensic Science and Research*, *6*(1), 024-041.

[3] Nandi, K., Sen, D. J., & Mahanti, B. (2021). BALLISTICS: THE MODERN DAY FORENSIC WEAPON.

[4] Heard, Brian (2013). Forensic Ballistics in Court: Interpretation and Presentation of Firearms Evidence. John Wiley & Sons, 33–42.

[5] Heard, Brian (2013). Forensic Ballistics in Court: Interpretation and Presentation of Firearms Evidence. John Wiley & Sons, 41.

[6] Melissa Hogenboom, "Origins of human throwing unlocked", *BBC News* (26 June 2013).

[7] Steele, Lisa (2008). "Ballistics" (PDF). Science for Lawyers. American Bar Association.

[8] Thompson, Robert (2010). "Firearm Identification in the Forensic Science Laboratory" (PDF). National District Attorneys Association.

[9] Sutton, George (2001), *Rocket Propulsion Elements* (7th ed.), Chichester: John Wiley & Sons, ISBN 978-0-471-32642-7

[10] MSFC History Office (2000), *Rockets in Ancient Times (100 B.C. to 17th Century)*, Marshall Space Flight Center History Office, archived from the original on 2009-07-09, retrieved 2016-06-09.

[11] US Army (February 1965), *Interior Ballistics of Guns* (PDF), Engineering Design Handbook: Ballistics Series, United States Army Materiel Command, AMCP 706-150, archived from the original (PDF) on September 24, 2020.

[12] Ballistics at Encyclopædia Britannica Online, Accessed April 27, 2009

[13] Physics 001 The Science of Ballistics Archived 2012-02-22 at the Wayback Machine accessed Apr 27, 2009

[14] "Comparison Microscopy". National Forensic Science Technology Center.

[15] O'Brien, John (2014). "The St. Valentine's Day Massacre". The Chicago Tribune.

[16] Ashcroft, Brent. "St. Valentine's Day Massacre: Tale of two guns". WZZM13.

[17] "Firearms and Toolmarks in the FBI Laboratory". Forensic Science Communications. **2** (2). April 2000. Archived from the original on September 20, 2015. Retrieved June 5, 2016.

[18] Pritam Bakshi, Dr. Dhrubo Jyoti Sen and Dr. Beduin Mahanti (2022); “CHEMICAL WARFARE & NERVE AGENTS: MODERN WEAPON OF MASS DESTRUCTION”, World Journal of Pharmaceutical and Life Science, ISSN 2454-2229, Vol. 8, Issue 2, 133-143.133-142.

[19] Krehl POK. History of Shock Waves, Explosions and Impact: A Chronological and Biographical Reference. Springer Science & Business Media. 1970; 2008

[20] Saha, D., Dhabal, S., & Sen, D. J. (2022). Forensic science deals with safety armour during warfare explosives. *Journal of Forensic Science and Research*, *6*(1), 024-041.

[21] Cooper, Paul W. Chapter 4: Use forms of explosives. Explosives Engineering. Wiley-VCH. 1996; 51–66.

[22] Assovskiy IG. Direct laser initiation of open secondary explosives. J Phys. 2015; 653: 012-014.

[23] Ellison DH. Handbook of Chemical and Biological Warfare Agents, Second Edition. CRC Press. 2007; 456.

[24] Hu H, Fine J, Epstein P, Kelsey K, Reynolds P, et al. Tear gas-- harassing agent or toxic chemical weapon? JAMA. 1989; 262: 660–663. PubMed://pubmed.ncbi.nlm.nih.gov/2501523/.

[25] Chacko, B., & Peter, J. V. (2019). Antidotes in poisoning. *Indian journal of critical care medicine: peer-reviewed, official publication of Indian Society of Critical Care Medicine*, *23*(Suppl 4), S241.

[26] Dr. Dhananjoy Saha, Dr. Sampa Dhabal and Dr. Dhrubo Jyoti Sen, FORENSIC INVESTIGATION OF NARCOTIC DRUGS THROUGH ANALYTICAL METHODS; ISSN 2349-8870, ejbps, 2022, Volume 9, Issue 3, 415-423.
[27] Tanistha Mumtaz Chatterjee, Dr. Dhrubo Jyoti Sen and Dr. Beduin Mahanti; HAIR SUGGESTS HEIR OF DNA ANALYTICAL REPORT IN FORENSIC SCIENCE CRIME SCENE, ISSN 2349-8870; ejbps, 2022, Volume 9, Issue 2, 325-330.
[28] Dhabal, S., Nandi, K., Sen, D. J., & Saha, D. Toxicology: It’s Basic Instinct & Application In Forensic Field, Insights of Herbal Medicine 2022, Volume-1, Issue-1, Pg 23to 30.

