Chapter 18 **Firearms and Ballistics**

By the end of this chapter you will be able to:

18.1 Compare and contrast the different types of firearms, including handguns, rifles, and shotguns.

18.2 Put in order the sequence of events that result in a firearm discharging.

18.3 Estimate the trajectory of a projectile.

18.4 Discuss the composition and formation of gunshot residue and its reliability as a source of evidence.

18.5 Compare and contrast entrance and exit wounds, including size, shape, gunshot residue, and the presence of burns.
Chapter 18 **Firearms and Ballistics**

By the end of this chapter you will be able to:

18.6 Distinguish among the various forms of firearms evidence, including rifling, markings on cartridges, marks on projectiles, and gunshot residue.

18.7 Discuss how technology has improved the ability to obtain, compare, analyze, store, and retrieve firearm and ballistics evidence.

18.8 Process and/or analyze a crime scene for firearm and ballistics evidence.
Chapter 18
Vocabulary

- ballistics
- breech
- bullet
- caliber
- cartridge
- firearm
- gunshot residue (GSR)
- lands and grooves
- pistol
- revolver
- rifle
- rifling
- trajectory
Introduction

Types of ballistic evidence that can be used to help solve a crime include:

- Guns used in a crime
- Spent cartridges
- Bullets embedded in a murder victim
History of Gunpowder and Firearms

- More than 1000 years ago, the Chinese invented gunpowder.
- In 14th-century Europe, inventors learned they could direct the explosive force of gunpowder down a cylinder to move a deadly projectile.
- The earliest firearms, which date back to 1475, had wicks to carry a flame to the gunpowder.
History of Gunpowder and Firearms (continued)

- At the beginning of the 1600s, flintlock firearms began to be used.
- Around 1820, percussion-cap firearms replaced flintlock firearms.

*Figure 18-1* A percussion-cap firearm ignites the gunpowder using a primer that explodes when struck by a small hammer.
Long Guns and Handguns

- Long guns require the use of two hands.
  - Rifles
    - Fire bullets
  - Shotguns
    - Fire either small round pellets or a single projectile

- Handguns can be fired with one hand.
  - Pistols (revolvers)
  - Semiautomatic firearms
**Figure 18-2** Shotguns, which are often used for hunting game birds, can fire many small pellets at once. Below right, you can see different types of shotgun projectiles, or “shells” (not to scale with the shotgun). Shells differ in size and shape depending on their use.
Firearms and Rifling

- Each rifled gun barrel is unique.
- As a gun is fired, the barrel marks the bullets with its own unique pattern.

Figure 18-3 Bullets fired from a firearm show patterns of lands and grooves that are consistent with the rifling of the firearm.
Bullets and Cartridges

The cartridge contains:

- Primer powder
- Gunpowder
- The bullet
- The casing material that holds them altogether
Bullets and Cartridges (continued)

- Anatomy of a Cartridge
  - Bullet
  - Primer powder
  - Headstamp

Figure 18-5: A typical centerfire cartridge.
Bullets and Cartridges (continued)

- The headstamp on the bottom of the cartridge casing identifies:
  - The caliber
  - The manufacturer
How a Firearm Works

- When the trigger is pulled, the primer powder mixture ignites.
- The primer powder mixture delivers a spark to the gunpowder supply.
- The pressure of the expanding gases propels the bullet from the casing and into the barrel.
- The bullet exits the barrel.
Figure 18-7 The sequence of events in the firing of a bullet.

1. Trigger
2. Hammer
3. Cylinder
4. Barrel
5. Firing pin
Caliber of a Cartridge

- The caliber is a measure of the diameter of the bullet.
  - Hundredths or thousands of an inch
- The European method of naming firearm caliber uses the metric system for measurement of bullet diameter.
  - Nine-millimeter firearms fire 9 mm bullets.
Figure 18-8  The caliber of a bullet is its diameter.
Evidence from Bullets and Cartridges

- To compare the markings on an evidence bullet to the markings on a suspected firearm barrel, a firearm examiner can test-fire similar bullets from the suspected firearm into a water tank or gel block.
- Ballistics soap can be used to determine the yaw damage caused by a bullet.
- Ballistics gel retains the path of a fired bullet.
Figure 18-9 The barrel of a firearm has a unique pattern of rifling, which leaves a corresponding pattern of lands and grooves on the bullets it fires.
Marks on Spent Cartridges

- Firing pin marks
- Breechblock markings
- Extractor and ejector marks
Figure 18-11  Depending on the firearm and cartridge used, the firing pin mark appears on the center (left) or the rim (right) of the spent cartridge.

Centerfire impression on a .40-caliber cartridge.  

Rimfire impression on a .22-caliber cartridge.
Gunshot Residue

- Gunshot residue can adhere to the person holding the firearm, leaving evidence on him or her.
- In close-range shootings, some GSR may be deposited on the victim.
Figure 18-12 When the trigger is pulled, the firing pin strikes the primer, which explodes, igniting the gunpowder. As gases from the explosion expand, the bullet and GSR are propelled forward.
Evidence from Spent Bullets and Wounds

- Generally, entrance wounds are smaller than exit wounds.
- If a bullet penetrates clothing first, fibers may be embedded in the wound, indicating the direction of penetration.
- If the bullet is fired when the muzzle is in contact with the skin, flash burns to the skin may result.
- Radial tears in the skin occur if the gunshot is directly over bone.
- Beyond four feet, only a bullet hole is visible.
Figure 18-13  Bullet holes from different distances. The GSR pattern (left) was produced by a close-range shot. The bullet hole on the right was produced by a shot from several feet away.
Gravity and Trajectory

Figure 18-14 A bullet’s trajectory is slightly curved, because as it moves toward the target, gravity pulls it downward. The following diagram is highly exaggerated to demonstrate this effect. The greater the distance between the shooter and target, the greater the effects of gravity, wind, and humidity.
Using Trajectory to Estimate the Location of a Shooter

Figure 18-15 The trajectory of the bullet is determined by using two points along its path: the hole in the windshield and the hole in the driver’s seat. Notice the right triangle formed (in red).

Windshield

Path of bullet

a = 60 feet (720 inches) to building
Databases

- National Integrated Ballistic Information Network (NIBIN)

- A combined database of the FBI and the Bureau of Alcohol, Tobacco, Firearms, and Explosives containing:
  - Firearms and projectiles databases
  - Firearm "fingerprints"
Ballistics Evidence Standards

- The Organization of Scientific Area Committees (OSAC)
- Coordinates standards to improve the reliability of forensic science evidence including digital images of the firearm fingerprint

Figure 18-16 This cartridge shows three distinct impressions—the firing pin (FP), the breechblock face (BF), and the ejector mark (EM).
Ballistics is the study of the mechanics of the launching, flight, and behavior of fired projectiles.

Modern firearms are divided into two basic types—long guns and handguns—that require two hands or one, respectively, for accurate firing.

Handguns can be classified as revolvers or semiautomatic firearms, depending on the loading mechanism.

Bullets fired from a firearm show patterns of lands and grooves that can be compared with the rifling pattern in the barrel of the firearm.
A cartridge consists of primer powder, gunpowder, a bullet, and the casing material that holds them all together.

The caliber of a cartridge is the diameter of its bullet and is included with the name of the manufacturer on the headstamp.

In addition to examining lands and grooves on a bullet, investigators can examine firing pin marks, breechblock marks, and extractor and ejector marks on a spent cartridge to compare evidence at a crime scene with a specific firearm.

Gunshot residue on shooters can help investigators identify a suspect.
Investigators can use databases, such as the national database NIBIN, to compare crime-scene evidence to evidence collected from previous crimes.

Using at least two reference points, an investigator can recreate a bullet’s trajectory and estimate the location of the shooter.

Advances in technology, including comparison microscopes and mass spectrometry, have improved the ability of firearms and ballistics experts to compare crime-scene evidence with test-fired projectiles and GSR analysis.