What is forensic science? What does the term “forensic science” mean? One definition is “relating to the use of science in the investigation of criminal activity and the analysis and presentation of evidence before the court.” Thus, forensic science is the interface of science and the law. Medico-legal, a term that is often substituted for forensic, makes clear this linkage between law and medical science. Forensic science is the application of various scientific methods to legal matters. It is the viewing of science, not through the glasses of a scientist, but rather through the lens of the law.

The word forensic is derived from the Latin word forum. In ancient Rome, the forum was where merchants, politicians, scholars, and citizens mingled and discussed issues of common interest. It also served as the place where public trials took place.

Today, the term “forensic” is applied to anything that relates to law, and forensic science is the application of scientific disciplines to the law. It is important to note that it differs from the term “clinical,” which means “related to a medical clinic.”

For example, clinical toxicology deals with medications and drugs in the care of medical patients. The clinical toxicologist will analyze samples
taken from an intoxicated or deceased individual to determine what drugs might be present and if they played a role in the person's intoxication or death. He will determine if a patient's blood level of a certain drug is adequate to treat his condition without being high enough to cause side effects or other medical problems. In other words, the clinical toxicologist is concerned with patient care and treatment.

A forensic toxicologist uses similar testing procedures to help resolve legal issues. Did the victim die from a poison or a drug overdose? Was the erratic driver intoxicated? Was a suspect's aberrant behavior due to drug usage? Was a particular employee complying with her company's drug policies? Forensic toxicology deals with these types of questions.

A similar difference is seen between a clinical (hospital) pathologist and a forensic pathologist, who sits at the apex of the forensic (medico-legal) investigative system. A clinical pathologist is concerned with helping other physicians treat the ill. To do this, he might oversee the clinical lab, interpret lab tests, review biopsies and surgically removed tissues, and perform medical autopsies. A medical autopsy is designed to determine why someone died and to discover what complicating disease processes might also have been present.

The forensic pathologist is concerned with criminal harm and death. She might direct the crime lab (although not always, since more often than not the crime lab falls under the wing of the police or sheriff's department), interpret forensic tests, and perform forensic autopsies. A forensic autopsy is designed to explain why someone died or was injured, with the focus being to determine if a criminal act had taken place.

Similarly, a forensic (crime) lab is quite different from a medical (clinical) lab. Tests performed within the clinical or hospital lab are directed toward aiding the diagnosis and treatment of ill patients. A forensic lab is geared toward evidence testing in the hope of establishing a link between a suspect and a crime.

How did this marriage between law and science come about?

**The Development of Forensic Science**

How old is forensic investigation? When was science first used to solve a criminal case? No one knows for sure, but many feel that the origins can
be traced to the famous Chinese investigator Sung T’zu, who published the first text on forensic science in 1247. It carried the rather poetic title Xi Yuan Ji Lu, or The Washing Away of Wrongs. It represented the first organized study of criminal investigation and touched on topics such as autopsies, causes of death, postmortem decay and insect activity, and poisoning. It soon enjoyed translation into other languages, including Japanese, German, French, Russian, and English.

The field of forensic science evolved in fits and spurts over the centuries that followed. Some techniques developed early and progressed rapidly, while others took a more leisurely pace, and still others are truly modern discoveries. No forensic science technique just magically appeared, but rather each followed its own unique evolutionary process.

Modern forensic science rests on a foundation of centuries of scientific discovery and, in fact, it could not have developed until sufficient knowledge of basic physical and biological principles was available. How could DNA testing become an accepted procedure until we knew DNA existed and understood how it worked? How could fingerprints be used for identification until we discovered their existence and their uniqueness?

The typical evolution of any scientific principle or technique is its initial postulation or discovery, followed by its testing and refinement by the scientific community. From there it usually enters the medical arena and then goes on to become a useful forensic tool. Virtually every forensic science technique, including procedures in ballistics, toxicology, and serology (the study of blood and body fluids), has followed a similar path.

For example, in 1901 Karl Landsteiner discovered that human blood contained certain proteins that could be grouped by types and from this devised the ABO blood groups that we still use today. His discovery opened the door for safe and effective blood transfusions without the danger of serious, even deadly, reactions. In 1915, Leone Lattes used Landsteiner’s discovery to develop a simple method for determining the ABO type of a dried bloodstain and almost immediately applied his new technique to criminal investigations. Even today, ABO typing is used to identify suspects, exonerate the innocent, verify or refute paternity, and reconstruct crime scenes.

Throughout this book we will see similar evolutionary processes for many other forensic science techniques.
The First Forensic Scientists

This will probably surprise you: The first forensic scientists did not come from the world of science but rather from the world of fiction. (Proof that not only does art imitate life, but also that life imitates art.)

Sir Arthur Conan Doyle’s Sherlock Holmes frequently used the sciences of fingerprinting, document examination, and blood analysis to solve crimes. In the first Sherlock Holmes novel, *A Study in Scarlet*, Holmes developed a chemical method to determine whether a stain was blood or not. Since this technique had yet to be used in a real-life criminal investigation, Sherlock was definitely ahead of the curve.

In his 1883 memoir *Life on the Mississippi*, Mark Twain talks of a thumbprint being used to identify a murderer. This predated both the groundbreaking work on fingerprints by Sir Francis Galton, who received knighthood for the “discovery” that he summarized in his 1892 book *Fingerprints*, and the famous Rojas case in Argentina (also 1892), which marked the first time that fingerprints had been used to gain a murder conviction. Later, Twain wrote of fingerprints being used in a trial in *The Tragedy of Pudd’nhead Wilson*, a work serialized in *Century Magazine* in 1893–1894 before appearing in novel form in 1894.

In each of these cases it is likely that the author was at least aware that testing for blood and fingerprint examinations was being studied rather than simply creating these techniques from whole cloth for their stories. Rumors and concepts often precede any true scientific discovery.

The first real-life forensic scientist was Hans Gross. His reasoned and methodic approach to criminal investigation and the mind of not only criminals but also their pursuers laid the foundation for modern criminology. In 1893, he published the first treatise on the use of scientific knowledge and procedures in criminal investigations. His classic 1910 work *Criminal Psychology* laid out the principles of criminal behavior and how evidence should be evaluated and used in criminal proceedings.

Others soon followed in Gross’s footsteps, most notably Edmond Locard, a police officer and professor in Lyon, France. Locard made an extremely important observation that became known as Locard’s Exchange Principle, which to this day remains the cornerstone of forensic investigation. It will be discussed in detail in Chapter 3.
An extensive timeline of forensic science achievements and milestones is included at the end of this book.

**The Coroner and the Medical Examiner**

You’ve probably seen the terms “coroner” and “medical examiner” used almost interchangeably. In truth they are quite different even though each can be the person in charge of “all things death.” The title this person carries, whether coroner or medical examiner, depends upon which system is in place in the particular jurisdiction. In the United States, these are county-level positions, and the title afforded and the duties that follow vary from county to county.

The term “coroner” derives from the English office of the “crowner of the king” or the “keeper of the pleas of the Crown.” It is unclear exactly when the office of coroner came into existence, but it might have predated the Norman Invasion since it was mentioned as early as 871, during the reign of Alfred the Great. However, it is believed that King Richard Plantagenet, also known as Richard the Lionheart, officially created the position in 1194. Then, in 1276 a legal document known as De Officio Coronatoris set out the coroner’s duties and obligations. This was later replaced and refined by the Coroner’s Act of 1887.

This “crowner” performed many functions that we associate with the modern coroner, including determining the cause of death. He also served as a judge in criminal proceedings. In this capacity he was considered an inquisitional judge in that he actually investigated crimes and actively pursued evidence and criminals rather than merely serving as “the trier of fact” for criminal cases. Inquisitional judges have their origin in ancient Roman law and serve as the basis for the judicial systems found in Russia, Spain, France, and other countries. Under English law, courtroom judges are non-inquisitional and are not actively involved in criminal investigation or evidence gathering. Rather, they hear the evidence provided by others and oversee the proceedings within the courtroom.

The English coroner is unique in that he is an inquisitional judge, who actively investigates crimes, in a non-inquisitional system. Early English settlers to the New World brought the office of the coroner with them so that in the United States we have a similar inquisitional coroner system.
The medical examiner (ME) is a more modern invention. Its origins can be traced to France and Scotland, and in the late 1800s this system was also brought to the United States. In almost all jurisdictions, the ME is a medical professional with at least an MD degree, and most modern MEs are trained in pathology, particularly forensic pathology.

In the United States, both of these forensic investigative systems exist. It varies from county to county so that one county might have a coroner while its neighbor has a medical examiner. For centuries in England, the king appointed the coroner. In the United States, since there was no king, the coroner became an appointed or elected position and this selection method, which also varies from county to county, continues today.

Who can be coroner? Almost anyone. Usually there are age and residency requirements, but often no special medical or forensic skills are part of the application process. The major skill required seems to be the ability to win an election or to secure an appointment from the county commission or whatever legal body is charged with the appointment. It is often more a popularity contest than anything else. The coroner might be the sheriff, newspaper publisher, neighborhood café owner, or local funeral director. As often as not he possesses little or no medical training or experience and thus might not be qualified to perform many of his duties. This deficiency led to the creation of the medical examiner system.

In 1877, Massachusetts mandated the replacement of coroners with medical examiners and required that medical examiners be licensed physicians. New York City adopted a similar system in 1915. In the 1940s, Congress established the Commission on Uniform State Laws and from this commission came the Medical Examiner’s Act, which was adopted by most states. This led to the replacement of most coroners with medical examiners. However, with the exception of the District of Columbia, no federal program existed for investigating deaths until 1990, when Congress established the Federal Medical Examiner’s Office in the Armed Forces Institute of Pathology.

Most medical examiner systems require the ME to be a pathologist, and some require that he be trained in forensic pathology. A forensic pathologist is a clinical (medical) pathologist with extra training in the field of forensics. He oversees all aspects of death and criminal injury, perhaps runs the crime lab, and performs “forensic autopsies.”
In an ideal world, every jurisdiction would have a medical examiner, and that person would be a forensic pathologist. But that’s not practical. Smaller and more rural jurisdictions simply do not have the population base nor the budget to justify the hiring of a qualified forensic pathologist as medical examiner. In this circumstance, the coroner has several options for acquiring specialized pathological services.

He might contract with a larger regional or state medical examiner’s office for pathological and laboratory testing or hire a part-time forensic pathologist to serve as medical examiner. This individual would likely be given a title such as Deputy Assistant Coroner. Under the legal umbrella of the coroner’s office, she would perform autopsies, testify in court, and perhaps oversee the crime lab. Also, in many areas where the coroner system is in place, the coroner will hire one or more full-time pathologists to serve as medical examiners or deputy assistant coroners. Each of these arrangements offers the (often unqualified) coroner a method to obtain the needed medical expertise so he can adequately investigate deaths and crimes.

The relationship of the coroner or ME to the crime lab varies from jurisdiction to jurisdiction. In some areas the ME oversees the forensic laboratory, while in others the lab might function under the auspices of law enforcement agencies such as the police or sheriff’s department. And as with pathological services, many rural jurisdictions obtain lab services through contracts with major city or state crime labs.

NOTE: Since both systems exist in the United States, in this book I will use the terms coroner and medical examiner (ME) interchangeably.

**Duties of the Coroner/Medical Examiner**

The coroner or medical examiner wears many hats and often acts as judge, juror, investigator, and scientist. Her responsibilities cover virtually every aspect of death investigation and include the following:

- Determination of the cause and manner of death
- Determination of the time of death
- Supervision of evidence collection from the body
- Identification of unknown corpses and skeletal remains
- Determination of any contributory factors in the death
• Certification of the death certificate
• Presentation of expert testimony in court
• Oversight of the crime lab (in some areas)
• Examination of injuries in the living and determination of their cause and timing

In fulfilling her duties, she might interrogate witnesses, review witness statements and police or hospital files, visit crime scenes, examine collected evidence, study the results of crime lab procedures, perform autopsies, and gather any other evidence she feels she might need. To accomplish all this the coroner is typically given full subpoena power. She will often work with the police and homicide detectives to help guide their ongoing investigations by supplying them with the results of any forensic tests she or the crime lab has performed.

**The Coroner/Medical Examiner in the Courtroom**

One of the coroner’s most important duties is to present evidence in the courtroom, for it is here that the world of science is brought to the law. His testimony can often make or break a case. In fact, his determination of the cause and manner of death will often determine whether a criminal case comes to court or not. If he states that the manner of death is natural or suicidal, it would less likely become a criminal proceeding. But, if the death is homicidal—and occasionally if it is accidental (as in an industrial setting)—the case might very well enter the courtroom.

He might be called to testify by either the prosecution or the defense. His sworn duty is to present the facts and offer an unbiased opinion based on these facts. He might be asked to discuss and explain the forensic evidence and to offer his expert opinion regarding this evidence to the judge and jury. In this regard he acts as an educator as well as a scientist. Often he is the only person the jury hears from who can make complex scientific information understandable. He might face experts with different opinions, so he must be able to pit his knowledge and communication skills against other experts in his field.

Each expert that appears before the court, including the coroner, should expect to be qualified before the jury. The attorneys will ask ques-
tions about his credentials, training, experience, areas of expertise, teaching positions, publications in the field in question, and anything else they deem will support or undermine his expertise. The side that called him will ask easy, supportive questions, while the other side will ask tougher questions in an attempt to “impeach” any testimony he might give. The coroner must be prepared for potentially unsettling questions.

Depending upon his own abilities and knowledge and depending upon the number and types of experts arrayed against or in support of him, the coroner might present all the evidence himself or he might ask members of his staff or the crime lab to present portions of the evidence. For example, he might give testimony regarding the autopsy, while a fingerprint expert might present that evidence. A toxicologist might discuss the results of the toxicological examinations. A firearms expert might reveal his findings. Or the coroner might present all this evidence himself.

With expert testimony, the judge typically allows a great deal more leeway as to how the information is presented to the jury than he does with most witnesses. Most witnesses are allowed only to answer questions, and if they stray too far afield the opposing attorney will object or the judge himself might rein them in. An expert is allowed to speak more broadly and to “teach” the jury. The reason for this latitude is that the expert is there to present and explain any evidence in his area of expertise. For example, it would be very difficult for the average juror to understand the impact of DNA evidence from a series of yes and no questions, but allowing the expert to explain what DNA is, how it is tested, and what the results of the testing mean gives the jurors the knowledge they need to understand and evaluate the evidence.

Because science is neither absolute nor static and because it is built on ever-changing theories, it is rare that an expert will say that something without doubt matches or that a particular result is absolute. Rather he will use phrases such as “similar to,” “consistent with,” “not dissimilar from,” “compatible with,” or “shares many characteristics with.” Each of these terms speaks to the fact that forensic evidence is rarely, if ever, absolute but rather that it states probabilities. For example, no two people have the same DNA, but the testifying expert will not say that the DNA “absolutely matches” that of the defendant. Instead he will say that the probability that it matches is a billion to one. Almost, but not quite, absolute.
Crime Lab Origins

The first forensic laboratory in the United States was established in 1923 by the Los Angeles Police Chief August Vollmer. In 1929, the famous St. Valentine’s Day Massacre (discussed in Chapter 17) prompted two Chicago businessmen to help establish the first independent crime lab, the Scientific Crime Detection Laboratory (SCDL) at Northwestern University. In 1932, the Federal Bureau of Investigation established a national forensic laboratory, which would offer services to law enforcement across the country. It served as the model for all future state and local labs so that now many states have networks of regional and local labs, which support law enforcement at all levels.

The CSI Effect

No discussion of forensic science would be complete without addressing the “CSI effect.” It’s a controversial topic in that there are widely differing opinions about its definition and even whether it exists or not.

The CSI effect derives from the many forensic science shows on TV, both fictional and documentary-style. Many point to the CBS series CSI: Crime Scene Investigation as the beginning of the phenomenon, which then expanded with the appearance of the “CSI clones” and other shows such as Bones, NCIS, Cold Case, and Forensic Files. It is almost impossible to turn on the TV without seeing a crime show, and forensic science is invariably part of the story. The same goes for virtually every case you see presented on national or local news.

The CSI effect could be defined as the impact of these shows, which reveal cool and clever forensic science techniques, on the public, criminals, law enforcement officials, juries, and courts. These shows have created a level of expectation that simply isn’t realistic. They portray crime labs as being fully equipped with very expensive instruments and staffed with brilliant minds that magically uncover the most esoteric evidence. They make the very rare seem almost commonplace. They suggest that all these wonderful tools are widely available and frequently employed in criminal cases. The truth is vastly different. DNA testing is involved in perhaps 1 percent of cases, and it isn’t available in 20 minutes. Crime labs are severely underfunded, and most have meager equipment, not the plasma screens and
holographic generators seen on TV. The lab techs are indeed smart and dedicated individuals, but they aren’t prescient. They can’t magically solve complex crimes by simply “seeing” the solution in a microscope or within their minds. It doesn’t work that way. (At least not often.)

So how does all this information—or misinformation—affect the public, criminals, and the police and courts? Simply put, they teach criminals how to avoid leaving behind evidence and unrealistically raise the expectations of the public.

Criminals watch these TV shows and learn to alter their behavior to avoid detection. They learn not to leave behind fingerprints and DNA evidence, to hide from surveillance cameras, to avoid using cell phones and computers in the planning and execution of their crimes, and a host of other things. Fortunately, these shows are not always accurate and don’t cover all contingencies involved in the planning and execution of a crime, proving the old adage that a little knowledge is a dangerous thing. The criminal thinks he has thought of everything, but while he focuses on one bit of evidence he ignores others. An example would be the thief who planned a breaking and entering home robbery. He knew that shoe prints could be left in the soft dirt of the planter beneath his entry point window so he took off his shoes. He then realized he had not brought gloves, so to prevent leaving fingerprints, he removed his socks and used them as hand covers. The crime was interrupted by the homeowner, an altercation with bloodshed followed, and the thief left a bloody footprint on a piece of broken window glass. This proved to be his undoing. True story.

The public, who make up juries, come away from these shows believing that high-tech investigations are involved in every case, and if the police or prosecutors fail to make DNA or blood analysis part of the case they must have done something wrong. And in some cases defense attorneys latch on to this and use it to undermine the police investigation. During the famous Scott Peterson case, how many times did you hear news reports and pundits talk about the lack of DNA evidence—as if this made the case weak? In truth, finding Laci’s blood or DNA on Scott or his clothing would be of little help. They were married and they lived together, so there were hundreds of innocent reasons for Laci’s DNA to be found.

Back in the 1960s and 1970s, juries wanted confessions and eyewitnesses, both of which can be false and erroneous. Now, after the saturation
of our psyche with forensic science, jurors expect DNA and other sophisticated evidence. This not only makes gaining a conviction more difficult but also gives prosecutors pause before filing charges in cases without such evidence.

So, it can be said that the CSI effect alters the criminal justice system in many ways. It helps criminals avoid detection, creates unrealistic expectations in the public and in juries, and makes prosecution of some crimes problematic. But there are positive aspects in that this increased interest in forensic science has led to more people choosing it as a career; indeed the number of colleges offering forensic science curricula and degrees has mushroomed.