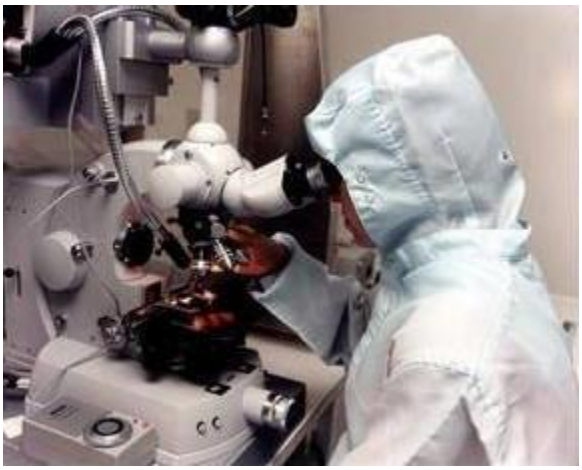
Forensic science



by Chris Woodford. *Last updated: September 22, 2019.*

We all love a good detective story. If we can figure out "whodunit" before the detectives on TV, we feel as smart as Sherlock Holmes! In reality, solving a crime usually takes an awful lot longer than a 60-minute episode of your favorite police drama. Vast amounts of evidence often have to be collected and processed, huge numbers of witnesses may have to be interviewed, and it can take years (sometimes even decades) before the person responsible for a crime is brought to justice. Sherlock Holmes, the famous fictional detective from London's Baker Street, relied on his powers of observation and deduction to solve crimes that baffled the police. But in the real world, it's often **forensic scientists**, working diligently out of the spotlight, who provide the crucial pieces of evidence. How can you use science to solve a crime? Let's take a closer look!

Photo: A forensic scientist examines evidence with an optical microscope. Photo by courtesy of US Department of Energy.

Making sense of a crime scene

The place where crimes like theft, murder, and terrorist attacks take place is called the **crime scene**. Once a serious crime has been reported, detectives head straight for the scene and seal it off to prevent anyone from removing or destroying any **evidence** that may be there. Crime scenes can vary greatly in size. If a car has been broken into in the street, the scene is effectively just the vehicle itself. If terrorist bombs blow airplanes down from the sky, the crime scene can extend over many miles on the ground as accident investigators struggle to recover important bits of the wreckage.

Photo: A forensic scientist searches the wreckage of an aircraft that crashed over Greenland in 1962. Photo by Jeffrey Lehrberg courtesy of US Navy.

A detective's first job is to try to make sense of the crime scene and understand exactly what has happened. This isn't always as easy as it seems. Imagine being called to a house by a neighbor who has heard loud piercing screams. You discover smashed windows, scattered clothes and papers, and a body shot dead in a bedroom. There's a shaken man outside who's trying to tell you about a car he saw screeching away from the house minutes after shots were fired. Are you investigating a robbery? A murder? Maybe the dead person committed suicide and the person who sped from the scene was racing off to get help? Perhaps the witness was mistaken and the

speeding car had nothing to do with the crime? Has the person in the car gone on to commit other crimes elsewhere? Maybe the man you're talking to is actually the murderer? There are often many possible explanations for what has happened. Establishing the exact **sequence of events** immediately before and after the crime was committed is a vital part of any criminal investigation.

Ordinary detectives (police officers who investigate complex crimes) are soon joined at the scene by specialist forensic scientists. These are the people you see on the television news, wandering round in the background of crime scenes in strange white suits. The scientists wear these suits (made from a disposable, papery-plastic protective material called Tyvek®) on top of their own clothes to stop them from contaminating the scene. Their job is to find every single piece of evidence, no matter how small, and take samples away for further investigation.

Picture: Every piece of evidence at a crime scene is meticulously recorded. Photo by Kevin Stabinsky (USAG Fort McPherson) courtesy of US Army.

Depending on the type of crime and how it was committed, there can be many different types of evidence at the scene. There might be fingerprints on doors or windows, on drinking glasses left on tables, or on many other objects around the scene. If someone has been shot, there could be discarded bullets or powder residues. In a sex crime, there may be samples of blood, semen, hair, or discarded clothes. One of the hardest things for a forensic scientist is separating out the really important evidence from all the other things they may find. If they discover hairs on a carpet in a bank where a robbery has taken place, they could well be hairs from the robber's head. Equally, though, they could be hairs from the hundreds or thousands of people who passed innocently through the bank in the weeks or months before. Somehow the forensic scientists have to sort out the one or two pieces of really important evidence from the hundreds or thousands of bits of irrelevant material they are certain to find.

Crime scenes cannot be preserved intact indefinitely, especially when crimes happen in public places that need to reopen as quickly as possible. So, apart from gathering evidence, detectives and forensic scientists aim to preserve an impression of the scene using photographs, sketches, and video recordings. The position of every piece of evidence is carefully measured and recorded before anything is removed. Items of evidence are stored in separate plastic bags and carefully labeled.

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Body of evidence

Picture: Evidence must be carefully protected against tampering once it's been gathered. Photo by Lance Cpl. Alvin D. Parson courtesy of U.S. Marine Corps.

A crime scene is the place where a crime is discovered—but it's not necessarily the place where the crime was committed. When people murder, they often kill in one place but dispose of the body in an entirely different location in an attempt to conceal what they've done. **Serial killers** (murderers who carry out a series of attacks) may kill and dispose of people in many different locations. In this case, the crime scene (the place where a body is discovered) typically contains less useful evidence, and the body recovered from the scene is where the forensic scientists focus their search for clues.

Once the scene has been fully investigated, the body is removed to a mortuary where a forensic **pathologist** will carry out an **autopsy** (a word that originally meant "seeing with your own eyes"), which is also called a **post-mortem** ("after death"): a detailed scientific inspection of the dead person's remains to establish the exact cause of death. Pathologists carefully examine the surface of the body for wounds and bruises, but they also cut it open and weigh and inspect all the internal organs looking for the tiniest of clues. They will look for obvious signs of physical damage (such as stab wounds or signs of strangling), but they'll also do tests to find chemical substances that may indicate poisoning. Murderers are often clever and cunning and they may try to disguise the real cause of death by mutilating the body. For example, if a murderer has killed someone by strangling them, he may attempt to burn the body to prevent the cause of death being established. Or he may cut off the victim's hands to reduce the likelihood of their being identified from fingerprints. Pathologists effectively have to carry out a mini-investigation within the wider criminal investigation to establish exactly how, when, and where someone died. Where a body has suffered multiple injuries or wounds, establishing which one caused the person's death is very important.

The human body is made from soft tissues built on a strong skeleton of bones. The tissues disintegrate quite quickly after death, which can make identifying a victim very difficult. Often detectives have to use dental records and **DNA** (the person's genetic material) to confirm who a person is.

Witnesses and suspects

Some of the most important evidence in a criminal investigation comes from the things people see and hear. Police always appeal for **witnesses** (people who have observed events before and after crimes take place), both to help them establish what has happened and to find out who was responsible. In complex cases, detectives can find themselves interviewing hundreds or even

thousands of witnesses. All these **statements** (the written descriptions of what people say they saw or heard) have to be checked and compared. To complicate matters further, statements often disagree because people don't always remember events accurately—especially in stressful situations or if a long time has elapsed between the crime being committed and the police asking questions.

Picture: Detectives search for witnesses at a crime scene. Photo by courtesy of US Army.

Some of those the police interview may be **suspects** (people thought to be involved in the crime) and they do not necessarily tell the truth when they are questioned. Suspects are usually interviewed much more thoroughly and formally than ordinary witnesses. These interviews may be carried out at a police station with lawyers present, and they are typically tape-recorded so anything the witness says can be used as accurate evidence in court. Sometimes suspects are interviewed repeatedly over a period of weeks or months to see if their stories remain consistent. If suspects are held in custody (locked up in a police station or prison), they are usually kept apart to prevent them fabricating stories. They are also interviewed separately and quizzed about any differences between their accounts of what happened. Police sometimes use psychological tactics to make suspects admit to committing crimes, but they are not allowed to use torture or other violent methods (sometimes known as the **third-degree**). You may have seen pairs of TV detectives using the famous "good-cop, bad-cop" routine, where one tries to befriend a suspect or act sympathetically, while the other is usually more angry and accusing. Psychological techniques like these put criminals under pressure and often yield impressive results.

Meanwhile, back at the lab...

While detectives are interviewing suspects and witnesses and trying to understand the crime more clearly, the forensic scientists will be examining evidence collected from the crime scene for clues. This sort of evidence can be used in two ways. One hope is that the scientists will discover something unusual among the evidence that sheds light on who committed the crime. Suppose samples taken from a murder scene include traces of a rare chemical discovered on a rug near the body. Perhaps it's a chemical the murderer trod in on his shoes that he uses in the course of his work? Identifying the chemical and where it came from then becomes a crucial part of finding the killer.

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Photo: A US army fingerprint specialist examines fingerprints taken from counterfeit currency to find out who they belong to. Photo by Colby T. Hauser courtesy of U.S. Army Criminal Investigation Command.

If the police have a suspect, forensic evidence can be used to try to link that person to the crime scene. Suppose, in the course of interviewing witnesses and suspects, the detectives find someone whom they think carried out a killing. If they can find something that uniquely ties the suspect to the crime scene, such as a sample of the suspect's blood or hair on the victim's clothes, that could help to establish the suspect's guilt. So, an important part of interviewing the suspect involves taking fingerprints plus blood and DNA samples and trying to match those with samples taken from the scene.

This kind of forensic investigation takes place at a police laboratory packed with pieces of state-of-the-art scientific equipment. It's here that forensic scientists carry out meticulous experiments on evidence recovered from the scene (and samples taken from suspects) in an attempt to shed more light on the crime. Just like chemists and biologists in an ordinary science lab, forensic scientists use ordinary optical microscopes for examining samples, but they also have powerful electron microscopes for looking at evidence in much more detail. They can use complex chemical techniques called mass spectrometry and gas chromatography to identify the precise chemicals contained in unknown samples recovered from the scene. With **DNA profiling**, they can attempt to match genetic information taken from a body or a crime scene with samples taken from a suspect.