



PISCATAWAY TOWNSHIP SCHOOLS

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Content Area: Forensic Science
Grade Span: 10-12
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COURSE OVERVIEW

Description

The Forensic Science program of study is designed for high school students as a college preparatory course. This 2.5 credit, semester elective exposes students to the processing of evidence toward the goal of solving crimes. As an interdisciplinary program of study, Forensic Science connects many areas of science including Biology, Anatomy, Chemistry, Physics, and Earth Science. Throughout the semester, Forensic concepts and applications are explored, consisting of; the scope and history of Forensics, the crime scene, physical, imprint and biological evidence, including the analysis of: Hair and Fiber, Handwriting and Ink, Fingerprints, Drugs, Toxins, Blood, and DNA. Students learn of the milestones and innovators of the field as well as the steps to process a crime scene. The class will focus on the importance of classification of evidence as either class or individual as well as other classifications. The hierarchy of evidence will include the evaluation of evidence with respect to the type of test, be it presumptive or confirmatory. Students investigate the evidence through the practices of science inquiry. Students ask questions about evidence, investigate, analyze, and interpret qualitative and quantitative data, as well as model the reconstruction of the crime scene to develop an explanation of what occurred, and how. Students argue and communicate their results to others as if in a court of law.

Goals

The goals of this course are for students to experience a college level elective course that is aligned with college standards. Through this course they will become proficient in skills required to process a crime scene. They will collect, identify, classify, and analyze various types of evidence. Students will use crime laboratory skills to reach a scientific conclusion in criminal investigations and prepare these results for presentation in court. Students will be exposed to careers in Forensic Science.

Scope and Sequence

Unit	Topic	Length
1	Introduction to Forensic Science: History, Crime Scene Analysis	8 blocks
2	Evidence: Physical, Biological & Imprint	33 blocks

UNIT 1: Introduction to Forensic Science; History, Crime Scene Analysis

Summary and Rationale

Forensic Science combines the diverse fields of physical and biological sciences to recreate the events surrounding a crime. In this unit students will examine a timeline that details the major contributions to the development of the field of forensic science and how their advances have contributed to the evolution of the field. Students discuss the role of crime laboratories and the services they provide.

Crime scene investigation begins with the steps that first responders must perform, simultaneously, to both secure and process a crime scene. This includes; protecting the crime scene from those who would tamper with it, collecting evidence, storing and processing evidence, understand the necessity for establishing a chain of custody, interviewing witnesses, being aware of the different types of evidences at the crime scene, detailing the role that evidence plays in recreating the events of a crime, identifying and differentiating between various types of evidence found at the crime scene such as class and individual evidence. Detail the role that evidence plays in recreating the events of a crime. Understand the importance of following the principles of science inquiry and the need for collecting control samples at every crime scene.

Recommended Pacing

8 blocks

State Standards

HS-ETS1-1 Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants

HS-ETS1-2 Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

HS-ETS1-3 Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

HS-ETS1-4 Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem

Instructional Focus

Unit Enduring Understandings (Cross Cutting Concepts)

- **Patterns:** Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.
- **Cause and effect:** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.
- **Structure and function:** Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem.
- **Connections to Nature of Science:** Science is a human endeavor
 - Technological advances have influenced the progress of science and science has influenced advances in technology.
 - Science and engineering are influenced by society and society is influenced by science and engineering.

Unit Essential Questions

- How has Forensic Science evolved over the centuries?
- How have scientific advancements contributed to the evolution of forensic science?
- How is the depiction of forensic science in popular culture misleading?
- What is the role of Forensic Science in the modern age?

- What is the best way to investigate crime and to process the crime scene?
- What are the subspecialties that contribute to the forensic investigation?
- What is a better type of evidence - testimony or physical evidence?

Objectives

Students will know:

- The three main focuses of Forensic Science are: The application of science to law, Provide expert testimony in court, Train law enforcement personnel in recognition, collection and preservation of evidence.
- The ten sections of the profession as described by The American Academy of Forensic Sciences are: Anthropology, Criminalistics, Engineering Sciences, Jurisprudence, Odontology, Pathology, Psychiatry and Behavioral Science, Questioned Documents and Toxicology.
- That first responders are to: secure and protect, process, and assess the crime scene, assist with medical attention, those who are hurt, detain the witnesses, arrest suspect(s).
- That investigators are to apply a search pattern, follow protocol when collecting and processing evidence, while maintaining chain of custody. That the crime scene must be documented using the skills of photographer, sketch artist, note taker, and measurer.
- That applying Locard's Exchange Principle can solve the crime.
- That the historical development of Forensics can contribute to an understanding of the evolution of applied science.
- That databases are used as a means of comparison of an unknown to a collection of knowns. Databases include: PDQ, SICAR, CODIS, NIBIN, IAFIS, ChemFinder, PharmInfoNet, TreadMate.
- That the crime can be described by the Facets of Guilt – means, motive and opportunity, the how, why and when/where of the crime.

Students will be able to (SEPs):

- Asking Questions and Defining Problems that arise from examining models or a theory to clarify relationships.
- Developing and Using Models based on evidence to illustrate to gain insights into the phenomenon being modeled and refine such models through an iterative cycle.
- Constructing Explanations and Designing Solutions that includes an initial claim, evidence and reasoning.
- Engaging in Argument from Evidence by defending a claim based on evidence.

UNIT 2: Forensic Evidence

Summary and Rationale

Hair and Fiber is trace evidence that can often be challenged in court for its uncertainty. Nonetheless, characterization of Hair and Fiber evidence plays an important role in providing investigative leads in many criminal cases. Hair evidence is individual evidence if the root is attached, which makes it stronger evidence in a court of law. Such evidence must be preserved, quickly since environmental factors could destroy this evidence. It is not as strong as DNA analysis, and is to be used complementarity with other evidence. Students analyze hair samples under a compound light microscope.

Questioned Document Analysis includes the analysis of handwriting, & ink and paper of a document. Students explore handwriting analysis and the guidelines for collecting known, exemplar writings, and comparing them to that of a questioned document. Students will also examine, compare and argue characteristics of inks as presented in ink chromatography and use document examination techniques to uncover alterations, erasures, obliterations, and variations in pen inks.

Fingerprint Evidence requires an understanding of dactylography. Students cite evidence of how to identify and analyze the three general fingerprint patterns, and assess the minutiae found in fingerprints in order to match prints. Latent fingerprints can be treated with either chemicals or powders. Surface type determines the lifting agent as well as the color of the revealed print.

Drug and Toxin Evidence analysis can identify an unknown substance either found inside or outside a victim's body. Students test known and unknown samples of simulated drugs and compare them. In so doing they make a claim, and support it with evidence. This unit also focuses on the toxicology and the chemistry of alcohol.

Blood is among the most common forms of evidence found at scenes of violent crimes. Blood may be found in trace amounts, or in larger spatters, blood can be animal or human. Blood samples should be collected from suspects and victims for examination and comparison. Blood evidence can help narrow a group of suspects, implicate a specific suspect or aid in the reconstruction of a crime. Students test simulated blood to compare an unknown to known blood to determine blood type.

DNA evidence is among the most reliable and useful evidence for Forensic Science. Students have the opportunity to investigate how DNA has become an "indispensable forensic science tool." Through the study of DNA structure, function, students conclude the uniqueness to each individual. Students compare various types of DNA typing, and explore several case studies involving DNA evidence such as cases as part of The Innocence Project which through the use of DNA evidence, serves to exonerate those who have been falsely convicted.

Recommended Pacing

33 blocks

State Standards

HS-ETS1-1 Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants

HS-ETS1-2 Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

HS-ETS1-3 Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

HS-LS1-1 Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.

Assessment Boundary	Assessment Boundary: Assessment does not include identification of specific cell or tissue types, whole body systems, specific protein structures and functions, or the biochemistry of protein synthesis.
HS-LS1-2 Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.	
Clarification Statement	Clarification Statement: Emphasis is on functions at the organism system level such as nutrient uptake, water delivery, and organism movement in response to neural stimuli. An example of an interacting system could be an artery depending on the proper function of elastic tissue and smooth muscle to regulate and deliver the proper amount of blood within the circulatory system.
Assessment Boundary	Assessment Boundary: Assessment does not include interactions and functions at the molecular or chemical reaction level.

Instructional Focus

Unit Enduring Understandings (Cross Cutting Concepts)

- **Patterns:** Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.
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- **Structure and function:** Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem.
- **Connections to Nature of Science** Science is a human endeavor
 - Technological advances have influenced the progress of science and science has influenced advances in technology.
 - Science and engineering are influenced by society and society is influenced by science and engineering.

Unit Essential Questions

- Is this confirmatory or presumptive evidence/test?
- How does the type of evidence impact the strength of the evidence in court?
- Is the evidence class, individual or both?
- What features make this evidence class or individual?
- How can crime scene reconstruction assist forensic scientists in solving crimes?
- Why is it important to preserve hair and fiber evidence from a crime scene?
- How can hair from different animals be distinguished from one another?
- How can fiber burn evidence be used to solve for an unknown fiber sample?
- How can handwriting be used as individual evidence?
- What is a “questioned document” and an “exemplar” and what is the value of them?
- What are the important guidelines necessary to collection of handwriting exemplars?
- How can the forensic scientist detect forgeries or counterfeits?
- How can a sample of ink/paper be analyzed?
- How are fingerprints formed and how does that contribute to the type of evidence it is?
- How can the various methods for processing, classifying and identifying fingerprints aid in a criminal investigation?
- How can fingerprints identify a criminal?
- What are the signs of drug toxin poisoning?
- What laboratory tests do forensic scientists rely on to identify unknown chemicals?
- How does chromatography work and how can it be modified to accomplish a specific chemical identification?

- What methods are available to determine the level of sobriety in a suspected impaired driver?
- What methods are used to determine toxicity in a person?
- How is blood analyzed by forensic investigators?
- What is the significance or value of DNA evidence to forensic investigation?
- How has DNA profiling contributed to the development of the field of forensic science?
- What DNA technologies have been developed that can be used to isolate and identify evidence?

Objectives

Students will know:

Investigation:

- Explain how evidence can be used in a forensic investigation.
- The importance of reference samples as a “negative control.”
- Tests performed on evidence is either presumptive; a type of screening test, or confirmative ; holds greater reliability and integrity in a court of law
- Students will be able to classify evidence by type: Nature, Class vs. Individual, Type (transient, etc).
- Evidence can be ranked on a hierarchy of evidence based on the type of evidence, class vs. individual and based on the type of test, confirmatory vs. presumptive. The strongest evidence is individual evidence, which can be tested by confirmatory means.
- Crime scene reconstruction helps to sort out the events surrounding the occurrence of a crime.
- Analyze different samples to create a database, then solve for an unknown using the database as a reference.
- That physical evidence is superior to testimony or physical evidence?

Hair & Fiber:

- Identify the various parts of hair and its structure of the medulla, cortex, and cuticle HS- Calculate the medullary index for a hair.
- Hair class can generally be determined through microscopic evaluation for the presence of the medulla, and its thickness, as well as the cuticle.
- Individual nature of hair can be determined if DNA – mtDNA is present in the root, which happens in the event of forcible removal.
- Distinguish hairs from individuals belonging to the broad racial categories.
- Prepare a wet mount slide. Identify various hair samples. Draw and label various parts of real hair samples. Determine type as: Human vs, non-human. Identify an unknown
- Hair can be tested for other characteristics such as substances absorbed or adsorbed (i.e. Drugs ingested).
- Fiber is considered class evidence, it can be natural or synthetic.
- Fiber can be evaluated through microscopic evaluation and through other tests such as a burn test, chromatography, and infrared analysis.

Document Analysis:

- Handwriting is both class; based on the source of learning and as individual evidence; as it becomes personalized by adulthood.
- Unknown questioned documents are compared to collected known documents called exemplars. Each can be analyzed for handwriting comparisons to determine if the author of each is the same
- Inks can be compared to determine if they share a common source, and the paper of the questioned document can be analyzed for thickness and quality.

- All three, handwriting, ink and paper (brush strokes, paint on canvas) can be analyzed to detect and reveal fraud and or to reveal the presence of alterations, obliterations, erasures, or variations.
- Chromatography is used to analyze ink. This can determine if a document is thoroughly original or had been tampered with.
- Create an exemplar of their own writing, and identify the individual characteristics of their own writing, and that of others.

Fingerprints:

- Explain the formation of fingerprints on the formative digits of the fetus in the womb as well as the history and development of fingerprints.
- Survey the history of using fingerprints as a means of identification; Anthropometry: Alphonse Bertillon, Henry System, IAFIS aka AFIS.
- Fingerprints are classified into three main classes of Loop, Arch and Whorl.
- Fingerprints are also individual evidence and can be used as evidence to build a case against a suspect. The uniqueness of fingerprints are based on a statistical improbability that no 2 fingerprints could be identical.
- Invisible – Latent prints will be made to appear visible through the application of various techniques, such as powders and chemicals which can develop Latent Prints.
- Compare prints, match prints, solve a crime with this evidence.

Toxicology:

- Understand the significance of drug analysis and toxicology to forensic investigations
- Chemical compounds are defined and classified in the Controlled Substances Act which are regulated by the United States government. Understand the significance of this classification system especially with regard to marijuana's schedule I status and the legal, political and social implications thereof.
- Describe tests that forensic toxicologists use to isolate and identify drugs and poisons, and apply this to simulated drugs in the class lab.
- Toxicology has a long historical presence and many applications in assessing possible cause of death.
- What the signs are of drug toxin poisoning and that symptoms of poisoning are key to solving the source of the poisoning.
- How alcohol is absorbed and processed in a living system and that there are various aspects of toxicity (factors) such as dosage, mode of entry, body weight of the consumer and time of exposure.
- The definition of toxins, and how they are classified according to the LD50 - Lethal Dose schedule which indicate the severity of the toxin for forensic investigation.
- Know the importance of the use of Forensic Toxicology to investigate drug use in; motor vehicle accidents, sports, workplace and the environment. To know what methods are available to determine the level of sobriety in a suspected impaired driver.
- Alcohol is a drug that is accessed by a BAC – blood alcohol calculator, the breathalyzer. People suspected of driving while intoxicated are subjected to Field Tests.

Blood:

- Serology, the study of all bodily fluids, involves a broad scope of laboratory tests that use specific antigen and serum antibody reactions.
- Blood is composed of red blood cells, white blood cells and plasma. Additionally some blood types have antigens.
- The History of Blood Typing- Karl Landsteiner.
- Blood type is an inherited trait that is a permanent feature of a person's biological makeup.
- Blood may link a criminal to crime.
- Individual blood stains can convey the directionality and impact of the blood when it strikes a surface. As well as type of injuries, when crime was committed, distance between the target surface and source via area of convergence and the angle of impact, amount of blood, velocity of blood and surface texture.

- It can be both class evidence and Individual evidence, however the individual evidence component is in the DNA evidence section.
- Identify characteristics/criteria that are instrumental in identifying the presence of blood, whether the blood is human vs non-human animal and identify human (simulated) blood as type A, B, AB or O blood and as RH positive or negative. Test simulated blood and “type” the blood, reading the results which can be clot, clump, fuzzy, unclear, and is known as an agglutination result.

DNA:

- Apply the principles of DNA as a means to identifying one person with a reasonable certainty.
- Describe the differences in nuclear DNA, mitochondrial DNA
- DNA evidence is highly important as, upon proper handling, it can directly link an individual to a crime scene.
- Understand the significance of the development of DNA technology to forensic science and will be able to compare segments of DNA and describe the use of DNA profiling in the CODIS database.
- Tests performed on evidence are either presumptive (a type of screening test) or confirmative (holds greater reliability).
- Confirmatory tests hold more integrity in a court of law.
- Apply the principles of DNA as a means to identifying one person with a reasonable certainty.
- Describe the differences in nuclear DNA, mitochondrial DNA.
- DNA evidence is highly important as, upon proper handling, it can directly link an individual to a crime scene. Understand the significance of the development of DNA technology to forensic science and will be able to compare segments of DNA and describe the use of DNA profiling in the CODIS database.
- The history of the discovery of DNA- Rosalind Franklin, Watson & Crick, shape double helix, Alec Jeffries, Electrophoresis.
- Human DNA is found in all nucleated cells, (and not in cells that lack nuclei).
- DNA is the highest form of individual evidence.
- Use of DNA evidence-paternity, identify remains, homicides and rapes, exoneration such as conducted by The Innocence Project
- Steps to DNA Profiling are: extraction, amplification, separation and analysis.
- Perform DNA extraction and isolation parts of electrophoresis of the cells of a plant.
- Match suspect’s DNA to the known reference database. The national database is known as CODIS.

Students will be able to (SEPs):

- Asking Questions and Defining Problems that arise from examining models or a theory to clarify relationships.
- Developing and Using Models based on evidence to illustrate to gain insights into the phenomenon being modeled and refine such models through an iterative cycle.
- Planning and Carrying Out Investigations. by designing investigations that generate data to provide evidence to support claims they make about how a crime occurred. Including deciding how to collect different samples of data under different conditions.
- Analyzing and Interpreting Data by identifying significant features and patterns in order to support their conclusions.
- Using Mathematics and Computational Thinking to engage in computational thinking, which involves strategies for organizing and searching data, creating sequences of steps.
- Constructing Explanations and Designing Solutions that includes an initial claim, evidence and reasoning.
- Engaging in Argument from Evidence by evaluating and defending a claim based on evidence.
- Obtaining, Evaluating, and Communicating Information via the written word, interpretation, as well as the ability to communicate clearly and persuasively.