Perspective
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Forensic Chemistry: An Overview

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Perspective

Forensic chemistry is the legal application of chemistry and its subdivision, forensic toxicology. A forensic chemist can help identify unfamiliar elements discovered at a crime scene [1]. This field's experts have a vast range of procedures and instruments at their disposal to aid in the identification of unknown compounds. High-performance liquid chromatography, gas chromatography-mass spectrometry, atomic absorption spectroscopy, Fourier transform infrared spectroscopy, and thin layer chromatography are examples of these techniques. Because of the destructive nature of some instruments and the quantity of potentially unknown compounds that might be detected at a scene, the variety of procedures is vital. Forensic chemists prefer to start with non-destructive methods to preserve evidence and assess which destructive approaches will yield the best findings [2]. Forensic chemists, like other forensic scientists, frequently testify in court as expert witnesses about their results. Forensic chemists adhere to a set of guidelines established by numerous authorities and regulating bodies, including the Scientific Working Group on the Analysis of Seized Drugs. In addition to the group's standard operating procedures, certain agencies have their own criteria for quality assurance and quality control of their data and instruments. To maintain the accuracy of their reports, forensic chemists routinely check and verify that their instruments are still capable of detecting and measuring varied concentrations of different chemicals [3].

Forensic chemists' analyses can give investigators with leads and validate or reject their assumptions. The identification of various compounds discovered at the site can help investigators choose what to look for during their search. During fire investigations, forensic chemists can identify whether an accelerant, such as gasoline or kerosene, was used; if so, this indicates that the fire was deliberately started. Forensic chemists can also narrow down the suspect list to individuals who would have had access to the drug used in the crime. In explosive investigations, for example, the presence of RDX or C-4 would imply a military connection because those compounds are military grade explosives. TNT, on the other hand, would expand the suspect pool because it is utilised by both demolition businesses and the military [4]. Detection of specific poisons during poisoning investigations might offer police an idea of what to look for when interviewing prospective suspects. An investigation involving ricin, for example, would direct detectives to hunt for ricin's predecessors, the seeds of the castor oil plant. In drug or alcohol situations, forensic chemists can also help to corroborate or disprove investigators' assumptions. Forensic chemists utilise tools that can detect minute quantities, and correct measurement is vital in offences such as driving under the influence since there are specified blood alcohol content cutoffs where penalties begin or increase. The amount of the substance found in the person's system can confirm or rule out overdose as the cause of death in suspected overdose situations.

Throughout history, poisons such as arsenic, nightshade, hemlock, strychnine, and curare have been used to commit murder. Until the early nineteenth century, there were no ways for determining whether a specific chemical was present, and poisoners were rarely prosecuted for their crimes. British chemist James Marsh made one of the earliest significant contributions to forensic chemistry in 1836. He developed the Marsh technique for arsenic detection, which was later successfully utilised in a murder prosecution. During this time, forensic toxicology was also acknowledged as a distinct field. During the early nineteenth century, Mathieu Orfila, known as the "Father of Toxicology," made significant contributions to the science. Orfila, a pioneer in the creation of forensic microscopy, made significant contributions to the growth of this approach for detecting blood and sperm [5]. Orfila was also the first scientist to successfully categorise various substances into groups such as corrosives, narcotics, and astringents. The next breakthrough in poison detection occurred in 1850, when scientist Jean Stas developed a reliable method for detecting vegetal alkaloids in human tissue. Stas' method was immediately copied and successfully utilised in court to convict Count Hippolyte Visart de Bocarmé of murder through nicotine poisoning. Stas was able to successfully separate the alkaloid from the victim's organs. Caffeine, quinine, morphine, strychnine, atropine, and opium tests were later added to Stas' technique. During this time, a wide range of forensic chemical analysis instrumentation began to be produced. Joseph von Fraunhofer invented the spectroscope in the early nineteenth century. In 1859, chemist Robert Bunsen and physicist Gustav Kirchhoff built on Fraunhofer's discovery. Their spectroscopic tests revealed that when some chemicals were subjected to specific wavelengths of light, they produced a distinct spectrum. The two scientists were able to identify chemicals based on their spectrum using spectroscopy, giving a technique of identification for unknown materials.

Paper chromatography, an early precursor to thin layer chromatography, was invented in 1906 by botanist Mikhail Tsvet, who used it to separate and study the plant proteins that make up chlorophyll. The capacity to split mixtures into their constituent parts enables forensic chemists to compare the components of an unknown item to a database of known products. Materials can be identified by matching the retention factors for the separated components with known values. To identify unknown elements found at a crime scene, modern forensic chemists use a variety of tools. The twentieth century saw significant technological advances that enabled chemists to detect tiny amounts of substances more accurately. The discovery of a spectrometer that could measure the signal created by infrared (IR) light was the first important advancement in this century, occurring in the 1930s. Early IR spectrometers employed a monochromator to measure light absorption in a very limited wavelength region. It wasn't until Peter Fellgett's 1949 connection of an interferometer with an IR spectrometer that the entire infrared spectrum could be measured at once.

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