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THE ROLE OF CHEMISTRY IN FORENSICS

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ABSTRACT:
This article highlights the role, significance, and modern methods of chemistry in the field of forensics and criminalistics. It analyzes the primary tasks of forensic chemistry and forensic toxicology, including the detection of criminal evidence, and the processes of classification and identification of substances. Furthermore, the article demonstrates the application of modern analytical technologies such as gas and liquid chromatography (GC-MS, LC-MS/MS), and spectroscopy, along with their effectiveness in analyzing biological samples (blood, urine, hair). The article concludes with insights into the future development prospects of forensic chemistry and the importance of nano-technologies.

Keywords: forensic chemistry, forensic toxicology, criminalistics, chromatography, mass spectrometry, drugs, poisons, DNA analysis, nano-technologies.

Forensic science is a field of science that emerged to solve various crimes in an easy way. Due to the proliferation of different methods to attempt to commit a crime, there must be a unique and numerous strategies to study it. Some crimes are well committed, no traces or evidence are found during the investigation. Forensic evidence is collected, examined, evaluated, understood and discussed to create meaning of the incident and guide the investigation. Forensic science has undergone an interesting development in recent times and has increased significantly in popularity among the public. Thus, forensic chemistry makes it easier to perceive and feel evidence at the scene of a crime. Forensic chemistry can be an important and broad field of forensic science. This review will explain how forensic chemistry helps in forensic science. It will also explain the different areas of forensic science and therefore the temporary introduction of forensic science and forensic chemistry. This represents the scope of forensic chemistry, including forensic toxicology, for the high and technological future. "Forensic chemistry" is a broad term that encompasses many functions relative to the law laboratory. The techniques used in forensic chemistry are used by both medical and trace analysis departments. Analyzing drug exhibits is fairly straightforward. The expert uses a series of non-specific tests to form an opinion on the content of the exhibit being examined. Confirmation. Drug analysis, each piece of physical and biological evidence, goes beyond the typical forensic framework of identification-classification-individualization. Analytical tools, when used properly, can almost indefinitely provide the definitive identification of a drug or substance. Classification includes presumptive tests and screening tests, but identification occurs after, rather than before, the classification, as in the case of our theoretical narrator. The processes of identification, classification, and differentiation are the main areas of forensic chemistry, although the order varies. Forensic chemistry is applied analytical chemistry. History of forensic chemistry. By the mid-19th century, advances in forensic chemistry were becoming more rapid. Medicine is the study of all interactions of drugs and similar substances with living organisms. Medicine includes the use of drugs, their absorption, action and interactions, metabolism, and elimination. Forensic toxicology Toxicology is the study of the harmful effects

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of drugs and poisons on living organisms. It includes the study of the symptoms, mechanisms, treatment, and detection of drugs and poisons. A drug is a substance that, when ingested, causes physiological changes. All substances are toxic, and whether they are drugs or poisons depends only on the dose used. If the use of drugs and poisons results in death under suspicious circumstances, it becomes forensic pharmacology. Pharmacology can be a branch of medicine. Forensic toxicologist Much of the work forensic toxicologists do involves determining the concentration of drugs and poisons in a variety of body fluids and substances, such as blood, urine, and breath. This is often done in living people, such as in cases of drunk driving or in cases where the medical examiner or medical examiner needs to investigate the cause and manner of death. These measurements are a type of analytical chemistry, and much of what forensic toxicologists need to understand is chemistry [1]. Forensic toxicology emerged as a separate scientific discipline in the 19th century with pioneering work.He laid the foundation for modern forensic toxicology and was able to identify poisons in blood, urine, and other body fluids using a combination of chemical and physiological methods. Scientists soon adopted these methods, and forensic toxicology became an important part of criminal investigations [2]. Newer techniques such as liquid chromatography-tandem mass spectrometry (LC-MS/MS) or gas chromatography-tandem mass spectrometry (GC-MS/MS) are the most commonly used methods for quantifying drugs and poisons in biological samples. Identification of poisons and drugs: Using methods such as GC-MS and LC-MS/MS, toxicologists carefully analyze biological samples (blood, urine, and tissue) to identify and identify the poisons or drugs present. Review and Interpret Results: In addition to identification, forensic toxicology examines and interprets identified substances in more detail in the context of the case, taking into account factors such as concentration, potential toxicity, and individual factors. This helps to determine whether a substance contributed to an individual's illness or death and to reconstruct the surrounding conditions. High-performance liquid chromatography (HPLC): HPLC is another valuable technique that separates the components of a mixture and is often used to quantitatively identify substances. It is particularly useful in pharmaceuticals and can be combined with mass spectrometry to enhance analysis [3]. Despite various concerns, forensic toxicology remains important in modern society, and researchers, policymakers, and practitioners need to understand the social or ethical issues and challenges in the field. In the early 1900s, analytical techniques such as spectroscopy and microscopy improved the detection of poisons. Other methods, such as Raman spectroscopy (SERS) and Fourier transform infrared spectroscopy, also aid in the identification of drugs and poisons in biological samples. Bibliometric analysis is a quantitative method that provides insight into the patterns and trends of scientific research in a particular field by analyzing the scientific literature. Recently, bibliometric analysis has gained attention as a tool for understanding the current state of research in forensic science, identifying research gaps, and identifying future research directions [4].

Postmortem toxicology typically uses a wide variety of biological samples for analysis. Some of the atypical matrices used include fingernails, saliva, hair, and sweat.

Analysis of biological samples

A semiquantitative method based on enzyme-linked immunosorbent assay (ELISA) has been validated for the rapid screening of benzodiazepines in blood and urine samples. Although the manufacturer recommended the use of oxazepam as the standard target substance, the authors replaced it with clonazepam. As a result, cross-reactivity with most of the 29 benzodiazepines was increased and the method's detection efficiency for designer benzodiazepines was improved [5].

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Hair analysis is an important tool in forensic toxicology. UPLC-MS/MS can be used to detect substances such as cocaine, amphetamines, opiates, and THC. The method is rapid, sensitive, and practical [6].

Application in death investigation. In cases of suspicious or unexplained deaths, forensic toxicology plays an important role in determining the cause of death. Toxicologists use samples such as blood, urine, and stomach contents to identify substances that may have caused the death.

Chemical forensics is used to identify acute and chronic poisonings. For example, heavy metals, pesticides, carbon monoxide, alcohol, or drug overdoses are detected through laboratory analysis. These methods allow us to distinguish between intentional poisoning, suicide, or accidental poisoning.

DNA analysis in forensics is one of the most reliable methods of identifying a person. DNA samples taken from blood, hair, saliva, bone, or other biological traces can be used to identify an unknown person, verify kinship, or find a criminal. This method is widely used in mass disasters, missing persons, and criminal cases. Samples are analyzed, which helps in autopsy reports and criminal investigations [7].

The use of modern technologies in the field of forensic chemistry significantly increases the accuracy and speed of examination results. New analytical methods have made it possible to detect even very small amounts of substances. In particular, methods such as gas chromatography, liquid chromatography, tandem mass spectrometry (GC-MS, LC-MS/MS) are widely used to detect drugs, poisons, and medications with high accuracy [8].

Automated laboratories reduce human error and allow for the testing of a large number of samples in a short time. Robotic systems increase the efficiency of sample preparation, separation, and recording of results.

Nanotechnology has ushered in a new era in forensic analysis. Nanoparticle-based sensors can detect explosives, poisons, or biological traces at very low concentrations. This helps to perform rapid and sensitive examinations in forensic examination.

Forensic chemistry is an important scientific tool in solving crimes and establishing the truth. Its main advantage is its high accuracy, reliability, and objective results. Chemical analysis can accurately detect poisoning cases, drugs, blood traces, and other evidence. However, there are some problems. Improper collection of samples, non-compliance with storage rules, or laboratory errors can lead to incorrect results. Sometimes outdated equipment or a lack of qualified specialists also cause problems. In the future, forensic chemistry will develop further with the help of artificial intelligence, automated analysis systems, and nano-sensors. The emergence of fast portable laboratories will allow for initial analysis at the crime scene.

Conclusion

Forensic chemistry plays an important role in forensic medicine and criminalistics. It is of great importance in solving crimes, determining the cause of death, investigating poisoning cases, and identifying individuals. The use of modern technologies increases the efficiency of this field, making the results more accurate and faster. Therefore, forensic chemistry is an indispensable scientific direction in the practice of law enforcement agencies and forensic examination.

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