BIOL 104 Forensic Biology

Chapter 3 Physical Evidence

I. Physical Evidence

* The examination of physical evidence by a forensic scientist is generally undertaken for the purposes of **identification** or **comparison**.

1. **Identification:** The process of determining a substance’s physical or chemical identity. Drug analysis, species determination, and explosive residue analysis are typical examples of this undertaking in a forensic setting. Identification has as its purpose the determination of the physical or chemical identity of a substance as near absolute certainty as existing analytical techniques will permit.
   * To do this requires the analysis and ultimate identification of a specific physical or chemical substance to the exclusion of all other possible substances.
2. Establish a series of tests for known reference standards
3. Conduct testing on all aspects of the known reference

standards to allow for unique identification

1. Inclusion of the known standard
2. Exclusion of all other possibilities (this is the difficult one)
3. Some standards may require only a single test to establish a unique identity
4. Some standards may require a series of tests to both eliminate other possibilities and identify the standard

2. Apply the identity testing to your suspect sample

a. Each sample should be treated as unique and requires

exhaustive testing to establish identity

1) unique identification of all sample components

2) unique identification of some sample components

b. Different samples will require different testing strategies

3. Compare the test results of your unknown to the test results of your

known reference samples

a. Compare to previously established reference sample results

b. Run knowns and unknowns in side-by-side testing (this is

usually the best)

4. Expertise is gained over time and after running many sample and

reference identifications. Ultimately, the conclusion will have to be substantiated beyond any reasonable doubt in a court of law.

1. **Comparison:** The process of ascertaining whether two or more objects

have a common origin. A comparison analysis subjects a suspect specimen and a standard/reference specimen to the same tests and examinations for the ultimate purpose of determining whether they have a common origin.

e.g. hair found at a scene to hair from a suspect, a paint chip found at

a scene with the paint from a suspect vehicle, fibers found on

a victim with fibers found in suspect’s back seat.

1. Forensic Comparison is a two-step procedure
2. Combinations of select properties are chosen from the

suspect and standard/reference specimen for comparison.

1. These will depend on the nature of the specimens

being compared.

1. Overriding consideration must be the ultimate

evidential value of the comparisons.

b. A conclusion must be drawn about the origins of the specimens.

1) Do they come from the same source?

a) If different then NO.

b) If the same then…still maybe NO.

2) It depends on the types of characteristics that are

compared.

c. To comprehend the evidential value of a comparison, one

must appreciate the role that probability has in ascertaining the origins of two or more specimens.

1. **Individual characteristics**: Properties of evidence that can be

attributed to a common source with an extremely high degree of certainty.

a. ridge characteristics of fingerprints

b. random striation markings on bullets or tool marks

c. irregular and random wear patterns in tire and footwear

impressions

d. handwriting characteristics

e. irregular edges of broken objects

f. manufacturing marks or striations that cover consecutive

items

* + In each case it is not possible to state with mathematical exactness the probability that specimens are of a common origin; it can only be concluded that this probability is so high as to defy mathematical calculation or human comprehension.

1. **Class Characteristics**: Properties of evidence that can be associated

only with a group and never with a single source.

a. paint chips

b. blood type

* **Product Rule**: To obtain the probability of properties occurring together, multiply the individual probability of each property occurring on its own.

* One of the current weaknesses of forensic science is the inability of the examiner to assign exact or even approximate probability values to the comparison of most class physical evidence.
* One of the primary endeavors of forensic scientists must be to create and update statistical databases for evaluating the significance of class physical evidence.
* The chances are low of encountering two indistinguishable items of physical evidence at a crime scene that actually originated from different sources.
* When one is dealing with more than one type of class evidence, their collective presence may lead to an extremely high certainty that they originated from the same source.

1. Forensic Databases
   * Computer technology has dramatically altered the role of the crime laboratory in the investigative process.

* Fingerprint Databases

**Integrated Automated Fingerprint Identification System (IAFIS)**

* DNA Databases

**Combined DNA Index System (CODIS)**

- forensic index

- offender index

* Other Databases

National Integrated Ballistics Information Network (NIBIN)

- **Integrated Ballistic Identification System (IBIS)**

International Forensic Automotive Paint Data Query (PDQ)

Shoeprint Image Capture and Retrieval (SICAR)

C. Types of Physical Evidence

* ***Blood, semen, and saliva***
* ***Documents***
* ***Drugs***
* ***Explosives***
* ***Fibers***
* ***Fingerprints***
* ***Firearms and ammunition***
* ***Glass***
* ***Hair***
* ***Impressions***
* ***Organs and physiological fluids***
* ***Paint***
* ***Petroleum products***
* ***Plastic bags***
* ***Plastic, rubber, and other polymers***
* ***Powder residues***
* ***Serial numbers***
* ***Soil and minerals***
* ***Tool marks***
* ***Vehicle lights***
* ***Wood and other vegetative matter***

Evidence Examples

1. Paint
   * + Physical and chemical analysis of paint evidence (chips or residue) can indicate its **class**, such as automobile paint, house paint, nail polish, etc. The evidence can be compared to 40,000 different types of paint classified in a database, which can be used to identify a particular make or model of car or brand of tool.
     + Paint evidence can also indicate **individual** characteristics if an investigator is able to find similarities between two samples, such as the color, number of layers, chemical composition, or a physical match between the edges of two paint chips – one from a tool and one from a crime scene.
2. Glass

* Glass particles can be found at various crime scenes, such as breaking and entering, hit and run, vandalism, or murder.
* Glass at a crime scene is analyzed to determine its color, surface characteristics, tint, thickness, density, chemical composition, and refractive index (RI).
* The results of the tests provide clues about the crime and help investigators connect the evidence to a suspect or other object used in a crime, such as matching glass from a crime scene to a headlight to a suspect’s car.

1. Explosives

* Explosive substances can be examined to determine their chemical composition to identify the type of explosive used and its origin.
* Traces of explosives found on a suspect’s clothing, skin, hair, or other objects may be matched to explosives from the crime scene.
* Materials used to make an explosive device will be compared to evidence found in the suspect’s possession to confirm a match.

1. Ballistics

* Characteristics of ammunition, firearms, and residue are examined to find matches between suspects and the evidence found at a crime scene.
* Chemical tests can reveal **gunshot residue (GSR)** on the hands, face, or clothing of a victim or suspect to indicate how close a person was to a fired gun.
* Rifling (grooves) in a gun barrel causes distinctive grooves, indentations and scratches upon fired bullets, which can be matched to the weapon that fired them.
* Police are able to search the **Integrated Ballistics Identification System (IBIS)** databaseto compare markings from bullets, cartridge cases, and shotgun shells to ballistic evidence.

1. Dust & Dirt

* Dust, dirt, or sand evidence can reveal where a person has traveled and may be picked up at a crime scene or left behind.
* Investigators examine the samples for chemical composition, pollen, plant material, and other organic matter to find links to a specific crime scene.

1. Fingerprints

* There are 3 types of fingerprint patterns: arches, loops, and whorls. Investigators also identify unique ridge characteristics in a fingerprint that can be used to identify a suspect or victim.
* **Integrated Automated Fingerprint Identification System (IAFIS)** is a database used by investigators at local, state, and national levels to search for matches to fingerprints found at a crime scene.

1. Shoeprints & Tire Tracks

* Impression evidence can be photographed, lifted with tape, or cast with plaster to compare to a suspect’s shoes or tires.
* Investigators will examine the evidence to identify the brand of shoe or tire based on its tread pattern and other physical features to provide leads in the case.
* Shoes and tires will also show wear patterns after being used for a period of time as well as other features (scratches, nicks, and cuts) that can be used to match evidence to specific items. For example, shoeprints can be matched to a suspect based on how the treads on the shoes are worn down due to that person’s walking style.

1. Bite Marks

* Each of the 32 teeth in humans is unique due to age and wear.
* Impressions and photographs of bite marks left on a victim, assailant, or other object at a crime scene can often be matched to dental records.

1. Tool Marks

* Tiny nicks and chips form on the edges of a tool as it is used, which can be used to identify matches between evidence and suspects.
* Tools may also pick up traces of blood or other substances that can be tested or have fingerprints that can be lifted.

1. Fracture Matches

* When an object is broken, torn, or cut, two unique edges are formed, which are referred to as fracture lines.
* These edges can be compared by the naked eye or with microscopes to see if they fit together, which indicates that they may have been part of the same object at one time.
* Investigators may compare the edges on pieces of tape, glass fragments, paint chips, pieces of a car from an accident, paper bag, etc. to find possible matches.

1. Wounds

* Wounds can often be matched to weapons or tool marks on the weapon. Investigators may also be able to determine the weapon's size, shape, and length.
* Analysis of a wound may provide clues to a victim’s injuries, characteristics of the suspect (left-handed, right-handed, height, etc.), and positions of the victim and suspect at the time of the incident.

12. Questioned Documents

* Examiners will analyze a ransom note or other document to find clues to link it to a crime scene or a specific suspect. They will analyze the type of paper used, printing method or handwriting style, and type of ink.
* Other unique features, such as watermarks on stationary or indentations made as someone wrote on a page in a notebook, may provide useful clues.

1. Insects

* Flies, beetles, and other insects can provide useful clues about a corpse.
* **Forensic entomologists** use factors such as weather conditions, the location and condition of the body, and their knowledge of the life cycles of insects to help them estimate the postmortem interval (PMI), or the time between death and the discovery of the body.

1. DNA

* Investigators can extract DNA from almost any tissue, including hair, fingernails, bones, teeth and body fluids. The DNA is used to create a profile that can be compared to profiles from suspects or victims.
* **Combined DNA Index System (CODIS)** is a database maintained by the FBI that is used to find matches to unknown DNA samples from a crime scene.

1. Body Fluids

* Blood, semen, saliva, sweat, and urine can be analyzed to give investigators information about the crime as well as its victim or the suspect.
* Chemicals and ultra violet light can be used at a crime scene to find body fluid evidence. Areas with potential evidence are swabbed, bagged and collected in vials, which are air tight and have a low risk of cross contamination.

Examples:

- Vomit and urine can be used to test for alcohol, drugs, and

poisons.

- Cigarette butts may contain dried saliva.

- Semen containing sperm is valuable for DNA analysis.

- Blood can provide DNA evidence and blood spatter can

provide clues about the crime.

1. Hairs & Fibers

* Hairs and fibers may be transferred from the suspect or the suspect’s clothes to the victims’ and vice versa. For example, a suspect may pick up carpet fibers on his shoes or leave hairs behind at a crime scene.
* Hairs can be examined to identify their origin, such as human or animal. Hairs with roots intact can be tested for DNA.
* Fibers are used to make clothing, carpeting, furniture, beds, and blankets. They may be natural fibers from plants or animals or synthetic fibers that are man-made.

II. **Forensic Pathology**

* This field involves the investigation of sudden, unnatural, unexplained, or violent deaths.
* The primary role of the medical examiner is to determine the cause of death.
* If a cause cannot be found through observation, an autopsy is normally performed to establish the cause of death.

1. After a human body expires there are several stages of death.
   * **Rigor mortis** results in the shortening of muscle tissue and the stiffening of body parts in the position at death (occurs within the first 24 hours and disappears within 36 hours).
   * **Livor mortis** results in the settling of blood in areas of the body closest to the ground (begins immediately on death and continues up to 12 hours).
   * **Algor mortis** results in the loss of heat by a body (a general rule, beginning about an hour after death, the body loses heat by 1 to 1-1/2 degrees Fahrenheit per hour until the body reaches the environmental temperature).
2. Skeletal Remains

* **Forensic anthropologists** analyze skeletal remains to determine four characteristics of a victim: age, sex, race, and stature (height/build).

-  Sex - Determined by examining the pelvis, humerus, and

femur

- Age and stature – Determined by analyzing the development

of the teeth, bone growth, and the length of specific bones, such as the femur.

- Race – Determined by analyzing the skull for characteristics

that are common among people of different races.

* DNA samples can be collected from bone, teeth, and hair to provide clues to a person’s identity. Scientists may also be able to gain clues as to a person’s past, recent injuries, or the cause of death based on bone fractures and other signs of trauma.
* What do forensic anthropologists do?

*Generally, forensic anthropologists DO NOT do any of the following:*

* Collect trace evidence (hair, fibers)
* Run DNA tests
* Analyze ballistics or weapon evidence
* Analyze blood spatter
* Conduct autopsies

***What a forensic anthropologist does DO to aid in a case:***

* Goes to a crime scene to assist in the collection of human remains
* Cleans up the bones so that they may be examined
* Analyzes skeletal remains to establish the profile of the individual
* Looks at trauma evident on the bones to establish the pathway of a bullet or the number of stab wounds
* Works with a forensic odontologist (dentist) to match dental records
* Testifies in court about the identity of the individual and/or the injuries that might be evident in the skeleton

**Assignment: Chapter 3 case analysis questions #1-5**