

Course Description

Course overview:

Forensic Science is a third or fourth-year, college preparatory, elective science course for those students interested in the detailed investigation practices used in the criminal justice system. This rigorous, multidisciplinary course integrates concepts from biology, chemistry, physics, and Earth science. Students will use the scientific method to solve mock criminal investigations. This course allows students to explore how science and inquiry can be applied to the criminal justice system. Topics include: crime scene analysis, physical/ chemical analysis of evidence, microscopy, chromatography, hair/fiber/glass/document/fingerprint analysis, firearms, drug, toxicology, entomology, anthropology, blood (serology) and DNA analysis. Principal methods of learning include lecture, demonstration, case study analysis, forensic journal reading, forensics competitions, lab activities and experiments. This course will emphasize potential career pathways, critical thinking, problem-solving, observation, data analysis, data collection, digital photography and technology in addition to scientific skills and techniques.

Forensic science is the application of multiple scientific disciplines to the investigation of criminal or civil questions of the law. In this course we will use biology, chemistry, and earth sciences to analyze and interpret evidence within the realm of our legal system. The course begins with an introduction to scientific inquiry and the process of forensic investigation. This inquiry is then applied to the analysis of crime scene analysis, physical/chemical analysis of evidence, microscopy, chromatography, hair/fiber/glass/document/fingerprint analysis, firearms, drug, toxicology, entomology, anthropology, blood (serology) and DNA analysis. Principal methods of learning include lecture, demonstration, case study analysis, forensic journal reading, forensics competitions, lab activities and experiments. This course will emphasize potential career pathways, critical thinking, problem-solving, observation, data analysis, data collection, digital photography and technology in addition to scientific skills and techniques.

Students upon completion of this course will:

1. Build upon the knowledge acquired in the prerequisites of Biology and Chemistry laboratory courses as they continue to investigate the major themes of the Next Generation Science Standards at an advanced level with a forensic science context.

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1. Further investigate the major theme of biology using standards based problems, investigations, laboratory experiments and data analysis in a forensic science context.
2. Meet the Next Generation Science Standards for Biology.

3. Using scientific terminology, principles and investigative processes to prepare students for the demands of college and university level laboratory science course.
4. Prepare proper laboratory reports and research papers to provide the student with the scientific reasoning and advanced literacy skills required at the college level.
5. Achieve scientific literacy (using the Common Core Standards for ELA) or the ability to use and apply scientific principles in everyday life by analyzing various types of literature from content related texts, research papers, journals and articles.
6. Understand the basic chemical and biological processes of cells, tissues, and organisms in relation to the area of Forensic Science.
7. Apply the scientific method to their laboratory investigations as students analyze various types of evidence.
8. Understand and apply proper techniques, safety considerations, and equipment use in order to analyze evidence in a Forensic Science.

10. Apply scientific reasoning to mock crime scene challenges and will be able to problem solve, think critically and interpret their laboratory results.

11. Maintain a properly documented laboratory notebook detailing their scientific investigations and analysis.

12. Use technology and advanced tools in their laboratory investigation and data presentation.

13. Be assessed through a variety of assessment tools including their performance on lab investigations and activities.

Prerequisites:

Biology (Required)

Chemistry (Required)

Algebra (Required)

Co-requisites:

None

Course content:

The shaded background of the following field indicates this course was approved by UC for the 2014-15 school year or earlier. Please refer to the current "a-g" course criteria and guidelines when completing your course submission form.

1. Introduction to Forensic Science Chapter 1)
2. Definition (terms)
3. History
4. Specialties

1. Scientific Methodology

2. Observations (Laboratory Journals, Notes)
3. Characteristics comparison
4. Similar characteristics, associated to same/similar course
5. Dissimilar characteristics, cannot be associated w/same source
6. No conclusion can be reached, exhibiting similarities & differences
7. Class vs. individual (or accidental) characteristics

B. Hypothesis (Logical Explanations)

C. Tests (w/Controls)

D. Assessments (against Hypothesis)

E. Refinement/Retesting Restating Hypothesis

F. Confirmation/Independent Testing Redundancies

G. Theory, Laws

H. Locard Exchange Principal (Theory of Physical Transfer)

(Lab Activity: Locard's T-shirt Exchange Assessment)

III. Safety

1. Laboratory Safety Procedures
2. Safety Clothing/Apparatus
3. Gloves, glasses and lab coats
4. Emergency shower/eye wash
5. Stryker Chair operations (single & multiple operations)

(Lab Activity: Fire Drill Deployment of Stryker Teams)

1. Emergency Procedures
2. Activate Emergency Medical Services (EMS) 911 call
3. Initiate safety response protocols
4. Emergency First Responder (Primary & Secondary Care)
5. CPR (Cardiopulmonary Resuscitation-Primary Care)
6. First Aid (Secondary Care)
7. Injury First Aid
8. Temperature-Related Injuries
9. Illness First Aid
10. AED (Automatic Electronic Defibrillator: Ventricular Fibrillation)
11. Emergency Oxygen Use
12. Material Safety Data Sheets (MSDS)

1. Incident Processing (Crime Science) Crime Science
2. Protocol (Standard Operating Procedures)
3. Personnel Tasks (Responsibilities)
4. Documentation, Documentation, Documentation
5. Chain of Custody/Chain of Possession

(Lab Activity: Create COP for Locard T-shirt Evidence)

1. Federal Rules of Evidence
2. Probative (Evidentiary) Value

(Lab Activity: Crime Scene Analysis)

(Lab Activity: The Murder of Lois Smith)

1. Physical Evidence (Chapter 3, 4, 5)
2. Impressions
3. Types
4. Footwear (Forensic Podiatry)
5. Tire tracks
6. Strangulation/ligature in skin
7. Bite marks
8. Tool marks
9. Frequency and durability
10. Documentation
11. Capturing digital images (in situ and close up, with and w/out scales)
12. Recovery and enhancement

(Lab Activity: Capturing digital images of foot impressions)

1. Databases
2. Relational databases
3. Inquires
4. Sampling Errors
5. Probability and Statistics
6. Experimental Results (Accuracy and Precision)
7. Soil Sciences (Mineralogy, Forensic Geology)
8. Introduction to Earth Sciences
9. Formation of soils (weathering)

10. Components of soil (top & sub soils)
11. Forensic soil examination (Purpose and procedures)
12. Soil Sampling
13. Preparation (identifying area sample represents)
14. Extraction
15. Correlation/interpretation
16. Mechanical sieve (particle) field analysis
17. Preparation (drying soil)
18. Appropriate size per sample/analysis
19. Diameter (very coarse, coarse, medium, fine, very fine; diameters mm)
20. Textural classification of soil
21. Percentages (amount sieved/volume per graduated scale)
22. Percent Clay, Silt, and/or Sand (loam)

(Lab Activity: Soil analysis, sieving, percentages of sample)

1. Soil Forming Factors
2. Parent materials
3. Climate
4. Organisms
5. Topography
6. Time
7. Physical Properties Analysis
8. States of Matter (Solids, liquids, Gas)
9. Pure substance (Elements/atoms)
10. Mixtures (homogeneous/heterogeneous)
11. Units of Measurement (Mass, volume, distance & time)
12. Mass/Weight
13. Density (mass per unit volume, and density gradient methods)
14. Temperature
15. Chemical Properties Analysis
16. Reactions, Properties and Changes
17. Multiple sampling testing (redundancy/independent/blind test)
18. pH (acidity or alkalinity determination, pH range)

(Lab Activity: Red Cabbage pH Indicator Solution)

1. Mathematics to Solutions (calculating pH)

(Lab Activity: Household Product pH report)

1. Nitrogen content
2. Nitrate

3. Nitrite (nitrate nitrogen decomposes to form nitrites)
 4. Ammonia (most abundant available form of nitrogen in forest solid)
 5. Potassium (Potash) Content
 6. Phosphorous content (extremely sensitive test, involved in rapid uptake of water/nutrients in plants, required for plant transfer of energy)
 7. Calcium & Magnesium content (neutralizing acids, essential for plant walls of plant cells- providing rigidity or stiffness)
 8. Chloride (present in practically all soils)
10. Sulfates (major sources are fertilizers)

1. Biological Properties Analysis
2. Introduction to Microscopy
3. Compound microscopes (parts, proper use)
4. Stereo-Zoom microscope (parts, proper use)

(Lab Activity: Proper use/care of microscopes, field-of-view measurement)

1. Preparing wet & permanent slides
2. Humus (plant and animal residue) – organic carbon
3. Plant tissue tests
4. Glass Analysis
5. Glass samples as evidence (properly collecting, preservations)
6. Cleaning glass samples, preparing for analysis
7. Polarized light microscopy (characterizing))
8. Refractive index
9. Direction of Fracturing Force
10. Types of fractures (low-velocity, high velocity, thermal)
11. Waller lines (ridges, 4R rule)
12. Cone or crater (high velocity impact)
13. Hackle Lines (stress marks)
14. Sequence of Fractures
15. Radial fractures

(Lab Activity: Wards: Glass Analysis)

1. Forensic Entomology
2. Introduction (myths busted!)
3. Study of insects and other arthropods in respect to legal matters
4. Estimating Post Mortem interval (Time of Death, TOD)
5. Introduction of chemical kinetics (rates of chemical reactions)
6. Kinetics and temperature

7. Kinetics and catalyst
8. Body Temperature (rate of cooling following death)
9. Progression of rigor mortis
10. Decomposition (definitions)
11. Insect activity (most accurate after 3 days)
12. Insect types and taxonomy
13. Introduction to Dichotomous (taxonomic Keys)
14. Necrophagous species (blow flies and flesh flies)
15. Parasites and Predators (soldier flies)
16. Omnivores and opportunists
17. Calliphoridae life cycle
18. Female laying eggs within minutes of death 200 to 300 in orifices
19. Eggs hatching 1 to 2 days later
20. Three larval (instars) stages (spiracles) – few day to a few weeks
21. Puparium transformation (outer cuticle/3rd instar lava hardens)
22. Adult hatching, taxonomic identification
23. Influences of Ambient weather on development rates
24. Sources for weather date (NASA, local TV/Radio weather bureau)
25. Temperature range
26. Humidity, precipitation
27. Diurnal/nocturnal cycle
28. Seasonal variation
29. Detailed entomological calculation
30. Determine temperature history at scene
31. Culture (rear) maggots to adulthood to identify species
32. Estimate time of egg laying

1. Hairs and Fibers (Chapters 7, 8)
2. Introduction to Anatomy
3. Cells, tissues, organs, organ systems
4. Epidermis Tissue
5. Corneal layer
6. Basal layer
7. Dermis Tissue
8. Sweat Glands
9. Sebaceous Glands
10. Muscle, vein, artery, nerve endings
11. Hairs (follicles in the skin of mammals)
12. Morphological Regions (Hair Form and Structure)
13. Cuticle
14. Cortex

15. Medulla
16. Root sheath
17. Sebaceous glands
18. Sweat (apocrine) glands
19. Hair-follicle receptors (nerve sensors)
20. Hair-follicle cycling and hair growth
21. Anagen (growth) phase
22. Catagen (regressing) phase
23. Telogen (resting) phase
24. Growth from root out (cellar division) adding to the hair shaft
25. Approximately 1 cm every 28 days in humans

(Lab Activity: Introduction to Hair Analysis; students examine hair and try to identify source of hair)

1. Fibers
 2. Introduction (Textile definitions: natural vs. synthetic)
 3. Natural
 4. Cotton, flax (linen), sisal, jute, hemp, kapok, coir
 - b. Wool, silk, camel, cashmere, mohair, and alpaca
 3. Synthetic (man-made)
 - a. polyester, nylon, acrylics, rayon and acetate
 - b. microscopic cross-section (shapes; round/trilobal/serrated/irregular)
 - c. colors (dyes, printed, absorption, and discoloration)
 - d. fabrics (construction, knitted, woven)

(Lab Activity: Ward's Scientific Hair and Fibers Lab)

4. Physical Analysis
 - a. Flame tests (fiber reaction to heat source)
 - b. Solubility tests (reactions to known chemicals)
 - c. Saturation, unsaturated, and supersaturated (Solubility Rules)

(Lab Activity: Fiber Flame & Solubility Tests, Lab Report)

VIII. Latent Prints (Processing) (Chapter 14)

- A. Introduction to Fingerprint Identification
 1. How fingerprints are made (left on surface) perspiration

1. latent

b. Plastic

c. visible

2. Friction ridges (epidermal layers)

3. History of Fingerprint development/identification

a. fingerprint types (loops, whorls, arches, accidental types)

b. Galtons Ridges (minutiae)

c. Henry FBI Classification

(Lab Activity: Rolling Fingerprint/Ten Print Cards)

B. Physical Processing

1. Dusting (graphites, fluorescent powders)

2. Lifting with tapes (cellophane adhesives)

(Lab Activity: Latent Print Dusting/Lifting)

IX. Serology (Blood Typing & Blood Stain Pattern Analysis) (Chapter 12)

A. Human Circulatory System

1. Arterial vs. Venial Blood

2. Red Blood Cells (erythrocytes)

3. White Blood Cells (leukocytes)

4. Platelets

B. Blood Types

1. A, B, AB, and O blood types

2. RH factor

(Lab Activity: Simulated Blood Typing)

3. Hemoglobin in Blood

4. Presumptive (Color) Stain Testing (Kastle-Meyer Tests, Hemastix)

5. Chemiluminesce (Luminol & BluStar)

C. Bloodstain Classification

1. Spatter Group (spurt, cast-off, drip and drip trail, impacts)
2. Nonspatter group (smear, pattern transfer, pool, flow)

E. Impact Angle and Directionality

F. Area of Origin Evaluation

(Lab Activity: Blood Stains Identification)

X. Toxicology (Poison Detection, Alcohol and Narcotics) (Chapter 9, 10)

A. Alkenes and Alkynes

B. Controlled Drugs

1. Hallucinogens (Cannabis, LSD, PCP, MDMA/Ecstasy)
2. Stimulants (Cocaine, Speed, Crank)
3. Narcotics (Morphine, Heroin, Opium, Codeine)
4. Depressants (Barbiturates, Quaaludes, Valium)
5. over the Counter (OTCs) Prescription, RX

(Lab Activity: Thin Layer Chromatography, TLC)

C. Poisons

1. History of Poisons
2. Elements of Toxicology
3. Measuring Toxicology (Toxins)
(Chronic exposure, acute toxicity, synergism, antagonism, chelating agents)

XI. DNA Analysis (Chapter 13)

A. Cytology (Cellular Biology)

1. Cellular structure
2. Cellular organelles
3. Nucleus

B. Deoxyribonucleic Acid (DNA) Fingerprinting

1. Chromosomes
2. Genes

3. Proteins (enzymes)
 4. Base Pairs (adenine, thymine, guanine, cytosine)
 5. DNA Structure (right-handed double helix)
- C. DNA Fingerprinting History in Forensics
- D. RFLP (Restriction Fragments Length Polymorphism) Analysis
1. Isolation of DNA
 2. Cutting with restrictive enzymes
 3. Sorting by base strands (length/size)
 4. analyzing (identifying specific alleles)
- (Lab Activity: PCR Amplification)
- F. Mitochondrial DNA
1. Hair Sources
- G. FBI CODIS

XII. Forensic Anthropology (Skeletal Remains Analysis)

- A. Osteology (Study of Bones)
- B. Human Skeleton (206 Bones in the Body)
1. Long Bones (longer than wide; arms, legs, hands and feet)
 2. Short Bones (as long as they are wide: wrist and ankle)
 3. Flat Bones (Skull, hip, ribs, scapula and sternum)
 4. Irregular Bones (skull and vertebrae)
- (Lab Activity: Identifying Bones)
- C. Estimating Stature (Height)
1. Femur, Tibia, Humerus and Radius
 2. Height Estimation Equations
- (Lab Activity: Height Determination by Long Bones)
- D. Sex Determination
1. Pelvis (os pubis, sacrum and ilium) most obvious differences in sexes
 2. Skull features (forehead, mastoid process, mandible,

- Satisfactory demonstration of skills directly to the teacher, through lab practical, team activities, and/or personal assessments.
- Write individual and team performance-based examination.
- Formal (per judicial protocol) laboratory reports assess per rubric.
- Independent validation of replicable results (performed by other students).
- Legal scientific notebooks (case evidence, chain-of-possession protocol)
- Research papers.

Locard T-Shirt Exchange Assessment: Students wear new T-shirt for afternoon evening activities, than “Bag n” Tag” T-shirt as evidence. Next day team members assess T-shirt for clues (hairs, stains, etc) to reconstruct the “suspect” (who wore the shirt) activity of the previous evening.

Safety Lab/Stryker Teams: Deployed teams (2 students) to assist with transport of wheelchair bound student from 2nd floor to staging area in parking lot.

Create appropriate Chain of Possession paperwork (from) for Locard T-Shirt evidence. Attention to case #, date and time collected, collected by, contact info and detailed description of evidence. Bagged evidence submitted to secured Property & Evidence lock-up.

Capturing digital images of foot impressions

Soil analysis; sieving to determine percentage of clay, sily and sand in sample.

Red cabbage used as pH indicator.

Household product pH determination with meter

Production of wet and fixed slide samples, creation of reference series from known samples (hairs & fibers)

Biological property analysis of soil samples

Magnified drawings of glass fractures, specifically waller and /or hackle lines

Indicating direction of force breaking the glass.

Magnified drawings of concentric and radial fracture lines to indicate sequence of breaks in class.

Data charts of daily observations of influencing weather patterns at body site and temperature reanges iover two week period of observation and maggot collection

Microscopic drawings (Zoom Microscope) of larval development, attention to spiracles for identification of instar larval stage.

Microscopic drawings of hair morphology, structures.

Microscopic drawings of hair characteristics from various parts of the (same) body; similar characteristics.

Microscopic drawings of hairs from various humans and animals noting the similarities and dissimilarities (cuticle scales, medulla complexity).

Microscopic drawings of dissimilarities between Caucasians, negroid and mongoloid head hairs.

Microscopic drawings of natural vs synthetic fibers

Fiber Flame and solubility tests data tables

Rolled fingerprint FBI 10 Box cards, identification of print types and distinguishing minutiae characteristics.

Latent print processing with dusting and tape lifts.

Chemical print processing, preservation (lifting w. tape)

Simulated human blood typing(a, B, AB, O and Rh factor)

Presumptive stain testing for blood (Kastie_Meyer test, Hemastix)

Presumptive "cleaned" stain test with Luminol and BluStar regents.

Thin layer chromatography of OTC drugs identification

Presumptive color tests for narcotics

Confirmatory lab tests (infrared spectroscopy and mass spectrometry)

Lab detection of the presence of lead poisoning

Electrophoresis/DNA/STR profiles produced and analyzed

PCR amplification of degraded DNA samples, followed with electrophoresis separation and str analysis

Identifying human bones.

Height/stature estimation from long bones.

Sex determination from skull bones

Owl Pellet analysis (number of "victims", ID victims)

Lip print patterns

Lipstick thin layer chromatography

- All lab assignments are assessed in respect to rubrics that the students are presented and discussed at length and reinforced after each assignment. Identifying key factors and "weighted" analysis based upon importance.
- Quizzes are administered following the introduction of a new topic. Assessments will be modified to follow the new district periodic assessments for chemistry and biology.
- Final assessments per topic are often assessed in a field activity: processing a crime scene with the attention on the most recently developed skills.
- Crime Scene Processing reports are prepared on the Detective Portfolio level (often shared with LAPD's onsite officer)

- Lab reports are prepared as formal laboratory reports as well as on the Prosecutor's level, anticipating independent analysis.
- Student teams frequently make presentations of collected evidence or high probative value to class.
- There are two capstone assignments, one each semester. Fall semester requires students to develop a crime scene and supporting documentation that allow invited students to collect clues and try to solve the "crime" with interactive activities that students perform. In the Spring, students create a 'diorama" that represents a recent real crime with supporting evidence. Both projects highlight the skill set the students have developed, as well as written and oral communication skills.
- This is a hands-on, laboratory course. Everything the students observe their teacher demonstrating, they participate in, and then demonstrate their capabilities and full comprehension of the topic allowing for individual assessment before moving on to the next topic. With a diverse student population (varying foundation knowledge levels of biology, chemistry, and earth science), it is anticipated to advance student knowledge and skill set. Students acting as "mentors" to those students who require additional time and support.
- The sequence of topics is based on the perceived pattern of crime scene processing throughout the year (from simple sketching to detailed DNA analysis of trace evidence stains). With the introduction of new skill within a topic or a new topic, PowerPoint presentations and interactive internet references are utilized to complement the assigned text readings.
- Rapid advancement in applied Forensic technology outdates published in a short period of time that students are required to establish and maintain Operations Manuals. In the OPS Manuals, students organize the accumulated information from topic discussions, handouts, and examples of their lab works (work products). These manuals become Professional Portfolios at the conclusion of the course and personal references for the students of the many Forensic Sciences they have been introduced too.
- Topic specific DVDs are viewed, frequently interrupted/stopped for open discussion. By the end of the course, similar DVDs are viewed without audio and the students are challenged to interpret what they are observing.
- Guest speakers (professionals from various related Forensic occupations, even individuals that have been observed on the DVDs) give presentations and answer from students.
- As a hands-on laboratory course, in excess of 50% of the time the students are actively involved in lab or field activities, practicing, improving upon the skills they have learned.
- Students conduct assigned and independent research. Present formal lab reports for assessment and make oral presentations to classmates, explaining and defending their results.
- Students work independently and in team scenarios, delegating and sharing in tasks.
- Student activities are often captured digitally as documentation and for critical reviewed.
- Professional internship opportunities are explored.

Textbook:

Title	Author
Forensic Science for High School	Barbara Ball-Deslich, John Funkheuser
Publisher	Edition
Kendall Hunt	2 nd Edition