Forensic science

Introduction: Definition, Scope, and History

Key Terms

Expert Witness
- Someone who is considered a professional in their field / line of work or has extensive knowledge of a particular topic

Locard’s Exchange Principle
- When two objects come into contact, a cross-transfer of materials occur

Scientific Method
- A process using strict guidelines to ensure careful and systematic collection, organization, and analysis of info

Forensic Science

Definition:
- Forensics science is the application of science to the criminal and civil laws

Scope: (Top 10 sections of professions utilizing FS)
- Criminalistics, Digital and Multimedia Sciences, Engineering Science, General, Jurisprudence, Odontology, Pathology/Biology, Physical Anthropology, Behavioral Science, Toxicology

1.1 Development of Forensics Science
- The earliest record of using Forensics comes from 3rd century China
  - A coroner solved a case in which a wife murdered her husband then burned the body, while the wife claimed he died in an accidental fire
  - Coroner noticed there were ashes in the man’s remains and burned two pigs, one alive & one dead.
  - He found the dead pigs remains had ashes in its mouth proving the man must have been dead prior to burning

The Father of Forensics

Mathieu Orfila:
- A Spaniard who legitimized toxicology as a scientific endeavor
  - Published a paper on detection of poisons and their effects on animals

Development of Forensics Science

Williams Nichol (1828):
- He invented the polarizing microscope
  - Polarized light is light that is focused in a specific direction

Henri-Louis Bayard (1839):
- First procedure for microscopic detection of sperm
  - First microcrystalline test for hemoglobin (1853)
  - First presumptive test for blood (1863)

During the 1850s & 1860s photography was used in forensics

Anthropometry
- Developed by Alphonse Bertillion in 1879
  - This was a systematic procedure in which measurements were taken to distinguish between one another
  - See page 9 in text
  - Considered most accurate form of identification for two decades until fingerprinting was developed by Francis Henry Galton in 1892

Sir Arthur Conan Doyle
- The best-known figure from the 19th century was not even real, Sherlock Homes and his partner Dr. John Watson were fictional characters created by Sir Doyle
- Holmes and Watson’s adventures were the first two apply the principles and procedures of forensics science to criminal investigation popularizing this new science
20th Century Breakthroughs

Dr. Karl Landsteiner (1901):
• Discovered that blood can be grouped into A, B, AB, & O

Dr. Leone Lattes (1915):
• Discovered a procedure for determining blood type from a dried blood stain

Albert Osborn (1910):
• Developed procedures for document examination

Locard's Exchange Principle
 o Edmond Locard (1910) believed that every criminal carried dust from the crime scene
 o He was able to prove men guilty of possessing counterfeit coins after analyzing the clothing the men were wearing with the coins in questions
 o He discovered metal particles that matched the coins exactly in all men’s pockets

Firearms Examination
• US Army Colonel Clavin Goddard refined the techniques used to examine firearms by using microscope comparison
• Investigators were able to apply his methods to determine if a bullet was or was not fired from a specific gun by analyzing striation lefts from the gun barrel on the bullet

DNA Typing
 o Sir Alec Jeffrey developed the first DNA profiling test in 1984
  ▪ One year later Colin Pitchfork was found guilty of murder due to blood found at the crime scene
  ▪ The same case also marked the first time DNA profiling established innocence of a different suspect

1.2 Crime Labs in the US
 o The oldest lab is that of the LA Police Dept. (est. 1923)
 o In 1932, J. Edgar Hoover organized the FBI
  ▪ Now the FBI is the world’s largest forensic lab
  ▪ Completes more than 1 million examinations per year
 o Current crime labs are best described as regional systems in that no national system exists

Drug Abuse & Crime Labs
 o Current estimates state that nearly half of the requests for examination deal with abused drugs
  ▪ All illicit drug seizures must be analyzed
  ▪ Since the 1960s drug abuse has elevated to nearly uncontrollable levels

DNA Profiling & Crime Labs
• Since the 1990s, technology has been able to trace blood stains, semen stains, hair, saliva, cups, bite-marks and so on to a specific individual
• CODIS (Combined DNA Index System)
  ▪ All offenders are sampled and entered into system
  ▪ Currently CA has the 3rd largest DNA system of profiles worldwide with approximately one million entries (Behind the UK and the FBI)

Four Major Crime Labs
• The FBI (Federal Bureau of Investigation)
  ▪ largest crime lab in the world
  ▪ Ultramodern facility in Quantico, VA
• DEA (Drug Enforcement Agency)
• Analyzes drug seized in violation of federal laws
  ▪ Regulates the production, sale, and transportation of drugs
Four Major Crime Labs

- ATF (Bureau of Alcohol, Tobacco, Firearms, and Explosives)
  - Analyzes alcoholic beverages, examines weapons, explosive devices, and documentation related to any of the above
- U.S. Postal Inspection Services
  - Maintains labs concerned with criminal investigations relating to the postal service

1.3 Factors for Crime Lab Increases Since 1960

- Requirement to advise criminal suspects of their constitutional rights
- Jaunting increase in crime rates
- The fact that all illicit drug seizures must be lab tested for identification
- The advances in DNA profiling

Services of the Crime Lab

- Due to several factors, not all crime labs possess the same services, but there are basic services included in almost all crime labs with optional services included as well if possible
- Factors affecting the number of services include:
  - variations in local laws
  - Capabilities and functions of the organization to which the lab is attached
  - Budgetary and staffing limitations

Physical Science Unit (Basic Service)

- Applies the principles and techniques of chemistry, physics, and geology to the identification and comparison of crime scene evidence
- Staff: Criminalists who have expertise in chemical tests and modern analytical instrumentation
- Examines: Drugs, Glass, Paint, Explosives, and Soil

Biology Unit (Basic Service)

- The unit identifies and profiles DNA from dried blood stains and other body fluids
- Staff: Biologists and Biochemists
- Examines: Hair, Fibers, Botanical materials (wood/plants)

Firearms Unit (Basic Service)

- Unit examines firearms and related materials to detect firearms discharge residues and to approximate distance from target at which the weapon was fired
  - Staff: Expert marksmen, chemists
  - Examines: Firearms, Bullets, Cartridge Case, Shotgun Shells, Clothing, Close proximity objects from weapon discharge

Document Unit (Basic Service)

- The unit studies handwriting and typewriting on questioned documents to ascertain authenticity and/or source. It also analyzes paper and ink sources.
  - Staff: General Scientist / Handwriting Expert
  - Examines: Paper, Ink, Erased Documents, Burned / Charred Documents

Photography Unit (Basic Service)

- The lab examines and records physical evidence along with preparing photographic exhibits for courtroom presentations
  - The unit utilizes specialized photographic techniques such as digital imaging, IR, UV, and x-ray photography to make invisible info visible to the naked eye
  - Staff: Expert photographic technicians and general scientists
Toxicology Unit (optional service)
- The unit examines body fluids and organs to determine the presence of drugs and poisons
- Staff: Biologists and Chemists
- The staff often trains field operators of mobile testing equipment and maintains/services instruments

Latent Fingerprint Unit (optional service)
- The unit processes and examines evidence for latent fingerprints on a variety of objects / sources
  - Latent - present but not evident
- Twins don’t even have the same fingerprint

Polygraph Unit (optional service)
- The lie detector test has become an essential tool for the criminal investigator rather than forensic scientist
- The validity of this service is often questioned but the American Polygraph Association has proven an average accuracy of 92% during three separate studies.

Voiceprint Analysis Unit (optional service)
- The unit investigates telephoned threats or tape-recorded messages and performs a voiceprint analysis to tie the voice to a specific suspect
- The sound spectrograph is an instrument that transforms speech into a visual graphic display called a voiceprint.

CSI Unit (optional service)
- The crime scene investigation unit is slowly gaining expectancy as a forensics service as trained personnel collect and preserve physical evidence from the crime scene to be later processed

Other Services...
- **Forensic Psychiatry**: examines the relationship between human behavior and legal proceedings (determine competency)
- **Forensic Odontology**: examines dental evidence
- **Forensic Engineering**: failure analysis, accident reconstruction, causes and origins of fires / explosives
- **Forensic CPU and digital analysis**: collecting, preserving, and examining digital devices

1.4 Scientific Method
- A process using strict guidelines to ensure careful and systematic collection, organization, and analysis of info
- A hypothesis must be formed and validated using experimentation. Once a hypothesis is validated it may be suitable for scientific evidence and admitted into a court of law

Steps in the Sci. Method
- Identify a problem
- Gather information, forming a hypothesis
- Experiment
- Analyze data
- Draw conclusions
- Repeat procedure to assure validity of experiment

An example...
- An investigator may start by asking the question, “Who committed the crime?”
- Next he develops a hypothesis which is a reasonable explanation proposed to answer the question
- The hypothesis is tested by running one or several experiments (firearms examination, fingerprint analysis, etc...)
- The hypothesis is validated and the experimental results are entered as evidence
Variables Within An Expt
• While running an experiment, scientists will often run both a control and variable.
  • Such as testing both the gun from a crime scene with another identical gun to see striations produced on bullets.
• Why would both a control and variable be necessary?

1.5 Scientific Evidence
• Two cases set the guidelines for determining the admissibility of scientific evidence
  • Frye v. United States
  • Daubert v Merrell Dow Pharmaceuticals, Inc.

Frye v. United States
• In 1923, the court rules that in order to be admitted as evidence, the questioned procedure, technique, or principles must be “generally accepted” by the scientific community

Daubert v. Merrel Dow Pharm. Inc.
• In 1993, the supreme court asserted that the Frye Standard is not absolute and a trial judge may deem evidence admissible as well
  • Trial Judge - establishes facts, decides if evidence is sufficient for trial and sets bail for criminal cases if necessary

Types of Evidence
• Circumstantial Evidence
  • A judge or jury make indirect inferences about what transpired at the scene
• Direct Evidence
  • Evidence that establishes a fact

Circumstantial Evidence
• Example: if fingerprints or hairs found at a scene are consistent with that of a perpetrator, jurors may infer that the print / hair belong to the defendant
• This type of evidence isn’t definitive proof
• It only provides a general idea of what occurred at a crime scene
• Evidence identified forensically is usually circumstantial

Direct Evidence
• Example: Statements or confessions made by the witnesses
• Eyewitness accounts, victims’ statements, or offenders’ confessions may influence the interpretation made by the medical examiner (ME)
• B/c of this, direct evidence isn’t considered as reliable as circumstantial evidence

Evidence
• People have tendencies to forget or to lie
• Circumstantial evidence is objective while direct evidence is subjective
  • objective - completely unbiased
  • subjective - from the perspective of observer (biased)
• It is found that eyewitness accounts are inaccurate half the time when saliva and blood are accurate 99% of the time

1.6 Expert Witness
• Someone who is considered a professional in their field / line of work or has extensive knowledge of a particular
• Role and Responsibilities:
  • In court he/she may be asked questions intended to demonstrate ability and competence about the
subject matter

• The expert must express his opinion on the matter
• The expert cannot render any view with absolute certainty and must base opinion on reasonable scientific certainty
• The expert must be an advocate of truth, not sides

Lay Witness

• The ordinary witness
• Must testify on events or observations from personal knowledge
• The testimony must be factual and cannot contain personal opinions of the witness