Biochemistry: The Silent Witness in Criminal Justice

Biochemistry is at the core of modern forensics, helping catch criminals and doing right by those who are wronged. From identifying suspects through DNA analysis to uncovering causes of death with toxicology, biochemical evidence helps courts determine innocence or guilt. These scientific techniques, in particular, have revolutionised criminal investigations, making cases more evidence-based and less reliant on witness testimony, which makes verdicts more reliable by not relying on the highly reconstructive memories of individuals.

DNA Analysis

DNA analysis has transformed the way investigators link individuals to crime scenes. Every person - except identical twins - is as unique as a snowflake regarding their genetic profile. This makes DNA results incredibly valuable and essential in criminal law cases specifically. Through the knowledge these results give us, they effectively serve as a cold superpower that no two people could match. Forensic teams collect biological samples like blood, saliva, or hair, extract DNA, and compare it to known samples to confirm a suspect's involvement. This process relies on techniques like polymerase chain reaction (PCR) to amplify DNA segments, ensuring that even tiny traces can be analysed. PCR (Polymerase Chain Reaction) is a laboratory technique used to amplify small segments of DNA by repeatedly copying a specific DNA sequence through cycles of heating (to separate strands), cooling (to allow primers to bind), and enzyme-driven extension (to synthesise new strands), enabling forensic scientists to analyse even minute traces of genetic material from crime scenes.

One of the most famous applications of DNA analysis in criminal law is forensic genetic genealogy (FGG). FCG (Forensic Computational Genomics) is an advanced forensic technique that applies computational algorithms and machine learning to analyse complex genetic data, improving the accuracy and efficiency of DNA profiling in criminal investigations. This method has been used to crack cold cases by tracing family connections through genetic databases. Take the case of the Golden State Killer, which was solved decades later through FCG. Investigators used DNA collected from crime scenes and matched it to distant relatives on genealogy websites, ultimately identifying the suspect. This same technology has also been instrumental in overturning wrongful convictions, as DNA evidence can provide definitive proof of innocence, correcting mistakes made due to faulty eyewitness accounts.

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One notable example of DNA overturning a wrongful conviction is the case of Kirk Bloodsworth. Kirk Bloodsworth was wrongfully convicted of rape and murder in 1985 and sentenced to death. Nearly a decade later, DNA testing proved his innocence, leading to his exoneration in 1993.

Toxicology

Forensic toxicology is the science of detecting drugs, alcohol, and poisons in the human body. It is extremely important in cases when people overdose, are poisoned, or drive after drinking alcohol. By looking at samples from whole blood, urine or other bits of tissue, toxicologists can find out what chemicals people were exposed to at the time of arrest or death.

In murder cases, toxicology usually turns out to be that little piece of the puzzle that helps to solve the case at hand, when all else fails. If a person dies under suspicious circumstances, forensic scientists test for toxic substances that could indicate poisoning. For instance, toxicology reports were crucial in identifying poisoning as the cause of death in high-profile cases like that of Russian ex-spy Alexander Litvinenko, who was killed using radioactive polonium-210.

Another place where toxicology is vital is in cases of drunk driving. Blood alcohol concentration (BAC) tests provide concrete evidence of impairment, as opposed to once again relying on the word of an individual. This biochemical and factual evidence further helps courts determine responsibility in accidents.

Biochemical Evidence

Beyond DNA and toxicology, forensic scientists analyse various biochemical markers to reconstruct crime scenes and establish timelines. Proteins, enzymes, and even microorganisms in a body can offer crucial clues. For example, changes in muscle enzymes help estimate time of death, while certain bacteria in a decomposing body can suggest how long a person has been dead.

Another emerging area in forensic biochemistry is the use of metabolomics—the study of small molecules in the body. Scientists can read metabolic changes by looking at blood or tissues, which tells them whether someone is using certain drugs, if someone has an illness, or even if they have come into contact with a certain kind of poison or harmful chemicals. Blood and body tissues carry stories in their chemistry that trained sight can help unlock.

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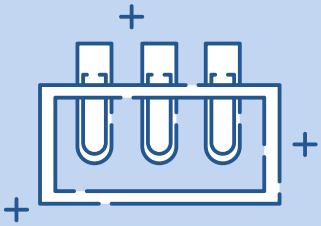
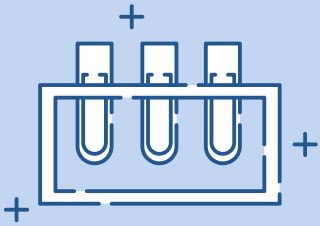
These biochemical traces can therefore help establish a suspect’s movements or even verify an alibi.

Challenges and Ethical Concerns

While biochemistry has revolutionised forensic science, it is not foolproof. DNA contamination, sample degradation, or misinterpretation of results can lead to wrongful convictions. Ethical concerns also arise, especially regarding genetic privacy. Using public DNA databases to solve crimes raises questions about people's permission and how monstrous big data invasions can be.

Despite these challenges, biochemistry remains one of the most powerful tools in criminal law. As technology develops more and more, science for solving crimes will grow even more precise, making it harder for crooks to get away with wrongdoings. Furthermore, and most importantly, it will help us to keep honest people who are wrongly accused safe and clear.





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