SECTION I

Introduction, Field and Laboratory
Protection of the scene is vital, and often law enforcement officers and crime scene technicians will seal off access using crime scene tape with a message such as “Police Line Do Not Cross.” The scene of a violent crime will often contain shed blood. Evidence collected at the scene is packaged in a way that will prevent loss or contamination and reveal unrecorded attempts to access it: Red or blue “evidence tape” that is impossible to peel away without damaging it is often used. Sometimes physical objects with an obvious evidential value are found; this handgun can be tested for fingerprints and DNA to attempt to identify the shooter, and bullets and cartridge cases from fired ammunition can be compared to those in the NIBIN database to see if the weapon has a history of criminal use. Fingerprints, whether obvious ones in blood as shown here or latents developed using a variety of techniques, have been the mainstay of scene evidence used to identify perpetrators for more than 100 years. Image from Stockxpert.
WHAT IS FORENSIC SCIENCE?

Forensic has several meanings, one of which pertains to courts of judicature. However, Webster includes “relating to or dealing with the application of scientific knowledge to legal problems” in its more modern definition. The application can be in one or more of many specific fields of study or branch of specialized knowledge such as science, technology, medicine, or other area of knowledge used to assist courts to resolve disputes, whether criminal, civil, or administrative. The term used in the book title is criminalistics, which is the application of forensic science to criminal matters. The term criminology is sometimes inaccurately used as a synonym for criminalistics but refers to the social science study of crime and criminal behavior, whereas criminalistics is the application of science to the solution of crimes.

Physical Evidence

In practice, “the application of science to the solution of crimes” is the examination of physical evidence in the field or the crime laboratory. Physical evidence consists of tangible articles such as hairs, fibers, latent fingerprints, and biological material. The strength of criminalistics lies in the reliability and objectivity of the scientific testing. The objectivity is a distinguishing feature of physical evidence from testimonial evidence such as written statements or the spoken word from the victims or witnesses.

Some evidence will be absolute, in that the examination reveals direct information about its identity and therefore its role in the crime being examined. Examples include Documents (Chapter 5); Drugs and Toxicology (Chapters 8 and 10); Explosives and Accelerants (Chapter 9); and Digital Evidence (Appendix B). Many times, however, samples removed from the crime scene are tested to produce evidence of association between people and places or objects, between different objects, or between people and other people. Examples include Tool Mark and Impression Evidence (Chapter 2); Firearms (Chapter 3); Fingerprints (Chapter 4);
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Physical Evidence (Chapter 6); Hair and Fiber (Chapter 7); Biology (Chapter 11); DNA (Chapter 12); and Personal Effects (Appendix A).

BOX 1.1 LOCARD’S EXCHANGE PRINCIPLE

The principle underlying the value of testing associative evidence is that every time someone enters an environment, something is added to and removed from it. This concept has become known as Locard’s exchange principle, named after the French criminalist Dr. Edmond Locard, who wrote several treatises in the 1920s postulating that microscopic examination of clothing and other physical evidence could reveal information about the history of the wearer. However, he never actually enunciated the principle, and its value is tempered by factors such as loss of transferred materials, contamination, and the extent to which the material is common throughout the environment of interest. Locard and others have called physical evidence the “silent witness,” and it can provide valuable information as to the circumstances of a crime.

INCEPTIVE EVIDENCE

Physical evidence may be a vital element in proving there was a crime, as in the case of identification of drugs in dealing or possession offenses, and the identification of accelerant in arson. Evidence used to show whether or not a crime has been committed is known as inceptive evidence. Inceptive evidence seldom also contains identification or associative evidence information.
IDENTIFICATION EVIDENCE

Physical evidence may help identify someone, as with fingerprints and DNA testing and databases. It is generally accepted that fingerprints (Chapter 4) and DNA profiles (Chapter 12) are sufficiently close to unique to provide compelling evidence of identity. However, it is important to be aware that the only absolute conclusion that can be drawn from physical evidence is that of non-identity, when the testing excludes a putative source as the origin of the physical artifact. Firearms (Chapter 3) and questioned documents (Chapter 5) are particular forms of identification evidence where the objective of the testing is to identify the weapon that fired a bullet or the person or machine responsible for creation of a document.

ASSOCIATIVE AND CORROBORATIVE EVIDENCE

As described previously, a common reason for testing physical evidence is to explore whether or not people and objects have been in contact with each other. The strength of this associative evidence depends on several things, including the circumstances of the case and how unique the material is that has been transferred. In the absence of an exclusion, physical evidence falls into the category of corroborative evidence providing support to testimonial or other physical evidence. Consider the situation where a rape victim nominates a man as her assailant. A DNA match between semen on a swab from the victim and the DNA of the suspect is a powerful corroboration indeed, but before the introduction of DNA, blood groups identified from tests on these samples might have matched but also have been found in 50% of the population — not very compelling yet not a result that refutes the testimonial evidence of the victim. And even the DNA evidence has its limitations: It proves intercourse between the two; however, intercourse is a crime only when there is no consent, and DNA is silent in that regard.

THE CRIME SCENE

Everything that happens at the crime laboratory concerning the scientific examination of physical evidence begins with the criminal act — at the crime scene. The crime scene therefore is the start of any forensic science investigation. Crime scenes may be indoors or outdoors. They may be expansive or quite small. In the case of a violent crime, the assailant’s body is also a crime scene.

Evidence is collected by any number of different personnel, depending on the nature of the crime. In less serious crimes, the first officer to arrive at the scene may collect evidence. In more serious or complex crime scene investigations, specialized personnel such as crime scene investigators and sometimes forensic scientists may be used. It generally depends on the resources of the investigating agency.

Scene Processing

Processing the scene follows a fairly consistent methodology. The scene must be well documented and the location of evidence recorded. This is done by...
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BOX 1.2 THE CRIME SCENE

The essential elements of successful crime scene investigation are:
- Protection of the scene against contamination, degradation, and loss of evidence
- Documentation of the scene to ensure the integrity of identification of samples and the place where they were found
- Systematic searching to ensure identification and collection of relevant evidence
- Appropriate collection, packaging, and labeling of evidence

In some cases with outside scenes, special steps will need to be taken to ensure one or more of the requirements is met. For example, it may be necessary to erect a tent to protect a scene from rain and wind, or physical marks such as tire tracks in snow may need to be given priority before the integrity of the mark is lost.

FIGURE 1.2 Documenting and collecting evidence from the scene. A crime scene officer from the Los Angeles County Sheriff’s Department identifying the locations of firearms evidence at an outdoor scene and collecting handgun for subsequent laboratory investigation. Image courtesy of LACS Crime Laboratory.

a variety of procedures: crime scene sketches, photography, videography, and, more recently, using laser-computer-assisted surveying devices. The point of this effort is to capture how the scene appeared after the crime was committed in hopes of reconstructing it, i.e., figuring out what happened and noting the location of physical evidence present at the scene.

Large scenes may be searched using one of several orderly approaches. Two common patterns are:
- Spirals working outward from a focal point
- Lanes in which the scene is divided into lateral or lengthwise segments

A smaller outdoor scene or an indoor scene such as a house can be methodically searched by areas or rooms, starting from the perimeter access point.

Vehicles can be searched on-site at the scene or transported to a garage or workshop. In the latter case, it may be advisable to conduct a preliminary search of the outside of the vehicle before removing it to the workshop so that evidence is not lost during the transportation process. On the other hand, a thorough search of a vehicle can involve methodical dismantling of the bodywork, for example, in locating concealed drugs.

Generally, the most fragile evidence is collected first. Thus, photographs are taken before anything is moved. Fingerprints are often collected next, as they may be accidentally destroyed. Next, small and even microscopic items of evidence are collected. The process may take a few hours to, in some cases, several days, depending on the nature of the scene. Sometimes time is of the essence, such as in a rain shower or when the scene is on
a busy highway or intersection. Experience, flexibility, and the nature of each case dictate how one may proceed. Each case has the possibility of being totally different from anything anyone has ever seen. Above all, cooperation and teamwork are key.

**Preservation of Evidence**

Crime scene personnel need to be aware of the potential that they possess to contaminate the scene. Protective clothing such as Tyvek paper suits (see Figure 1.3), mouth masks, hair nets, latex or nitrile gloves, sleeve protectors, and shoe covers are essential when examining a scene where biological or trace evidence may be collected. Aids such as an alternate light source (see Chapter 6, “Physical Evidence”) or fingerprint collection kits may need to be deployed.

Entry and egress points need to be controlled to prevent damage to marks (Chapter 2) or introduction of misleading marks from investigator footwear or vehicles.

Collected evidence must be packaged correctly. Biological samples should be collected dry, or if that is not possible, placed in paper bags; in order to prevent development of molding, they must never be placed in plastic bags. Weapons require special care to prevent accidental discharge of firearms or damage to or from knives.
Drug laboratories are highly specialized scenes with many hazards including reaction chemicals, highly potent drug products, and even deliberate placement of booby traps.

Evidence such as clothing must be placed in packages that are completely sealed in a manner that prevents loss or contamination of contents, and the packages must be labeled with a unique identification that is recorded in the scene log. Seals should be made with material that will show when an attempt to tamper with the closure has been made. In the case of larger items, evidence areas can be protected by taping paper over the area of interest. Smaller trace materials can be removed by taping, vacuuming through a filter, or scraping (Chapter 6).

**Chain of Custody**

Every item removed from the scene and taken to the laboratory must be identified in a way that guarantees its integrity. It must have a unique marking that can be used to identify its history from collection to disposal.

**PROVISION OF FORENSIC SERVICES**

**Crime Laboratory Services**

Crime laboratory services are delivered in a wide variety of ways. The American model varies from state to state and is different from most other systems throughout the world. The United States maintains a federal delivery system and a state–local system, each with differing yet occasionally overlapping jurisdictions. Most of the crimes are committed within state jurisdictions. Federal violations are typically interstate crimes and federal crimes, for example, counterfeiting and smuggling. Federal investigators and their forensic science laboratories, such as the FBI and the Drug Enforcement Administration, investigate these crimes while local jurisdictions rely on state or local crime laboratories in the majority of criminal investigations.
State and municipal forensic science services are provided for in different ways depending on the region of the country. Most forensic science or crime laboratories are under the jurisdiction of police or sheriff’s departments. Some come under prosecutor’s offices, and others are part of medical examiner or coroner offices. A few states have forensic science departments that are not directly affiliated with police or prosecutorial offices. Most crime laboratories provide services at no charge.

Crime laboratories vary in the range of services that they provide. Most of the medium to larger size facilities offer “full service” operations. These are essentially the tests described in this book, namely:

- Tool marks and pattern evidence (Chapter 2), often provided as part of the firearms section (Chapter 3) and sometimes provided by law enforcement personnel not part of the crime laboratory
- Fingerprints (Chapter 4), and as with tool marks, sometimes provided by law enforcement personnel not part of the crime laboratory
- Documents (Chapter 5), one area that has seen a decline in its presence in public laboratories in recent times but that has an active private sector presence, especially for civil work
- Physical evidence (Chapter 6) and hair and fibers (Chapter 7), often combined into “trace evidence” but an area that has changed from dominating associative evidence to become less significant with the almost explosive growth of DNA
- Controlled substances (Chapter 8)
- Arson and explosives (Chapter 9), often described as “chemical trace” and sometimes combined with the paint and glass work of the physical evidence section
- Toxicology (Chapter 10), often restricted to alcohol and mainly found in the very largest crime laboratories and medical examiner–coroner facilities
- Biology (Chapter 11) and DNA (Chapter 12), with biology being mainly pre-DNA screening; DNA is also the area of criminalistics that has the greatest volume of delivery from the private sector, but mainly in the form of analysis of reference samples for DNA databasing
- Digital evidence (Appendix B)

Specialist areas such as terrorist and civilian bomb scene analysis are conducted mainly by federal units, including the Bureau of Alcohol, Tobacco, and Firearms; other specialist techniques such as bloodstain pattern analysis are found mainly in larger crime scene units attached to law enforcement rather than crime laboratory sections.

**Death Investigation**

Death investigation is under the purview of the medical examiner or coroner’s office, which has the responsibility to determine the manner and mode of death. That task is the responsibility of the forensic pathologist.
Some medical examiner and coroner offices are large enough to maintain postmortem forensic toxicology services to examine tissue for the presence of drugs. Alternatively, that service may be performed by the crime lab or private laboratories.

**QUALITY ASSURANCE AND PROFESSIONAL ISSUES**

It should be obvious that the test results and conclusion of forensic science work are important to the outcome of police investigations. Appalling things can happen if mistakes are made in the lab. The wrong person has been sent to prison and in some instances executed because of improper work. It is no stretch of the imagination to suggest that if an innocent person is convicted, the guilty may continue to commit crimes. The consequences are significant, and the public has an interest in first-rate forensic science work being done in criminal investigations.

How can the criminal justice system and the public be assured of quality forensic science? Consider hospitals as a benchmark. It is doubtful that anyone would deliberately go to a nonaccredited hospital for a medical procedure. Similarly, patients would be averse to using non-board-certified physicians to perform surgeries. Forensic science laboratories and practitioners should be viewed in the same fashion.

**Accreditation**

In August 2004, the American Bar Association adopted the following resolution (which is part of a larger series of recommendations) on forensic evidence:

> The American Bar Association urges federal, state, local and territorial governments to reduce the risk of convicting the innocent, while increasing the likelihood of convicting the guilty, by adopting the following principles: Crime laboratories and medical examiner offices should be accredited, examiners should be certified, and procedures should be standardized and published to ensure the validity, reliability, and timely analysis of forensic evidence.

**Accreditation, certification, and proficiency testing** are the corner stones to an effective quality assurance program in a forensic science laboratory. While no program can guarantee a process to be totally error free, a well run quality assurance program lessens the chances for errors to occur. In the United States, quality assurance programs are largely voluntary. A few states require their public crime laboratories to be accredited.

There are two accreditation programs for crime labs in existence today in the United States, both based around ISO 17025. The American Society of Crime Laboratory Directors/Laboratory Accreditation Board (ASCLD/LAB) program is the oldest specialist crime laboratory accreditation program in the world. A more recent accreditation program for forensic science based on an internationally accepted standard for the competency of testing laboratories was introduced...
in 1999 by Forensic Quality Services, and a similar program is now also offered by ASCLD/LAB. Programs for toxicology laboratories and for medical examiners are offered by the American Board of Forensic Toxicology and the National Association of Medical Examiners, respectively.

**Certification**

In contrast to accreditation, which is focused on the overall quality system implemented by the laboratory, certification deals with credentialing individual practitioners and demonstrating competency in various forensic disciplines. Certification of forensic scientists, like accreditation of crime laboratories, is largely a voluntary program. Some forensic science laboratories use certification as a means to evaluate competency to promote practitioners from entry-level positions to journeyman-level positions.

The American Board of Criminalistics (ABC) defines certification as

> a voluntary process of peer review by which a practitioner is recognized as having attained the professional qualifications necessary to practice in one or more disciplines of criminalistics

ABC has earned wide acceptance in the forensic science community in forensic chemistry, forensic biology, and criminalistics-related areas.

Other organizations that offer certifications in related fields are the International Association for Identification (IAI) and the American Board of Forensic Toxicology (ABFT). The ABC, IAI, ABFT, and other credentialing bodies are well regarded in the forensic science community, and practitioners who work toward these certifications often show great promise in the forensic field. However, not all certifying bodies have shown the same degree of professionalism. The American Academy of Forensic Sciences (AAFS) established the American Specialties Accreditation Board as an independent body to accredit certifying bodies.

**Proficiency Testing**

If laboratory accreditation and individual certification are essential elements to quality in forensic science, proficiency testing helps to demonstrate that labs and examiners maintain a level of competency in their field. Proficiency tests are manufactured, made-to-look-like-evidence tests. They are available for purchase from external vendors, can be produced by other forensic labs, or prepared by the forensic lab.

There are a few different types of proficiency tests that forensic labs use: blind, declared, and re-examination tests. Blind samples are tests that are made to appear like casework and are created so that examiners do not know they are being tested. Outwardly, blind tests look like any other case.

Blind proficiency tests lend themselves to high-volume cases such as drug and toxicology casework. They are easily prepared and simple to introduce into the lab as casework. Blind proficiency
tests do present some difficulties as tests for evidence in major crime cases. Often, labs have backlogs in their major crime cases, that is, homicides, rapes, and assaults. As a consequence, the way in which crime labs prioritize such cases is to triage them. The most serious cases, cases with court dates, high-profile cases, and so on, are given priority and examined first. Often, examiners contact detectives to decide what work needs to be done on a given case or if the case is still active. For blind proficiency testing to work, detectives, and in some cases, prosecutors, have to “play along” and convince the examiner that the examination is really needed.

In addition to having detectives and prosecutors participate in keeping a blind proficiency test program “blind,” another issue concerns types of evidence placed into state or national databases. Part of the DNA testing protocol involves entering results into CODIS, the national DNA database. Naturally, these samples need to be “flagged” and the results removed at some point.

While some who are unfamiliar with case management or forensic lab operations suggest that blind proficiency testing is a viable solution to enhanced laboratory performance, others recognize that these practices are often difficult to manage and cause undue burdens on already over burdened forensic laboratories.

**SUMMARY**

Forensic science is the application of scientific knowledge to legal problems. Criminalistics is the application of forensic science to criminal matters. Physical evidence consists of tangible materials. The strength of criminalistics lies in the reliability and objectivity of the scientific testing. Evidence may include documents, drugs, biological fluids, tool marks, fingerprints, firearms, DNA, or even personal effects. Locard’s exchange principle posits that every time someone enters an environment, something is added to and removed from it. Inceptive evidence is used to show whether or not a crime has been committed. Identification evidence is sufficiently close to unique to provide compelling evidence of identity. Corroborative evidence supports testimonial or other physical evidence.

The absence of evidence is not the evidence of absence.

The crime scene is the start of any forensic science investigation. Evidence may be collected by different personnel under different circumstances; however, the steps to processing a crime scene are generally the same:

- Secure the scene against contamination, degradation, and loss of evidence
- Document the scene
- Search the scene and collect relevant evidence
- Package, label, transport the evidence to the lab

Documentation captures the scene after the crime was committed—noting the location of physical evidence present—so that a reconstruction may be attempted. Methods of documentation include sketches, photography, videography, or laser-sighted computer-assisted surveying devices.
Large crime scenes may require pattern searches. Two common methods are spirals working outward from a focal point and “lanes” in which the scene is divided into lateral or lengthwise segments.

Collected evidence must be collected and packaged correctly. For example, wet biological samples should be placed in paper bags and firearms must be secured to prevent accidental discharge. Trace materials can be removed by taping, vacuuming through a filter, or scraping.

Every item removed from the scene and taken to the laboratory must be identified in a way that guarantees its integrity.

Crime laboratories vary in the range of services that they provide. Processing may include:
- Tool marks and pattern evidence
- Firearms
- Fingerprints
- Documents
- Physical evidence (paint, glass, etc.)
- Hair and fibers
- Controlled substances
- Arson and explosives
- Toxicology
- Biological samples and DNA
- Digital evidence

Accreditation, certification, and proficiency testing are the cornerstones to an effective quality assurance program in a forensic science laboratory.

**PROBLEMS**

1. Give the word or phrase for the following definitions:
   a. the application of scientific knowledge to legal problems
   b. the application of forensic science to criminal matters.
   c. evidence used to show whether or not a crime has been committed.
   d. evidence consisting of tangible materials.
   e. evidence supporting testimonial or other physical evidence.
   f. a process which ensures the quality of a laboratory or facility.

2. Explain Locard’s exchange principle.
3. Describe the steps to processing a crime scene.
4. Describe several methods of documentation.
5. Describe two common methods of searching.
6. Describe the process of removing evidence from a crime scene.
7. Name seven types of evidence.
8. Describe the uses of accreditation, certification, and proficiency testing.

**GLOSSARY**

Accreditation ensures the quality of a laboratory or facility.

Certification ensures the quality of a forensic examiner.
Criminalistics the application of forensic science to criminal matters.
Documentation sketches, photography, videography, or laser-sighted computer-assisted surveying to capture the scene after a crime was committed—noting the location of physical evidence present—so that a reconstruction may be attempted.
Forensic science the application of scientific knowledge to legal problems.
Identification evidence evidence sufficiently close to unique to provide compelling evidence of identity.
Inceptive evidence evidence used to show whether or not a crime has been committed.
Locard’s exchange principle every time someone enters an environment, something is added to and removed from it.
Pattern searches methods to search large crime scenes.
Physical evidence tangible materials; physical evidence may include documents, drugs, biological fluids, tool marks, fingerprints, firearms, DNA, or personal effects.
Proficiency testing evidence manufactured to look like a real case to test forensic examiners’ abilities.