Grade 12

Forensics

SC620 - 1 credit

Connecticut Technical High School System
39 Woodland Street
Hartford, Connecticut 06105

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CTECS - Vision of a Graduate

The Vision of a Graduate (VoG) at the Connecticut Technical Education and Career System (CTECS) embodies our commitment to preparing students for success in Connecticut's workforce.

Developed in collaboration with students, parents, staff, and employers, the VoG ensures that CTECS students are not only job-ready but also equipped to lead, innovate, and adapt in a dynamic world.

As educators, we are dedicated to developing these qualities by providing a comprehensive education that empowers our students to achieve their fullest potential and make meaningful contributions to society.

A Problem Solver

Problem solvers tackle challenges by identifying root causes of issues, brainstorming solutions, implementing effective strategies, and demonstrating adaptability.

- ➔ Engage students with open-ended, creative thinking tasks that require both conventional and innovative solutions.
- ➔ Facilitate group discussions and collaborative projects.
- ➔ Use real-world scenarios and hands-on activities.
- ➔ Highlight the importance of effort, persistence, and continuous learning.
- ➔ Provide regular feedback and encourage reflection.

Work Ready

To be work-ready includes a combination of technical expertise, soft skills, and personal qualities that ensure a graduate can effectively contribute to the workplace from day one.

- ➔ Set high standards for punctuality, responsibility, professionalism, and task completion.
- ➔ Use project-based learning and collaborative assignments.
- ➔ Emphasize clear written and verbal communication.
- ➔ Offer practical exercises like mock interviews and resume workshops.
- ➔ Integrate technology and teach digital literacy.

Respectful

Graduates who embody respectfulness emphasize the importance of treating others with dignity, valuing diversity, and fostering an inclusive and positive environment, both personally and professionally.

- ➔ Demonstrate personal, interpersonal, and professional skills.
- ➔ Show respect for diversity.
- ➔ Model respect through active listening and empathy.
- ➔ Set clear expectations for respectful interactions.
- ➔ Promote collaboration and group discussions.
- ➔ Celebrate respectful behavior.
- ➔ Address disrespect promptly and constructively.

Skilled Socially

Graduates who are skilled socially are equipped to navigate social environments, build relationships, and contribute positively to their communities and workplaces.

- ➔ Show awareness of global responsibility to others and the environment.
- ➔ Participate in community involvement.
- ➔ Design cooperative group projects and team activities
- ➔ Set expectations for respect and give regular feedback.
- ➔ Facilitate discussions on inclusivity, kindness, and respect.
- ➔ Model positive interactions and recognize strong social skills.

A Critical Thinker

Critical thinkers approach problems systematically by analyzing, evaluating, and synthesizing information to make well-informed decisions and contribute to innovative solutions.

- ➔ Encourage critical thinking individually and collaboratively.
- ➔ Design lessons that challenge assumptions and explore diverse viewpoints.
- ➔ Use open-ended questions, rigorous activities, and cross-curricular projects.
- ➔ Integrate project-based learning and real-world problem-solving.
- ➔ Offer reflective opportunities like journaling and discussions.
- ➔ Cultivate an environment that values curiosity and inquiry.

An Effective Communicator

Effective communicators convey ideas, information, and emotions accurately and persuasively, fostering understanding and collaboration.

- ➔ Communicate effectively using oral, written, visual, artistic, and technical modes.
- ➔ Include group discussions, presentations, and peer reviews.
- ➔ Promote active listening and thoughtful responses.
- ➔ Offer clear guidelines and constructive feedback.
- ➔ Stress clear, respectful, and purposeful communication.

CTECS Instructional Model

CTECS uses the Marzano Compendium to guide research-based instructional strategies that differentiate learning and promote access, engagement, and success for all students. Teachers apply these strategies to support diverse learners (including multilingual learners, students with disabilities, and students with varied academic or technical backgrounds) through scaffolds, modeling, guided practice, and multiple ways to participate and show understanding. This approach ensures every student can work toward proficiency in the Priority Standards and the competencies outlined in the CTECS Vision of a Graduate.

Curriculum Introduction

This curriculum document outlines the essential learning for this academic program and provides a clear structure for planning, instruction, and assessment. It includes the components required by NEASC Standard 2.2a, along with elements that reflect the unique nature of CTECS academic programs. The curriculum is organized to show what students learn in each course, how learning progresses across grade levels, and how instruction supports both technical skill development and the CTECS Vision of a Graduate.

Teachers should use this document to:

- Understand the overall structure and expectations of the course sequence
- Reference the Course Map to see the scope and sequence of Priority Standards
- Use the Priority Standards and Units of Study to guide daily, weekly, and cycle-based planning
- Integrate Big Ideas, Essential Questions, Skills/Learning Outcomes, vocabulary, and resources during lesson design
- Plan and implement formative assessments to monitor progress and guide instruction
- Prepare students for the District Summative Assessments, ensuring alignment with the Course Map
- Maintain consistency of instruction across campuses while adapting to student needs

Curriculum Components

Course Map

A Course Map serves as the scope and sequence for this course by outlining the progression of instructional units and the standards that guide teaching and assessment. While each campus will have individual student needs, cycle schedules, and industry-based opportunities, all instructors are expected to teach the standards outlined in the Course Map. Using the Course Map below, teachers will intentionally plan learning experiences that prepare students to meet the identified standards within the designated assessment windows.

Priority Standards (Units of Study)

Priority Standards identify the most essential learning in the trade program. They reflect the core technical competencies, safety practices, and industry-aligned skills that require the greatest instructional focus and appear on program assessments. In CTE programs, each Priority Standard also functions as a Unit of Study, because it includes the required components such as big ideas, essential questions, content topics, and skills/learning outcomes aligned to assessments.

Learning Outcomes

Learning outcomes are what students will know (Concepts) and be able to do (Skills). Concepts identify the major content topics within the Priority Standard (Unit of Study). They appear in the left column of the Learning Outcomes table and follow a similar coding structure as the Priority Standard. Skills are learning objectives that describe the measurable actions students must be able to perform to demonstrate proficiency. They appear in the right column of the Learning Outcomes table and show the progression of learning evidence in the Priority Standard.

Resources

Resources include the tools, equipment, texts, materials, and digital tools that support learning within each unit and reflect industry standards.

Assessment Practices

Teachers use ongoing formative assessments—such as questioning, checks for understanding, performance demonstrations, reflections, and teacher observation—to monitor progress, guide instruction, and support all learners in mastering the Priority Standards.

Vocabulary

Essential vocabulary includes the technical and academic terms students must understand and use accurately to engage in scientific learning and demonstrate proficiency on assessments. Vocabulary is foundational to safety, precision, and communication, and should be a primary initial focus within each unit and taught explicitly through modeling, demonstration, and repeated application.

Forensics Philosophy

The Forensic Science course is an interdisciplinary program designed to help students apply the principles of Life and Physical Sciences to the legal system. This academic curriculum ensures students develop an in-depth understanding of scientific content while building essential skills, such as communication, collaboration, inquiry, and problem-solving that are central to their educational and professional lives.

Aligned with the Next Generation Science Standards (NGSS), the program engages students in Scientific and Engineering Practices and Crosscutting Concepts to investigate the complex intersection of law and science. Students gain rigorous academic and practical experience through hands-on laboratory activities, technology-based inquiry, and the active collection and analysis of student-generated data.

In accordance with NGSS philosophy, instruction is driven by observable phenomena and student-generated questions, challenging learners to use scientific knowledge to explain or predict real-world events. By exploring specialized fields such as DNA analysis, toxicology, and forensic pathology, students prepare for a successful transition to post-secondary education or professional careers in the scientific and criminal justice communities.

INSTRUCTIONAL CONSIDERATIONS

Anchoring Phenomena: In accordance with NGSS philosophy, instructors will ***use observable phenomena and student-generated questions to drive instruction***. Natural phenomena are observable events that occur in the universe and that we can use our science knowledge to explain or predict; they are the context for the work of both the scientist and the engineer. The point of using phenomena to drive instruction is to help ALL students engage in practices to develop the knowledge necessary to explain or predict phenomena. Effective instruction, therefore, results in students being able to explain carefully selected and relevant phenomena by developing and applying the Learning Outcomes and crosscutting concepts (CCCs) through the use of the science and engineering practices (SEPs).

Forensics - Course Map

Semester 1

- Unit 1 Foundations of Forensic Science and Scene Processing
  - Priority Standard 1: History and Legal Framework of Forensic Science
  - Priority Standard 2: Crime Scene Investigation and Evidence Collection

- Unit 2: Biological Evidence and Individual Identification
  - Priority Standard 3: Fingerprints
  - Priority Standard 4: Blood and Blood Spatter
  - Priority Standard 5: DNA Analysis

Semester 2

- Unit 3: Trace Evidence and Forensic Anthropology
  - Priority Standard 6: Hair & Fibers
  - Priority Standard 7: Human Remains (Forensic Anthropology & Pathology)

- Unit 4: Specialized Chemical and Physical Analysis
  - Priority Standard 8: Documents and Handwriting
  - Priority Standard 9: Drugs and Toxicology
  - Priority Standard 10: Glass and Soil Analysis

***Suggested pacing includes one standard per academic cycle**.

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Unit 1: Foundations of Forensic Science and Scene Processing

Unit 1 Anchoring Phenomenon: The Invisible Witness: Present a case where a suspect was convicted solely on physical evidence despite having a strong testimonial alibi, driving questions on Locard's Exchange Principle

Priority Standard 1: History and Legal Framework of Forensic Science

Big Idea(s):

- Forensic science is the intersection of law and science, requiring strict adherence to legal standards to ensure justice.
- The evolution of forensic techniques reflects a continuous effort to improve the reliability and admissibility of evidence in the justice system.
- Forensic science must balance technological advancement with ethical considerations regarding privacy and civil liberties.

Essential Question(s):

- How has the historical evolution of forensic science shaped modern criminal investigations?
- Why must forensic evidence meet specific legal criteria (Federal Rules of Evidence) to be used in court?

Students will Know:	*As evidenced by:*
1.1 Forensic Specializations and Roles ● Pathologists ● Odontologists ● Toxicologists ● Anthropologists ● Expert Witnesses 1.2 Historical Milestones ● Locard's Exchange Principle ● Fingerprinting (Galton) ● DNA Profiling (Jeffreys) 1.3 Evidence Admissibility Standards ● Frye Standard ● Daubert Ruling 1.4 Legal System Categories ● Statutory Law ● Common Law ● Civil Law ● Criminal Law 1.5 Criminal Offense Classifications ● Felonies ● Misdemeanors 1.6 Probable Cause Requirements	● Analyze the impact of historical milestones (e.g., Locard, Galton, Jeffreys) on the evolution of modern forensic standards. ● Create a timeline of key historical milestones in forensic development. ● Evaluate the admissibility of evidence in a mock scenario by applying the *Daubert Standard* and *Federal Rules of Evidence*. ● Distinguish between the roles of forensic specialists (e.g., Pathologist vs. Anthropologist) through a comparative career research project. ● Contrast the legal requirements of Civil and Criminal law as they pertain to expert witness testimony. ● Investigate how forensic science was started and the social need for solving crimes. ● Evaluate the social/ethical implications of forensic databases (e.g.,CODIS) and the potential for bias in testimonial vs. physical evidence.

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Vocabulary: Ballistics, Civil law, Criminal law, Daubert ruling (1993), Entomology, Expert witness, Felony, Frye standard (1923), Material evidence, Miranda rights, Misdemeanor, Odontology, Pathology, Polygraph, Probable cause, Probative evidence, Testimonial evidence, Toxicology

Resources: Mock trial transcripts, and legal case studies, Dark Side of the District Attorney Article.pdf

SEP and CCC Connections:

• SEP: Engaging in Argument from Evidence. Students evaluate the admissibility of expert testimony by applying legal standards like the Daubert ruling and Frye standard .

• CCC: Stability and Change. Students analyze how the social need for forensics and scientific advancements have caused forensic standards to evolve from early history to modern-day practices .

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Priority Standard 2: Crime Scene Investigation and Evidence Collection

Big Idea(s):

- The integrity of a criminal investigation depends on the systematic documentation and preservation of the "Chain of Custody".
- Every contact leaves a trace (Locard's Exchange Principle), but only properly collected evidence is viable for analysis.

Essential Question(s):

- How does the systematic documentation and preservation of the "Chain of Custody" protect the integrity of a criminal investigation?
- Given Locard's Exchange Principle ("every contact leaves a trace"), why is the use of specific collection and packaging protocols necessary for evidence to be considered viable for analysis?
- How do forensic tools, such as scaled sketching and specific search patterns (Grid, Spiral, Zone), assist in the accurate investigation and documentation of a crime scene?

Students will Know:	*As evidenced by:*
2.1 Evidence Classifications ● Class ● Individual ● Physical ● Testimonial 2.2 Eyewitness Reliability Factors ● Memory Reconstruction ● Stress ● Leading Questions ● Post-event Information 2.3 Scene Preservation and Documentation ● Scene Security ● Contamination Prevention ● Notes, Sketches, and Photographs 2.4 Collection and Packaging Protocols ● Container Selection ● Labeling and Sealing 2.5 Chain of Custody Process	● Construct a scaled crime scene sketch using triangulation or baseline mapping, including a north arrow, fixed points, and legend. ● Match crime scene jobs with descriptions ● Execute proper "Chain of Custody" protocols by documenting, packaging, and sealing evidence to prevent cross-contamination. ● Select and justify a search pattern (Grid, Spiral, Zone) based on the environmental constraints of a provided mock scene. ● Categorize collected items into "Class" vs. "Individual" and "Physical" vs. "Testimonial" evidence to determine their probative value in an investigation. ● Investigate how to gather physical evidence and document the particulars of a crime scene.

Vocabulary: Chain of Custody, Circumstantial Evidence, Class evidence, Individual evidence, Locard's Principle, Physical evidence.

Resources: Crime scene kits (tape, evidence bags), digital cameras, and materials for sketching.

SEP and CCC Connections:

• SEP: Planning and Carrying Out Investigations. Students systematically search, document, and collect physical evidence using specific search patterns and Chain of Custody protocols .

• CCC: Systems and System Models. Students treat a crime scene as a system where every contact leaves a trace (Locard's Principle), requiring a systematic approach to preserve the integrity of the evidence .

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Unit 2: Biological Evidence and Individual Identification

Unit 2 Anchoring Phenomenon: The Cold Case: Introduce a real-world "Innocence Project" case where 20-year-old biological evidence was re-tested using modern STR and CODIS technology to exonerate the wrongly accused .

Priority Standard 3: Fingerprints

Big Idea(s):

- Fingerprints are a unique, lifelong biological identifier that provides a definitive link between an individual and a location.
- The systematic classification of ridge patterns and minutiae allows for an objective, scientific method of human identification.

Essential Question(s):

- Why are fingerprints considered the "gold standard" of individual evidence in forensic science?
- How do environmental factors and surface types dictate the choice of fingerprint detection methods?

Students will Know:	*As evidenced by:*
3.1 Individual Identification 3.2 Classification and Analysis ● Loops, Whorls, and Arches ● Ridge Characteristics (Minutiae) 3.3 Detection and Visualization Methods ● Powder Dusting ● Chemical Reagents ● Alternative Light Sources	● Classify unknown fingerprints into primary patterns (Loop, Whorl, Arch) and identify specific minutiae points (bifurcations, ridge endings). ● Perform various lifting techniques, including black powder dusting, magnetic powder, and cyanoacrylate (superglue) fuming. ● Compare a latent print found at a scene to a "Tenprint Card" exemplar to determine a point-by-point match or exclusion. ● Analyze the effect of different surfaces (porous vs. non-porous) on the quality and recovery of latent prints. ● Choose the correct fingerprint visualization technique for the surface ● Identify the various types of fingerprints and compare them to known prints.

Vocabulary: Arch, Bifurcation, Core, Delta, Latent Print, Loop, Minutiae, Patent Print, Plastic Print, Ridge, Visible print, Whorl

Resources: Ink pads, lifting powders, brushes, fuming chambers, and fingerprint magnifiers.

SEP and CCC Connections:

• SEP: Analyzing and Interpreting Data. Students examine fingerprint ridge characteristics and minutiae to differentiate individuals and support criminal investigations .

• CCC: Patterns. Students classify fingerprints based on the regular arrangement of Loops, Whorls, and Arches to determine individual identity.

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Priority Standard 4: Blood and Blood Spatter

Big Idea(s):

- Serology and bloodstain pattern analysis allow investigators to reconstruct the "mechanics" of a crime, such as the direction and force of an impact.
- Inherited biological markers (antigens/antibodies) provide a statistical method for excluding suspects or determining parentage.

Essential Question(s):

- How can the physical properties of blood (surface tension, velocity) be used to reconstruct a timeline of events?
- How does the presence of specific antigens determine blood compatibility and forensic identification?

Students will Know:	*As evidenced by:*
4.1 Antigens, Antibodies, and Agglutination 4.2 Blood Typing Systems ● A, B, AB, and O ● Rh Factor (+/-) 4.3 Spatter Pattern Characteristics ● Shape and Size ● Distribution and Velocity 4.4 Genetic Inheritance Patterns ● Alleles ● Punnett Squares	● Use simulated anti-serums to determine blood type ● Calculate the angle of impact of blood droplets using the trigonometric formula (sin(theta) = Width/Length). ● Analyze the Kastle-Meyer presumptive test and the Precipitin confirmatory test to distinguish between human and animal blood. ● Reconstruct the point of origin for a multi-drop spatter pattern using the stringing method or computer-aided modeling. ● Interpret bloodstain patterns (Passive, Transfer, Projected) to determine the direction of travel and velocity of the impact. ● Investigate the differences in blood types and characteristics of bloodstains.

Vocabulary:

Agglutination, Angle of impact, Antibodies, Antigens, Area of convergence, Cast off pattern, Donor Blood factors, High/Medium/Low-velocity blood, Luminol, Passive, Precipitin test, Presumptive test, Projected, Red Blood Cell, Rh factor, Spines/tails, Transfer stains/patterns, Type A, Type B, Type AB, Type O, Universal donor, Universal recipient

Resources: Synthetic blood kits, protractors, stringing kits, and Kastle-Meyer reagent.

SEP and CCC Connections:

• SEP: Using Mathematics and Computational Thinking. Students use trigonometry to calculate the angle of impact and identify the area of convergence for blood spatter .

• CCC: Cause and Effect. Students investigate how different forces and velocities (high, medium, low) result in specific, predictable bloodstain patterns .

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Priority Standard 5: DNA Analysis

Big Idea(s):
DNA is the ultimate "biological blueprint" that provides individual identification with near-certainty.

National databases (CODIS) allow for the "cold-hit" identification of suspects by matching DNA profiles across jurisdictions.

Essential Question(s):
How do we compare DNA found as evidence to samples taken from a suspect?

What are the ethical implications of maintaining a national DNA database?

Students will Know:	*As evidenced by:*
5.1 Forensic DNA Applications ● Crime Scene Investigation ● Paternity Testing ● Missing Persons 5.2 Molecular Structure ● Double-helix ● Nucleotides ● Base Pairs (A-T, G-C) 5.3 Inheritance Types ● Nuclear DNA (Both Parents) ● Mitochondrial DNA (Maternal) 5.4 DNA Profiling and Statistical Probability 5.5 CODIS Database	● Extract and visualize genomic DNA from a biological sample using laboratory reagents and precipitation techniques. ● Interpret DNA profiles from a gel electrophoresis "ladder" to identify matching STR (Short Tandem Repeat) patterns. ● Model the PCR (Polymerase Chain Reaction) process to explain how forensic scientists amplify small or degraded biological samples. ● Analyze the statistical probability of a DNA match within a population using CODIS-style data sets. ● Investigate DNA extraction and the process of DNA coding

Vocabulary:

chromosome, CODIS, Gel Electrophoresis, gene, heterozygous, homozygous, Mitochondrial DNA, Nuclear DNA, Nucleotide, Polymerase Chain Reaction (PCR), restriction enzymes, Single-nucleotide polymorphisms (SNPs), STR (Short Tandem Repeat), STR electropherogram

Resources: DNA extraction kits, electrophoresis chambers, micropipettes, and virtual CODIS simulations, Jackson Labs

SEP and CCC Connections:

• SEP: Obtaining, Evaluating, and Communicating Information. Students interpret DNA profiles and understand how the CODIS database is used to communicate matching data across jurisdictions .

• CCC: Structure and Function. Students explore how the molecular structure of DNA (nucleotides and STRs) determines its function as a unique biological blueprint for identification .

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Unit 3: Trace Evidence and Forensic Anthropology

Unit 3 Anchoring Phenomenon: The Forest Remains: Present a scenario of skeletal remains found in a wooded area, driving inquiry into how entomology (blowflies) and bone morphology establish the time and nature of death .

Priority Standard 6: Hair & Fibers

Big Idea(s): Trace evidence, though often circumstantial, provides a critical "link" between a suspect, a victim, and a location through Locard's Exchange Principle.

Microscopic morphology allows for the classification of materials into "class" or "individual" categories.

Essential Question(s):
Under what specific conditions can hair be considered individual evidence rather than just class evidence?

How does the chemical composition of synthetic fibers differ from natural fibers under forensic testing?

Students will Know:	*As evidenced by:*
6.1 Hair Morphology ● Cuticle, Cortex, and Medulla ● Root and Shaft 6.2 Human vs. Animal Differentiation ● Medullary Index ● Scale Patterns ● Pigment Distribution 6.3 Hair Growth Stages ● Anagen, Catagen, and Telogen 6.4 Chemical and Substance Records 6.5 Evidence Conditions ● Class Characteristics ● Individual (DNA) Factors 6.6 Fiber Classifications ● Natural (Plant/Animal) ● Synthetic (Manufactured) 6.7 Evidence Transfer Types ● Direct Transfer ● Secondary Transfer 6.8 Trace Evidence Connections	● Distinguish between human and animal hair by calculating the medullary index and identifying cuticle scale patterns under a microscope. ● Categorize unknown fibers as natural, synthetic, or regenerated through a series of burn tests, solubility tests, and microscopic analysis. ● Analyze the morphological features of hair (cortex, medulla, root) to determine if a sample was forcibly removed or naturally shed. ● Identify fiber cross-sections (e.g., trilobal, round) to narrow down the manufacturer or source of trace evidence.

Vocabulary: Anagen, Catagen, Coronal, Cortex, Cuticle, Follicular Tag, Imbricate, Keratin, knit, Medulla, Medullary Index, medullary index, Morphology, natural, Polymer, satin, Spinous, Synthetic, synthetic, Telogen, twill, weave patterns (plain, satin, twill, knit)

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Resources: Microscopes, polarized light filters, burn test kits, and hair/fiber reference sets.

SEP and CCC Connections:

• SEP: Planning and Carrying Out Investigations. Students use microscopic analysis and burn tests to identify the morphology and chemical composition of trace evidence .

• CCC: Scale, Proportion, and Quantity. Students compare microscopic features, such as the Medullary Index, to distinguish between human and animal sources .

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Priority Standard 7: Human Remains (Forensic Anthropology & Pathology)

Big Idea(s):
Skeletal remains provide a permanent record of an individual's biological history, including age, sex, and ancestry.

The biological "clock" of decomposition (entomology and mortis stages) is essential for establishing the Post-Mortem Interval (PMI).

Essential Question(s):
How do the physical changes of a body after death allow scientists to "speak for the dead"?

How do the skeletons of males and females differ as an adaptation to biological functions?

Students will Know:	*As evidenced by:*
7.1 Physiological Mortis Stages ● Algor Mortis (Cooling) ● Livor Mortis (Lividity) ● Rigor Mortis (Stiffening) 7.2 Entomological Timelines (PMI) ● Blowfly Life Cycle ● Environmental Variables 7.3 Biological Profile ● Sex, Age, Stature, and Ancestry 7.4 Bone Morphology ● Human vs. Animal Skeletal Features 7.5 Manner of Death Categories ● Accidental, Homicide, Natural, Suicide, or Undetermined 7.6 Cause of Death Definitions	● Estimate the Post-Mortem Interval (PMI) by analyzing the life cycle stages of blowflies and other necrophagous insects. ● Determine the biological sex, age range, and stature of a skeleton by measuring the pelvis, skull landmarks, and long bones (femur/humerus). ● Identify the three "Mortis" stages (Algor, Livor, and Rigor) to establish a physiological timeline of death. ● Distinguish between various manners of death (Accidental, Homicide, Natural, Suicide, Undetermined) based on autopsy report findings.

Vocabulary:

Algor Mortis, algor mortis, anthropology, caucasoid, coleoptera, diptera, entomology, Epiphyseal Plate, epiphyses, femur, Forensic Entomology, humerus, insect succession, livor mortis, mogoloid, negroid, OS pubis, osteology, osteons, pathologist, Pelvic Inlet, Post-Mortem Interval (PMI), postmortem interval (PMI), radius, Rigor Mortis, rigor mortis, sutures, tibia, ventral arc

Resources: Skeletal models (human and animal), insect life cycle charts, and virtual autopsy tools.

SEP and CCC Connections:

• SEP: Constructing Explanations. Students use data from forensic entomology and the stages of mortis to construct an explanation for the estimated Post-Mortem Interval (PMI) .

• CCC: Cause and Effect. Students analyze how biological and environmental factors cause predictable changes in human remains, such as Rigor Mortis and Algor Mortis .

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Unit 4: Specialized Chemical and Physical Analysis

Unit 4 Anchoring Phenomenon: The Counterfeit/The Poisoner: Display two "identical" ransom notes or two "clear" liquids (one water, one toxin) to drive inquiry into chromatography and chemical reagents .

Priority Standard 8: Documents and Handwriting

Big Idea(s):
Handwriting is a complex motor skill that results in unique individual characteristics that are difficult to forge.

The chemical analysis of ink and paper can provide chronological evidence of a document's origin or alteration.

Essential Question(s):
How can an individual's "natural variation" in writing be distinguished from a deliberate attempt to forge a signature?

What technologies do modern governments use to prevent the counterfeiting of currency?

Students will Know:	*As evidenced by:*
8.1 Handwriting Characteristics ● Diacritics ● Slant and Line Quality ● Letter Spacing 8.2 Document Tampering Signs ● Obliterations and Erasures ● UV and IR Light Detection 8.3 Security Features ● Ink Chromatography ● Watermarks and Microprinting	● Identify individual handwriting characteristics (slant, line quality, diacritics) to determine the authenticity of a questioned document. ● Execute paper chromatography to compare the chemical "signature" of different ink samples found on an altered document. ● Analyze documents for signs of forgery, such as obliterations, erasures, and "hesitation marks" using UV light or magnification. ● Compare security features (watermarks, security threads, microprinting) in authentic currency versus counterfeit samples.

Vocabulary: Backhand writing, blind forgery, Chromatography, Counterfeiting, Diacritics, erasure, Exemplar, forgery, indented writing, infrared luminescence, natural variations, Obliteration, Questioned Document, simulated forgery, traced forgery

Resources: Chromatography paper, UV lights, counterfeit detection pens, and handwriting analysis templates.

SEP and CCC Connections:

• SEP: Analyzing and Interpreting Data. Students analyze handwriting characteristics, such as diacritics, and use chromatography data to identify forgeries or ink origins .

• CCC: Patterns. Students identify unique, repetitive patterns in an individual’s handwriting or the chemical "signatures" of different ink types .

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Priority Standard 9: Drugs and Toxicology

Big Idea(s):
Forensic toxicology determines the presence of drugs and poisons to establish their role in medical-legal investigations.

The classification of drugs by their physiological effects (Controlled Substances Act) guides the legal and forensic response to substance abuse.

Essential Question(s):
How do presumptive color tests differ from confirmatory instrumental analysis in a drug lab?

What is the societal impact of the classification of illicit drugs?

Students will Know:	*As evidenced by:*
9.1 Controlled Substance Classifications ● Stimulants ● Narcotics (Opioids) ● Hallucinogens 9.2 Presumptive and Preliminary Screening ● Marquis, Scott, and Duquenois-Levine Reagents ● Thin-Layer Chromatography (TLC) 9.3 Metabolism and Toxicity Levels ● ADME Process ● Acute vs. Chronic Toxicity ● LD50 (Median Lethal Dose)	● Identify different substances based on chemical testing and reactions to reagents. ● Categorize illicit drugs into schedules (Stimulants, Narcotics, Hallucinogens) based on their physiological effects and chemical properties. ● Perform presumptive color tests (e.g., Marquis, Scott, Duquenois-Levine) to identify unknown controlled substances. ● Execute a Thin-Layer Chromatography (TLC) lab to separate and identify the chemical components of a drug mixture. ● Analyze toxicological data to determine the "LD50" (lethal dose) of various poisons and their impact on the human body.

Vocabulary:

acute toxicity, Chromatography, chronic exposure, confirmatory tests (spectrophotometry, mass spectrometry), Controlled Substance, depressants, Hallucinogen, hallucinogens, LD50, Narcotic, opiates/analgesics, Reagent, schedules, screening/presumptive tests, stimulants, Toxicology, toxicology, toxins

Resources: Spot test reagents, TLC plates, solvent systems, and the Controlled Substances Act schedules.

SEP and CCC Connections:

• SEP: Planning and Carrying Out Investigations. Students perform presumptive and confirmatory tests using chemical reagents to identify unknown controlled substances .

• CCC: Energy and Matter. Students investigate how different classifications of matter (Narcotics, Hallucinogens, etc.) interact chemically with reagents to produce observable changes .

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Priority Standard 10: Glass and Soil Analysis

Big Idea(s):
Physical properties like density and refractive index act as "chemical fingerprints" to link evidence to a source.

The analysis of fracture patterns allows for the chronological reconstruction of events at a crime scene

Essential Question(s):
How can the microscopic properties of matter be used to connect a suspect to a location?

How do we use fracture patterns to determine the sequence of impacts in a window?

Students will Know:	*As evidenced by:*
10.1 Glass Physical Properties ● Density ● Refractive Index (Becke Line) 10.2 Fracture Patterns ● Radial and Concentric ● 3R Rule 10.3 Soil Properties and Analysis ● Color, Texture, and pH ● Density Gradient	● Calculate the density of glass fragments using the displacement method (Density = Mass/Volume) and comparative flotation. ● Execute the Becke Line method using immersion liquids to determine the refractive index of unknown glass samples. ● Interpret glass fracture patterns (Radial vs. Concentric) to determine the sequence of impacts and the direction of force (3R Rule). ● Perform a soil analysis lab including pH testing, microscopic observation, and density gradient tube comparison to link soil to a specific location.

Vocabulary:

Amorphous, Becke Line, borosilicate glass, Clay, Concentric Fracture, density, Density Gradient, float glass, Horizon O, laminated glass, normal line, Parent material, Radial Fracture, refraction, Refractive Index, refractive index, Sand, Silt, Soil, Soil artifacts, Soil profile, Subsoil, tempered glass, Topsoil

Resources: Refractive index liquids, microscopes, soil samples, and triple beam balances.

SEP and CCC Connections:

• SEP: Analyzing and Interpreting Data. Students interpret refractive index data and fracture patterns to link evidence to a specific source or sequence of events .

• CCC: Cause and Effect. Students determine the direction and sequence of force by analyzing the resulting radial and concentric fractures in glass samples .

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Appendix A: Vocabulary

• Agglutination: The clumping of blood cells that occurs when antibodies bind to their target antigens; it forms the basis for blood typing tests.
• Algor Mortis: A mortis stage used to establish a timeline of death based on the cooling of the body.
• Amorphous: A solid material whose atoms are not arranged in a regular, repeating lattice pattern; characteristic of glass.
• Anagen: The active growth phase of a hair follicle.
• Angle of impact: The angle at which blood droplets hit a surface, calculated using a trigonometric formula.
• Antibodies: Proteins produced by the immune system that recognize and bind to specific antigens (A, B, Rh) to prevent foreign blood from surviving in the body.
• Antigens: Inherited biological markers on blood cells that determine blood compatibility and forensic identification.
• Arch: A primary fingerprint pattern where ridges enter from one side and exit the other.
• Area of convergence: The 2D point from which various blood drops in a spatter pattern originated.
• backhand writing: Handwriting that slants to the left.
• Ballistics: The study of projectile motion.
• Becke Line: A halo-like shadow used in the immersion method to determine the refractive index of unknown glass samples.
• Bifurcation: A specific minutiae point where a single ridge splits into two.
• blind forgery: A forgery made without a model of the original signature.
• borosilicate glass: Heat-resistant glass often used in laboratories (e.g., Pyrex).
• Cast off pattern: A bloodstain pattern created when blood is flung from a moving object, such as a weapon.
• Catagen: The transition phase of a hair follicle, occurring after the growth phase.
• caucasoid: A term historically used in forensic anthropology to describe ancestry related to European, Middle Eastern, or North African origins.
• Chain of Custody: The systematic documentation and preservation of evidence to ensure its integrity, credibility, and admissibility in legal proceedings.
• Chromatography: A chemical analysis method (such as paper or thin-layer chromatography) used to separate and compare the chemical components or 'signatures' of mixtures like ink or drugs.
• Circumstantial Evidence: Evidence that relies on an inference to connect it to a conclusion of fact, rather than direct observation.
• Civil law: Governs disputes between private parties and/or organizations.
• Class evidence: Evidence that links an item to a group, such as a blood type or a paint chip sample.
• CODIS: The Combined DNA Index System; a national database used for matching DNA profiles across jurisdictions.
• coleoptera: The order of insects comprising beetles, often found in late stages of decomposition.
• Concentric Fracture: A circular fracture pattern that forms around the point of impact.
• confirmatory tests (spectrophotometry, mass spectrometry): Analytical methods used to positively identify a substance, providing high specificity.
• Controlled Substance: Drugs classified into 'schedules' (e.g., Stimulants, Narcotics, Hallucinogens) based on their physiological effects and potential for abuse.
• Core: The approximate center of a fingerprint pattern.
• coronal: A type of hair cuticle scale pattern (like a crown) often found in rodents.
• cortex: The middle layer of the hair shaft that contains pigment granules.
• Counterfeiting: The illegal production of fake currency or documents designed to look authentic.
• Criminal law: Governs disputes between citizens and society.
• cuticle: The outermost protective layer of the hair shaft consisting of overlapping scales.

• Daubert ruling (1993): A legal standard where the judge determines the reliability of expert witness testimony based on specific enumerated factors.
• Delta: A triangular ridge pattern found in loops and whorls.
• Density Gradient: A method using specialized tubes to compare soil samples to link them to a specific location.
• depressants: A class of drugs that slow down the central nervous system.
• Diacritics: One of the 12 individual handwriting characteristics, referring to the way an individual dots 'i's or crosses 't's.
• diptera: The order of insects comprising flies, critical in determining the Post-Mortem Interval.
• Donor Blood factors: Specific antigens on red blood cells used to determine compatibility.
• Entomology: The study of insects.
• Epiphyseal Plate: The growth plate at the ends of long bones used to estimate the age of skeletal remains.
• epiphyses: The ends of long bones that eventually fuse with the shaft.
• erasure: The removal of writing, typewriting, or printing from a document, often by chemical or mechanical means.
• Exemplar: A known sample used for comparison against questioned evidence.
• Expert witness: An individual whose testimony is based on opinion, allowed through the establishment of specialized credentials or experience.
• Felony: Serious offenses, usually punishable by more than one year in prison, fines, or both.
• femur: The thigh bone, often used to estimate height in skeletal analysis.
• Follicular Tag: A piece of tissue often attached to the root of a forcibly removed hair, which contains nuclear DNA.
• Forensic Entomology: The study of insects, such as blowflies, to estimate the Post-Mortem Interval.
• Frye standard (1923): A legal standard where the jury determines the reliability of expert witness testimony based on its “general acceptance” in the scientific community.
• Gel Electrophoresis: A laboratory technique used to separate DNA fragments to identify matching STR patterns.
• Hallucinogen: A classification of illicit drugs based on their physiological effects.
• hallucinogens: Drugs that cause profound distortions in a person's perceptions of reality.
• heterozygous: Having two different alleles for a particular gene.
• High/Medium/Low-velocity blood: Classifications of blood spatter based on the speed of the impact that created them.
• homozygous: Having two identical alleles for a particular gene.
• humerus: The upper arm bone.
• imbricate: A flattened, overlapping scale pattern commonly found in human hair.
• indented writing: Impressions left on sheets of paper below the one that was written on.
• Individual evidence: Evidence that links an item to a single source, such as DNA or a fingerprint.
• infrared luminescence: A technique used to detect alterations or erasures in documents by observing how ink reacts under infrared light.
• insect succession: The predictable pattern of insect colonization on decomposing remains over time.
• Keratin: The primary structural protein that makes up hair.
• knit: A type of fabric made by interlocking loops of yarn.
• Latent Print: A fingerprint found at a scene that is typically invisible and requires visualization techniques.
• LD50: The lethal dose of a toxin that kills 50% of a test population.
• livor mortis: The settling of blood in the lower parts of the body after death, causing discoloration.
• Locard’s Principle: The principle that 'every contact leaves a trace'.
• Loop: A primary fingerprint pattern where ridges enter and exit from the same side.
• Luminol: A chemical that exhibits chemiluminescence when it reacts with the iron in blood.
• Material evidence: Evidence that is relevant and significant to the facts of a case.
• medulla: The central core of the hair shaft.

• Medullary Index: A calculation used to distinguish between human and animal hair under a microscope.
• medullary index: The ratio of the diameter of the medulla to the diameter of the entire hair shaft.
• Minutiae: Specific ridge characteristics used to differentiate individuals and support investigations.
• Miranda rights: A warning given by police to suspects in custody advising them of their right to silence and an attorney.
• Misdemeanor: Minor offenses, usually punishable by less than one year in prison, fines, or both.
• Mitochondrial DNA: DNA found outside the cell nucleus; used as an alternative to nuclear DNA in some forensic cases.
• mogoloid: A term historically used in forensic anthropology to describe ancestry related to Asian or Native American origins.
• Morphology: The physical structure of hair, including the cortex, medulla, and root.
• Narcotic: A classification of illicit drugs based on their physiological effects.
• natural: Fibers derived from plants (e.g., cotton) or animals (e.g., wool).
• natural variations: Normal differences that occur in an individual's handwriting over time.
• negroid: A term historically used in forensic anthropology to describe ancestry related to sub-Saharan African origins.
• normal line: An imaginary line perpendicular to the surface of a material where light enters.
• Nuclear DNA: DNA found in the cell nucleus, which is inherited from both parents.
• Nucleotide: The basic structural building block of nucleic acids (DNA/RNA).
• Obliteration: The act of making writing unreadable by marking over or smearing.
• Odontology: The study of teeth, including dental records.
• opiates/analgesics: A group of drugs used to relieve pain, often derived from poppy plants.
• OS pubis: The pubic bone, a key skeletal landmark for determining sex.
• osteology: The scientific study of bones.
• osteons: Microscopic structures in bone tissue.
• Parent material: The underlying geological material (e.g., bedrock or drift) in which soil horizons form.
• Passive: Bloodstain patterns produced by the force of gravity.
• Patent Print: A visible fingerprint made when fingers touch a surface after contact with a colored material like blood or ink.
• pathologist: A medical professional who examines bodies to determine the cause and manner of death.
• Pathology: The study of diseases, including autopsies.
• Pelvic Inlet: The opening to the pelvic canal, used to determine sex.
• Physical evidence: A tangible material that can be collected and examined.
• Plain: A simple textile weave pattern where the warp and weft yarns cross over each other regularly.
• Plastic Print: A 3D fingerprint indentation left in soft material like wax or soap.
• Polygraph: A device, often called a lie detector, that records multiple physiological indicators while a person is asked questions.
• Polymer: A substance with a molecular structure consisting of many similar units bonded together; many fibers are polymers.
• Polymerase Chain Reaction (PCR): A process used to amplify (make copies of) small or degraded biological samples for analysis.
• Post-Mortem Interval (PMI): The time elapsed since an individual has died.
• postmortem interval (PMI): The time elapsed since death.
• Precipitin test: A confirmatory test used to distinguish between human and animal blood.
• Presumptive test: A preliminary test (like the Kastle-Meyer test) used to suggest the presence of blood.
• Probable cause: Reasonable grounds for making a search or pressing a charge.
• Probative evidence: Evidence that has the ability to prove or demonstrate something relevant.
• Projected: Bloodstain patterns produced by a force other than gravity.
• Questioned Document: A document whose authenticity or origin is being investigated.
• Radial Fracture: A fracture pattern that radiates outward from the point of impact.

• Reagent: A chemical substance used in tests to produce a specific reaction for identifying unknown drugs.
• Red Blood Cell: Cells that carry oxygen and contain the antigens used for blood typing.
• refraction: The bending of light as it passes from one medium to another.
• Refractive Index: A physical property of glass that acts as a 'chemical fingerprint' for identification.
• Rh factor: A protein factor on red blood cells that can be positive or negative.
• Ridge: The raised portion of the skin on the fingers and palms.
• Rigor Mortis: A mortis stage used to establish a timeline of death based on the stiffening of the muscles.
• rigor mortis: The temporary stiffening of muscles that occurs after death.
• satin: A weave pattern characterized by a smooth, lustrous surface.
• schedules: Categories used to classify drugs based on potential for abuse and medical utility.
• screening/presumptive tests: Preliminary chemical tests used to indicate the possible presence of a drug or biological fluid.
• Single-nucleotide polymorphisms (SNPs): Variations in a single nucleotide base in the DNA sequence.
• Soil: A mixture of organic matter, minerals, gases, liquids, and organisms.
• Soil artifacts: Man-made objects found within soil samples that can aid in forensic identification.
• Soil profile: A vertical section of soil showing its different horizons.
• Spines/tails: Pointed edges or extensions of a blood droplet that indicate the direction of travel.
• spinous: A petal-like hair scale pattern, often found in cats or seals.
• stimulants: Drugs that speed up the central nervous system.
• STR (Short Tandem Repeat): Specific patterns in DNA used by forensic scientists for individual identification.
• STR electropherogram: A visual representation (graph) of DNA fragments generated by electrophoresis.
• Subsoil: The layer of soil beneath the topsoil.
• sutures: The seams or joints between the skull bones, used to estimate age.
• Synthetic: Man-made fibers, as opposed to natural fibers like wool or cotton.
• synthetic: Fibers that are entirely man-made (e.g., polyester, nylon).
• Telogen: The resting phase of a hair follicle.
• Testimonial evidence: A spoken or written statement by an individual with knowledge of a situation.
• tibia: The larger of the two lower leg bones.
• Topsoil: The upper layer of soil, rich in organic matter.
• Toxicology: The study of toxins/poisons and their physiological effects on living organisms.
• toxins: Poisons produced by biological organisms or chemicals that are harmful.
• Transfer stains/patterns: Patterns created when a wet, bloody surface comes in contact with another surface.
• twill: A textile weave pattern that produces diagonal parallel ribs.
• Type A, Type B, Type AB, Type O: The four major human blood types.
• Universal donor: A person with Type O negative blood, which can be given to patients of any blood type.
• Universal recipient: A person with Type AB positive blood, who can receive blood from any type.
• ventral arc: A bony ridge on the female pubic bone, used for sex determination.
• Visible print: Also known as a patent print.
• Whorl: A primary fingerprint pattern that forms a circular or spiral shape