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Course Overview

Forensic Science will allow students opportunities to develop and extend scientific skills and processes through problem-based learning. Students will engage in activities that will relate to other subject areas such as: biology, chemistry, physics, mathematics, sociology, archaeology, anthropology, anatomy, health, and writing. Forensic Science will connect these subject areas to real-life applications used in criminal investigations.



FORENSIC SCIENCE: AN INTRODUCTION

Unit Overview

Forensic science is one of the fastest growing fields for high school science classes as well as at the college level. Forensics, as defined in broad terms, is the application of science to criminal and civil laws. This particular unit on forensic science introduces the student to the subject and the technical support provided by crime laboratories.

Directions

Read the following text, look at the illustrations, and answer the questions. Key terms will be highlighted in bold print.

Key Terms		
forensic science	criminal investigation	criminalistics
criminology	Locard's Exchange Principle	physical science unit
Biology unit	firearms unit	photography unit
documentation	examination unit	toxicology unit
latent fingerprinting unit	anthropology	polygraph unit
voiceprint analysis unit	voiceprint analysis unit	forensic pathology
entomology	evidence collection unit	crime scene investigation
psychiatry	odontology	engineering

Introduction to Forensic Science

Welcome to the world of forensic science! This is one of the fastest growing topics for high school programs. Just a few years ago no one would have imagined that the subject of forensic science would become part of our television culture. For many years, forensic science has been a part of the criminalistics profession and has provided a level of sophistication to criminal investigations that has been unparalleled. Perhaps it is the desire to see criminals apprehended with evidence to support and ensure justice.

Forensics has become a part of our society through television programs, news reports, and written media such as newspapers and magazines. In fact, forensics seems to be in the news everyday and is at the forefront of our public response.

This course will allow you, the student, the opportunity to develop and extend your scientific skills and processes through problem-based learning. You will engage in activities that will relate to other subject areas such as: biology, chemistry, physics, mathematics, sociology, archaeology, anthropology, anatomy, health, and writing. This course will relate the above subject areas to real-life applications of criminal investigations. In some units students will have the opportunity to create their own **“Forensic Science Kit”** which will include the materials needed to complete the

activities for that unit. Click on the PDF to see the materials needed for your “**Forensic Science Kits**” for the entire course. [PDF File Forensic Science Kits](#) The following skills and scientific strategies will be presented:

This course will relate the above subject areas to real-life applications of criminal investigations. The following skills and scientific strategies will be presented:

observation	techniques
critical and logical thinking	documentation
experimentation	problem solving
organization	the scientific process

Each unit and activity has a different procedure that helps you to develop a variety of general and science-specific skills and processes. This course places an emphasis on the process of learning how to complete the activities as well as an introduction to forensic science.

Forensic Science



Forensic science can be defined as the application of science to law. As crime has become more prevalent in our society, law enforcement has found it increasingly necessary to seek assistance from the scientific community for advice and technical support. Much of this support has been in the field of forensic science. Science has come to occupy an important place in the field of criminal investigation. **Criminal investigation** can be defined as an inquiry into a particular crime. Because science plays such an important role, forensic science supplies information that is accurate and objective. In other words we could say that forensic science is the application of science to criminal and civil laws that are enforced by the criminal justice system.

The term **criminalistics** is often used in place of the term forensics. Criminalistics can be defined as a professional and scientific discipline which involves the recognition, identification, individualization, and analysis of physical evidence by application of the natural sciences in criminal matters. **Criminology**, is not the same as criminalistics. It is the scientific study of crime and the criminal. The crime scene investigator, when looking

for a motive, will begin to shift from criminalistics to criminology. The following units will not focus on criminology, but rather the crime scene from an objective and scientific point of view.

The History of Forensics



Forensic science has been around for quite some time; however, it was not originally recognized by the law enforcement community as a means of solving crimes. Its origins are owed to those first individuals that developed and fine-tuned the principles needed to identify and compare physical evidence.

There have been many scientists who have contributed great advances in this field. Some of the better known are listed here along with their discoveries:

<ul style="list-style-type: none">• Mathieu Orfila (1787 – 1853) considered to be the father of forensic toxicology
<ul style="list-style-type: none">• Alphonse Bertillion (1853 – 1914) devised first system of personal identification
<ul style="list-style-type: none">• Francis Galton (1822 – 1911) development of fingerprinting and classification
<ul style="list-style-type: none">• Leone Lattes (1887 – 1954) discovered blood grouping
<ul style="list-style-type: none">• Calvin Goddard (1891 – 1955) ballistics comparisons
<ul style="list-style-type: none">• Albert O. Osborn (1858 – 1946) document examination
<ul style="list-style-type: none">• Walter C. McCrone (1916 – 2002) analytical technology
<ul style="list-style-type: none">• Hans Gross (1847 – 1915) application of scientific disciplines
<ul style="list-style-type: none">• Edmond Locard (1877 - 1966) Locard's Exchange Principle

Of all the men who contributed greatly, as indicated in the list above, Edmond Locard is probably the most well known because of his discovery of the exchange principle. Locard's belief was that when a criminal came in contact with an object or person, a cross-transfer of evidence occurred. His basic principle of forensic science stated that a criminal always takes something to the scene of a crime and always leaves something there. Locard's accomplishments became known worldwide and it became known as **Locard's Exchange Principle**. He believed that every criminal could be connected to a

crime by dust particles carried from the crime scene. This concept was reinforced by successful and well-publicized investigations.

In 1932 the United States undertook a commitment to forensics. The FBI, under the directorship of J. Edgar Hoover, organized a laboratory that offered forensic services to all of the law enforcement agencies across the country. Today this FBI lab is the largest in the world, performing over one million examinations every year. In fact, the accomplishments of this lab have earned worldwide recognition. Its structure and successful accomplishments have served as a model for state and local agencies across this country as well as in other countries. This program grew into the FBI's Forensic Science Research and Training Center in 1981.

This facility was dedicated to conducting research to develop innovative and new scientific methods that can be applied to forensic science. Lab personnel are also trained at this facility in the latest techniques and methods in forensics.

Modern forensic science has advanced greatly since the first crime lab was established. Today there are over 400 crime labs and nearly 40,000 forensic scientists in the United States. Modern techniques involving very sophisticated machines and procedures help forensic scientists solve crimes. Technology has speeded up and improved analysis and data retrieval, making possible the ability to store vast amounts of information about criminals – information that can be readily exchanged within and between law enforcement agencies.

Forensic Science Timeline	
700s	Chinese used fingerprints to establish identity of documents and clay sculptures, but without any formal classification system.
ca.1000	Bloody palm prints were meant to frame a blind man of his mother's murder.
1149	Idea of having a coroner was started by King Richard of England
1248	A Chinese book contains a description of how to distinguish drowning from strangulation. This was the first recorded application of medical knowledge to the solution of crime.
1447	Missing teeth used to identify the body of the French Duke of Burgundy.
1599	Beginnings of the modern microscope developed.

1609	The first treatise on systematic document examination was published.
1686	A professor of anatomy noted fingerprint characteristics. However, he made no mention of their value as a tool for individual identification.
1670	First simple microscope with powerful lenses created.
1732	The basis of lie detection equipment made possible with the discovery that the human nervous system transmits information electronically.
1776	Body of a U.S. general is identified by Paul Revere who made his false teeth.
1784	In England a man was convicted of murder on the basis of the torn edge of a wad of newspaper in a pistol matching a remaining piece in his pocket. This was one of the first documented uses of physical matching.
Ca-1800s	An English naturalist used engravings of his own fingerprints to identify books he published.
1807	Forensic Science Institute was established in Scotland.
1810	The first recorded use of questioning document analysis. A chemical test for a particular ink dye was applied to a document.
1814	First scientific paper on the detection of poisons published.
1823	Whorls, ellipses and triangular description and a classification system is developed based on nine major types. The individualizing potential for fingerprinting is not recognized yet
1835	The first bullet comparison was used to catch a murderer.
1836	Method for the detection of arsenic poison is developed.
1849	Bones and teeth remains used as evidence of murder.
1850	First private detective agency in the U.S. set up by Allan Pinkerton.
1862-63	First presumptive blood was developed.

1864	Photography used for the identification of criminals and documentation of evidence and crime scenes.
1877	Markings on the palms and fingertips used for identification in criminal cases.
1879	System of identifying people by special body measurements.
1880	First criminological use of fingerprints.
1888	First hand-help camera invented by American George Eastman.
1889	System of matching bullets to the gun that fired it.
1892	Scientific classification of fingerprints developed.
1895	X-rays discovered.
1901	Basic blood groups are identified.
1903	New York City Police Department began fingerprint files of arrested persons.
1905	FBI established.
1906	Bite marks found at scene of the crime first used as evidence in court.
1910	First comprehensive hair study.
1920	Weapon manufacture data is categorized.
1920s	Tool mark comparison used.
1921	First polygraph (lie detector) developed.
1924	First U.S. police crime laboratory.
1932	FBI forensic science laboratory established.

1940s	Ways of comparing teeth from a corpse with dental records.
1941	Voice print identification technique developed.
1950	Tape lift method of collecting trace evidence.
1954	Breath analyzer for field sobriety testing developed.
1957	Skeletal growth stages, the basis of Forensic Anthropology identification.
1960	First laser design used to identify fingerprints.
1967	Tests for dried bloodstains developed.
1971	Photo-fit enabling witnesses to piece together facial features developed
1980	Method developed for detecting DNA differences.
1983	First use of personal computers in U.S. police control cars provide quick information from National Crime Information Centre.
1984	Genetic profiling using DNA developed.
1987	First time DNA evidence used to get a conviction in the U.S.
1991	Automated imaging system developed to compare marks left on fired bullets, cartridge cases, and shell casings.
1996	FBI introduces computerized searches of a fingerprint database.

This timeline is in no way a comprehensive listing of all the significant events in the development of forensics. However, many of the significant events have been listed here to show the progression of scientific sophistication.



The Crime Laboratory

Crime laboratories in the United States have grown by leaps and bounds over the last 40 years. At the present time there are over 300 public crime laboratories operating at the federal, state, county, and municipal levels of government. The size of these crime labs and the diversity with which they operate depends on their capabilities to analyze crime scene evidence. Some labs are small and operate as part of a police department, while others are placed under the direction of a prosecutor's or district attorney's office. Some labs function as a part of the medical examiner or coroner's office. Few are affiliated with universities or exist as independent agencies. Staff sizes of these labs vary from one person to more than 100, while the services may be diverse or specialized, depending upon the responsibility of the agency that houses the lab and its services.

Due to judicial changes in requirements for accurate and scientifically evaluated evidence, crime labs have had to make changes to incorporate the skills of forensic science experts. It is not surprising that crime rates have increased, so consequently the number of crime labs has had to increase. Not every crime requires a forensic evaluation, however, many do just because the judicial system requires scientifically evaluated evidence. Drug cases require a forensic lab to do a chemical analysis and this factor alone has helped to increase the number of labs. Once DNA profiling was used extensively, the demands for more sophisticated technology required that forensic labs expand their capabilities to evaluate biological evidence and update the technology to enable those tasks.



Most state governments now maintain crime laboratories that service state and local law enforcement agencies. However, some larger cities maintain their own facilities. This has helped to increase the accessibility of local law enforcement agencies to have access to crime evidence. Forensic science has grown worldwide too. Over 100 countries worldwide now maintain facilities offering forensic services.



Full service crime labs offer a variety of basic services and many also provide optional services as well. The **physical science unit** applies the principles and techniques of chemistry, physics, and geology to the identification and comparison of crime-scene evidence. Expert criminalists staff this unit and use modern analytical instrumentation for a diverse examination of evidence.

A **biology unit** is staffed with biochemists and biologists that apply techniques to identify DNA profiling, blood, and other body fluids. They also examine hairs, fibers, wood, and plants.

The **firearms unit** is a busy place due to the number of firearms used in crimes. They also study discharged bullets, cartridges cases, shotgun shells, and ammunition of all types. The comparison of tool marks is also examined at this unit.

The **photography unit** examines and records physical evidence. Highly specialized technology aids in the preparation of photographic exhibits for courtroom presentation.

At the **document examination unit** handwriting and typewriting on questioned documents are studied to ascertain authenticity and/.or the source.

The **latent fingerprinting unit** processes and examines evidence for latent fingerprints.

The **toxicology unit** examines body fluids and organs to determine the presence or absence of drugs and poisons

In the **polygraph unit**, or lie detector, the staff is trained in the techniques of criminal investigation and interrogation. The lie detector has become to be recognized as an essential tool of the criminal investigator rather than the forensic scientist.

In the **voiceprint analysis unit** investigators tie the voice to a particular suspect. A sound spectrograph is used that transform speech into a visual graphic display called a voiceprint. Sound patterns produced in speech are unique to the individual and this validity provides the uniqueness of the speech patterns.

The **evidence collection unit** incorporates crime-scene evidence collection into the total forensic science is slowly gaining recognition in the U.S. The unit dispatches specially trained personnel to the crime scene to collect and preserve physical evidence that will later be processed at the crime lab.

Other forensic services offered at a full-service crime lab might include: **forensic pathology, anthropology, entomology, psychiatry, odontology, and engineering**. This is by no means a complete list of services provided by a crime laboratory. The various units and their services will be discussed in detail in future content of this course.



Scene-of-the-Crime

Forensic investigators use tools from a scene-of-the-crime kit when they are out in the field investigating crimes. Kits that are used to process crime scenes come in different sizes and contain instruments and implements for different purposes. These kits can be purchased commercially, or investigators can put together their own version. Most kits are a large box, similar to a fishing tackle box. The following tools would be found:

Scene-Of-The-Crime Tool Kit		
crime scene tape	flashlight	Logbooks
pens	camera and film	paper sacks
tongue depressors	rubber bands	sketch pad
disposable clothing	disposable masks	latex gloves
coveralls	protective cap	shoe covers
measuring implements	fingerprinting items	Casting items

orange flags	string	Butcher paper
rape investigation kit	field test kit for drugs	blood draw kits
chalk and/or tape outline	scalpel	angled mirror
tweezers	glass jars	magnifying glass
evidence labels		



Taped inside the lid of the kit can be found a conversion chart for distance, weight, and volume. It is always a good idea to keep the living victims in mind and include pamphlets on domestic abuse victims and the telephone numbers of local rape counselors.

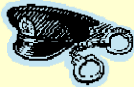
Once investigators leave the office or the crime lab, they may be in for long hours at the scene of the crime. In order to be prepared every time with the needed tools, anything that is used up in the kit must be replaced immediately. Another kit kept in the crime scene vehicle contains tools such as hammers, pliers, a screwdriver, etc. Some types of kits are for a specific use such as a fingerprinting kit, a casting kit (for tire, shoe, and footprints), a trajectory kit (for shootings), a trace evidence kit, and a sexual assault kit. There are special kits for gunshot residue, the presence of blood, for blood tests, bodily fluid collection, bug sample collecting, and for assessing hazardous situations. When the evidence is collected, it goes right back to the lab for processing.

U.S. Crime Facts



Forensics is not just used for crime evidence. It has successfully been used in other areas as well. These other areas will be discussed at a later time. However, this section of the unit will present some interesting facts on crime in the United States. Some of these statistics will likely surprise you. It will become obvious why forensic investigations are at an all time high.

- about 90% of local police agencies have fewer than 25 sworn officers



- New York City has the largest police department, with more than 30,000 sworn officers
- almost half the police departments in the U.S. have fewer than 10 sworn officers
- a property crime is committed every 3 minutes
- a motor vehicle theft occurs every 20 seconds
- about 43.5 million crimes are committed each year
- the most common reason for arrest in this country is “driving under the influence”
- there are almost 24,000 arrests made for murder each year
- California has the most murders, with almost 4,000 each year
- about 70% of murders are committed with a firearm
- a murder is committed every 23 minutes
- a violent crime takes place every 17 seconds

<ul style="list-style-type: none">• about 60% of murders in big cities are solved
<ul style="list-style-type: none">• about 75% of murders in small rural areas are solved
<ul style="list-style-type: none">• about 87% of murder victims knew their killers
<ul style="list-style-type: none">• according to one survey, 1 out of every 6 children ages 10 to 17 has seen or knows someone who has been shot
<ul style="list-style-type: none">• an aggravated assault occurs every 28 seconds
<ul style="list-style-type: none">• there are approximately 43, 547,400 crime victims each year, not including murders
<ul style="list-style-type: none">• there are almost 520,000 arrests each year for aggravated assault
<ul style="list-style-type: none">• about 6% of all criminals commit 70% of all violent crimes
<ul style="list-style-type: none">• approximately 10% of all violent criminals each commit more than 600 crimes per year
<ul style="list-style-type: none">• those arrested for violent crimes average 9.4 arrests each
<ul style="list-style-type: none">• there are over 400,000 arrests made for burglary each year
<ul style="list-style-type: none">• a burglary happens every 12 seconds
<ul style="list-style-type: none">• a robbery is committed every 51 seconds
<ul style="list-style-type: none">• poor households (families with yearly incomes less than \$7,500) are victims of crime almost twice as often as upper-income household
<ul style="list-style-type: none">• about 80% of people arrested are male
<ul style="list-style-type: none">• 70% of all arrests are men ages 15 to 34
<ul style="list-style-type: none">• One larceny (theft) is committed every 4 seconds

Forensic Science Today and Tomorrow



Forensic science has played a large and critical role in a wide range of cases for many years. Forensic science does not solve the crime alone; however, it does give the detectives a powerful tool to assist in the investigation and conviction of criminals. By using the latest available methods and technology, modern forensic scientists can confirm or discount theories with a certainty that would have amazed previous generations. Keep in mind that forensic science is not foolproof and can sometimes be open to interpretation. As forensics becomes more powerful and reliable, it must be handled with care if the guilty parties are to be convicted and the innocent

cleared. But not all forensic investigations involve crime solving. After 9/11 and the tsunami disaster in the Pacific Ocean, for example, forensics is quickly becoming a means of identifying the dead. Forensics has been used to identify the dead for quite some time, however, it becomes a powerful tool following mass disasters, including such events as airplane crashes and war crimes.

The future of the forensics field promises to be increasingly reliable. As technology advances, the accuracy of forensics advances as well. There will be significant advances in DNA profiling, fingerprint analysis, voice prints, retinal screening, and the analysis of chemical screening in perspiration. These types of futuristic ideas will be used to help identify suspects but can also be used for security purposes for regular citizens. And of course the future of computer possibilities are endless. The future of forensic science is sure to be capable of things we can barely imagine today. The goals of forensics cannot be isolated; they must work in partnership with law enforcement agencies, the academic community, and private industry to develop, analyze, promote, and interpret new technologies that will advance crime-solving capabilities.



The Forensic Scientist

A **crime scene investigator** works in crime laboratories where s/he must be skilled in the application of principles and techniques of the physical and natural sciences. They are not freelance detectives, but work for the state. If we would want to be more precise, they work for the court and everything they do has a legal goal in mind. That goal is to find evidence that proves who did this, how they did it, and why. The rules of the court and the admissibility of evidence is always in the background, influencing the collection process of evidence. Everything that a crime scene investigator (C.S.I.) investigates may be held up for display in a courtroom. At this point in time we will not go into the legalities of presenting evidence in court. But keep in mind that crime scene investigators must remain aware of what the court system demands and disallows.

With that in mind, let's talk about what a C.S.I. does. They work in crime laboratories, both small and large, and analyze, identify, and classify evidence as it is related to criminology, law enforcement, or investigative work. They collect and preserve evidence in a variety of ways that will be discussed in a later unit. A C.S.I. may be employed in a state crime lab, by the secret service, the FBI, and the military.

Some of these professionals work in labs while others work the scene of a crime. A C.S.I. starts at the bottom and works up through the system.

A C.S.I. handles detailed work so thoroughness and accuracy are of the utmost importance. Good communication and writing skills are necessary, especially when testifying in court. There is constant pressure on these professionals to be accurate, since their findings are essential to solving crimes and convicting criminals. Work in this field can be both challenging and rewarding.

Some of the characteristics a C.S.I. must possess are: curiosity, excellent observation skills, the ability to recall facts and events, ordinary intelligence and common sense, an unbiased mind, avoidance of inaccurate conclusions, knowledge of the essential elements of a crime and evidence collection, resourcefulness, etc. This list is not complete; however, it gives you an idea of the characteristics a good C.S.I. should possess.

Crime scene investigators are the specialists who do the scientific and technical work of criminal investigations. Some forensic positions require an associate's degree or a high school diploma. Workers with this type of education are technicians who label evidence or do basic tasks in the lab. They are under the supervision of a crime lab scientist. Forensic workers come from a variety of backgrounds ranging from the hard sciences to social sciences to art. Some of them are engineers, dentists, doctors or nurses, chemists, toxicologists, anthropologists, artists, or psychologists. The range of specialties is broad. At the very least, these specialties require at least a bachelor's degree and often more advanced or professional degrees. Earnings can vary widely depending on the degree and specialization, often ranging from \$20,000 up through \$200,000 each year. The job outlook is good and technicians with training in DNA and its related topics are in high

demand. Some specialized fields such as anthropology and entomology are difficult to get into.



Conclusion

Forensic Science is an up and coming field of science. It's everywhere you look: television programs, news reports, magazines, and newspapers. Forensics has become a part of our everyday society. In this Unit you were introduced to forensic science, the history of forensics, a timeline, the crime laboratory, crime facts, and the forensic scientist. Forensics has been used to solve crimes, as well as in mass disasters to identify the dead. As technology advances, the future of forensics holds great promise that will assist in crime-solving capabilities.