Criminalistics

Criminalistics is the science and profession dealing with the recognition, collection, identification, individualization, and interpretation of physical evidence, and the application of the natural sciences to law−science matters. The term originated from the book *Handbuch für Untersuchungsrichter als System der Kriminalistik* (3d ed., 1898) by Hans Gross, an investigating magistrate and professor of criminology at the University of Prague. He described the need for a scientifically trained investigator who could undertake certain technical aspects of an investigation and could also serve as liaison between scientific specialists who might assist in the investigation of criminal activity. This concept was popular in Europe, where a number of forensic science institutes were developed to apply the tools and techniques of the natural sciences to the investigation of crime and, generally, in official governmental inquiries.

In the United States and the United Kingdom, with legal systems fundamentally different than those of Europe, the criminalistics profession has developed in a different fashion. Criminalistics laboratories were established in a few police departments in the early decades of the twentieth century (in Chicago, Los Angeles, and New York) and in the Federal Bureau of Investigation (FBI). In the 1970s an infusion of money from the federal government resulted in the formation of numerous laboratories associated with state and local law enforcement agencies.

The majority of criminalists work in laboratories associated with governmental agencies charged with enforcing local, state, or federal laws or regulations. However, a number of criminalists engage in private practice or are employed by academic institutions.

Education

Criminalists require a broad education in the natural sciences, including inorganic, organic, and analytical chemistry; physics; mathematics and statistics; and biology and biochemistry. In addition, curricula in criminalistics or forensic science leading to bachelor's or master's degrees include courses dealing with specific types of commonly encountered evidence materials (such as dried biological fluid stains, impression evidence, or trace evidence), with specific analytical procedures (such as microscopy or instrumental analysis), and with applicable legal issues.

As a consequence of the small number of graduates with degrees in criminalistics or forensic science, many criminalists have undergraduate or graduate degrees in scientific disciplines such as chemistry, biochemistry, genetics, or biology, and have chosen a career in criminalistics after completing their education. A wide variety of in−service training is available, including training through the FBI, the California Department of Justice (through the California Criminalistics Institute), and various professional associations.

Specialists

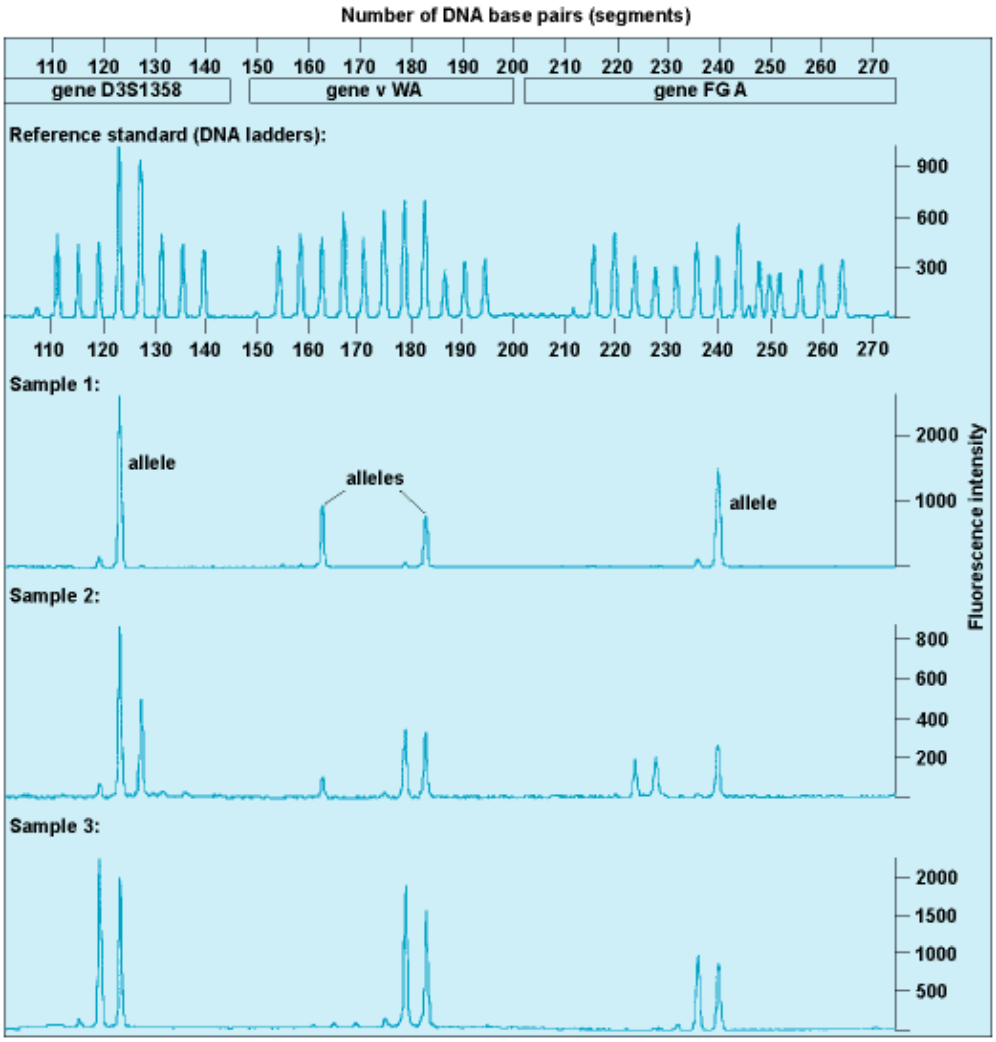
It is not possible for a single person to become proficient in the examination and analysis of all types of physical evidence. Increasingly, criminalists and other workers in forensic science laboratories are specializing in the examination of one or a few types of physical evidence.

Forensic biologists

Forensic biology is the analysis of the biological or genetic properties of evidence. Criminalists specializing in forensic biology are involved in the identification of biological evidence and attempts to determine its source. Traditional methods for the analysis of blood group antigens and genetically variant proteins present in blood, semen, and other biological materials have given way to the analysis of DNA (deoxyribonucleic acid) which can be recovered from such materials. (Fig. 1). The ability to identify the individual from whom a blood or semen sample has come has revolutionized the science of criminalistics. See also: Deoxyribonucleic acid (DNA); Forensic medicine

Fig. 1 Capillary electropherogram of DNA isolated from biological evidence. DNA, isolated from biological material such as blood, semen, hair, or tissue, can be compared with DNA obtained from

suspects or victims of crimes. The polymerase chain reaction (PCR) is used to increase minute amounts of DNA isolated from evidenciary specimens. Analysis by capillary electrophoresis, or other techniques, allows the criminalist to determine, with a very high degree of certainty, that the evidenciary sample is or is not from a particular individual. (*Forensic Science Associates*)



Trace evidence analysts

These specialists analyze material that is transferred between two objects which come into contact (Fig. 2). The Locard exchange principle, credited to the French criminalist Edmond Locard, states that whenever two objects come into contact, portions (or traces) of one object will be transferred to the other. Finding these traces, identifying what they are, and determining their origin through the process of individualization (determination of the parameters of a sample which will allow it to be distinguished from other or all similar items) is the job of the trace evidence analyst. This analysis is based on the chemical or physical properties of the material. Use of the optical microscope and the electron microscope and highly sensitive methods of chemical analysis (such as Fourier transform infrared spectroscopy, energy dispersive x−ray analysis, mass spectroscopy, and neutron activation analysis) are typically used by trace evidence specialists. See also: Mass spectroscope; Scanning electron microscope; Spectroscopy; X−ray fluorescence analysis

Fig. 2 Fiber photomicrographs. Trace evidence such as fibers, hairs, soil, glass, paint, or botanical material may be transferred between two objects which come into contact. A variety of analytical techniques, including polarized light microscopy, fluorescence microscopy, infrared spectroscopy, scanning electron microscopy, energy−dispersive x−ray spectroscopy, and microspectrophotometry are used for the analysis of such materials. The finding of material from one object on another

object provides evidence that the two objects were in contact. (*Forensic Science Associates*)

Firearms and toolmark examiners

These specialists examine firearms, ammunition components, and tools and marks left by them. The underlying principle is that when a tool acts on some object it will leave a mark which is unique due to the configuration of the cutting edge. The uniqueness of each tool is a result of manufacturing processes and postmanufacturing wear and damage. The tool may be a screwdriver which was used to pry open a door or window, or a gun barrel which produced distinctive markings on a fired bullet. The firearms and toolmark specialist will compare the marks on a recovered bullet or a toolmark on a window with guns or tools recovered during the investigation. It is often possible to conclude that a recovered bullet was fired from a particular firearm or that a mark on a window was made by a particular screwdriver.

Other evidence specialists

At a crime scene, physical evidence is routinely encountered (for example, shoe or tire impressions, gunpowder residues on the body or clothing of victims or perpetrators in shootings, fragments of bombs or destructive devices recovered from scenes of sabotage, or pieces of botanical material). There are people who specialize in some of these areas, but often a criminalist is called upon to develop a method for examination of unique evidence, or to consult with a scientist from an industrial or academic laboratory with expertise in an unusual field (such as forensic anthropology). See also: Forensic anthropology

Criminalists are often involved in the analysis of suspected illegal drugs and narcotics, the examination of questioned documents, or fingerprint identification. Although they are familiar with the techniques used for the examination of these types of evidence, the examinations are usually performed by specialists. See also: Fingerprint; Forensic chemistry; Forensic toxicology

Analytical techniques

A wide variety of techniques are used by criminalists for the location and collection of evidence at crime scenes as well as for the examination and analysis of that evidence in the laboratory. Crime scene techniques may involve the use of lasers or other light sources to locate biological stains or minute fibers or paint particles, chemical tests for lead around suspected bullet holes, electrostatic devices to recover a dusty shoe sole impression from a floor, or special reagents for the development of latent fingerprints.

Many techniques used in the forensic laboratory are the same ones that are used by analytical chemists, molecular biologists, materials scientists, and so on. Often these techniques are adapted to the special requirements of the forensic science laboratory. Infrared spectroscopy, mass spectrometry, gas chromatography, optical and electron microscopy, and a host of other standard analytical chemistry techniques find common use by criminalists. See also: Gas chromatography

Routine techniques and procedures have been developed by forensic scientists which have little or no application outside the forensic laboratory. Examples are the determination of genetic markers in minute fragments of dried biological material, the determination of the refractive index of microscopic glass fragments, the microscopic comparison of individual human hairs, and the microscopic comparison of markings on the surface of bullets.

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For Further Study

Topic Page: Chemistry: Analytical chemistry

Topic Page: Medicine: Forensic science

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Additional Readings

- *Journal of Forensic Sciences*, American Academy of Forensic Sciences, Colorado Springs; *Journal of the Forensic Science Society*, Forensic Science Society of Great Britain.
- Criminalistics.com
- Zeno's Forensic Site