INTRODUCTION OF FORENSIC SCIENCE

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Forensic science - Application of science in the service of LAW.

Crime - It is an unlawful act committed by a person.

Crime Scene – it is a place where actual crime occurs. Here all most all evidences found related to the particular crime scene. Specially this is a place where criminal or crime get connected the victim and place of occurrence along with the evidences.

Classification of Evidence

Testimonial evidence is a statement made under oath; also known as direct evidence or *prima facie* evidence.

Physical evidence is any object or material that is relevant in a crime; also known as indirect evidence. Examples are hair, fiber, fingerprints, documents, blood, soil, drugs, tool marks, impressions, glass, bullet, cartridge case etc**.**

Reliability of Eyewitness

Factors that affect accuracy:

- Nature of the offense and the situation in which the crime is observed

Additional factors:

- Witness's prior relationship with the accused
- Length of time between the offense and the identification

Physical Evidence

- Is generally more reliable than testimonial evidence
- Can prove that a crime has been committed
- Can corroborate or counter testimony
- Can link a suspect with a victim or with a crime scene
- Can establish the identity of persons associated with a crime
- Can allow reconstruction of events of a crime

Types of Physical Evidence

Transient evidence is temporary; easily changed or lost; usually observed by the first officer at the scene.

Pattern evidence is produced by direct contact between a person and an object or between two objects.

Conditional evidence is produced by a specific event or action; important in crime scene reconstruction and in determining the set of circumstances or sequence within a particular event.

Transfer evidence is produced by contact between person(s) and object(s), or between person(s) and person(s).

Examples of Transient Evidence

Odor—putrefaction, perfume, gasoline, urine, burning, explosives, cigarette or cigar smoke

Temperature—surroundings, car hood, coffee, water in a bathtub, cadaver

Imprints and indentations— footprints, teeth marks in fresh foods, tire marks on certain surfaces

Examples of Pattern Evidence

Pattern evidence—mostly in the form of imprints, indentations, striations, markings, fractures, or deposits

Blood spatter
Glass fracture
Fire burn pattern
Furniture position
Projectile trajectory
Tire marks or skid marks

Clothing or article distribution
Gunpowder residue
Material damage
Body position
Toolmarks
Modus operandi

Examples of Conditional Evidence

Light—headlight, lighting conditions, lights on or off

Smoke—color, direction of travel, density, odor

Fire—color and direction of the flames, speed of spread, temperature and condition of fire

Location—of injuries or wounds, of bloodstains, of the victim's vehicle, of weapons or cartridge cases, of broken glass

Vehicles—doors locked or unlocked, windows opened or closed, radio off or on, odometer mileage

Body—position and types of wounds; rigor, livor, and algor mortis

Scene—condition of furniture, doors and windows, any disturbance or signs of a struggle

Classification of Evidence by Nature

Biological—Blood, semen, saliva, sweat, tears, hair, bone, tissues, urine, feces, animal material, insects, bacteria, fungi, botanical material

Chemical- Gunpowder, Ink, Cosmetics, Lubricants, Fertilizer, liquid

Physical—Fibers, Glass, Soil, Fingerprints, Footprints, Shoeprints, Handwriting, Firearms, Tire marks, Tool marks.

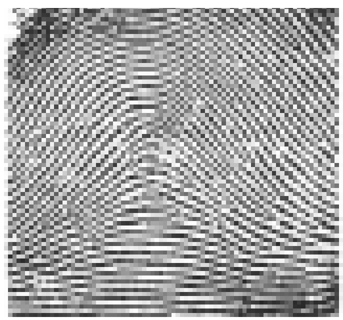
Miscellaneous—laundry marks, voice analysis, polygraph, photography, stress evaluation, psycholinguistic analysis, vehicle identification

Evidence Characteristics

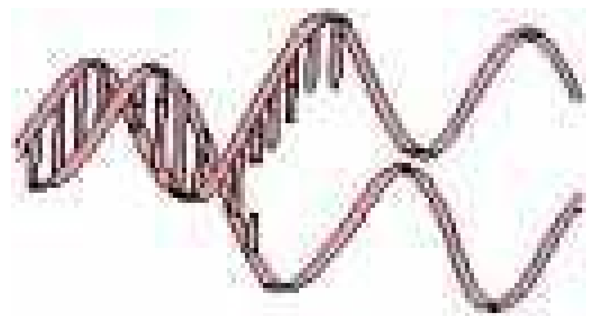
Individual—can be identified with a particular person or a single source

- **Fingerprints - 1 X 10^{60}**
  - 1 in 1,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000

Fingerprints



Blood DNA Typing



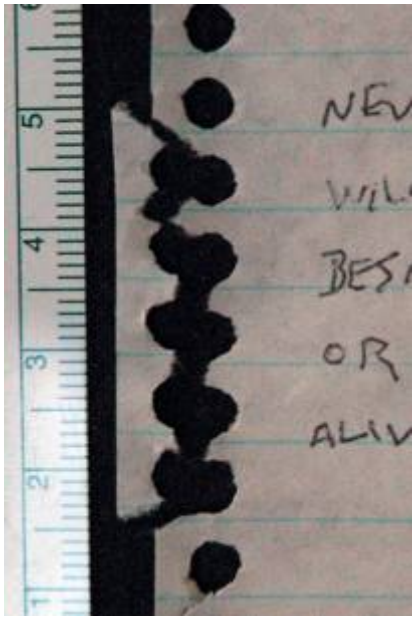
Class—common to a group of objects or persons

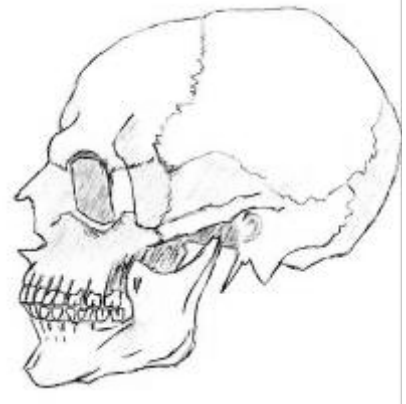
Class vs. Individual Evidence

These fibers are class evidence; there is no way to determine if they came from this garment.

The large piece of glass fits exactly to the bottle; it is individual evidence.

Class vs. Individual Evidence, *continued*





Which examples do you think could be individual evidence?

Forensic Investigations

Include some or all of these seven major activities:

1. **Recognition**—the ability to distinguish important evidence from unrelated material

   Pattern recognition

   Physical property observation

   Information analysis

   Field testing

2. **Preservation** through the collection and proper packaging of evidence

Forensic Investigations, *continued*

3. **Identification** using scientific testing
   - Physical properties
   - Chemical properties
   - Morphological (structural) properties
   - Biological properties
   - Immunological properties

4. **Comparison** of class characteristics measured against those of known standards or controls; if all measurements are equal, then the two samples may be considered to have come from the same source or origin

Forensic Investigations, *continued*

5. **Individualization** in demonstrating that the sample is unique, even among members of the same class

6. **Interpretation**—giving meaning to all the information

7. **Reconstruction** of the events in the case
   - Inductive and deductive logic
   - Statistical data
   - Pattern analysis
   - Results of laboratory analysis

Collecting Trace Evidence

Who collects the evidence?

- Police Officer
- Forensic Scientist

Collect trace or entire object?

Suppose a glove appears to have glass, fibers and blood on it.

Should the glass, fibers and blood be removed and packaged separately?

Should the entire glove be packaged?

Considerations before packaging entire object:

- Object may be too large or difficult to move
- Trace evidence may fall off item during transport.
- Trace Evidence may be transferred to different, irrelevant area of object.

If packaging object, **package objects separately.**

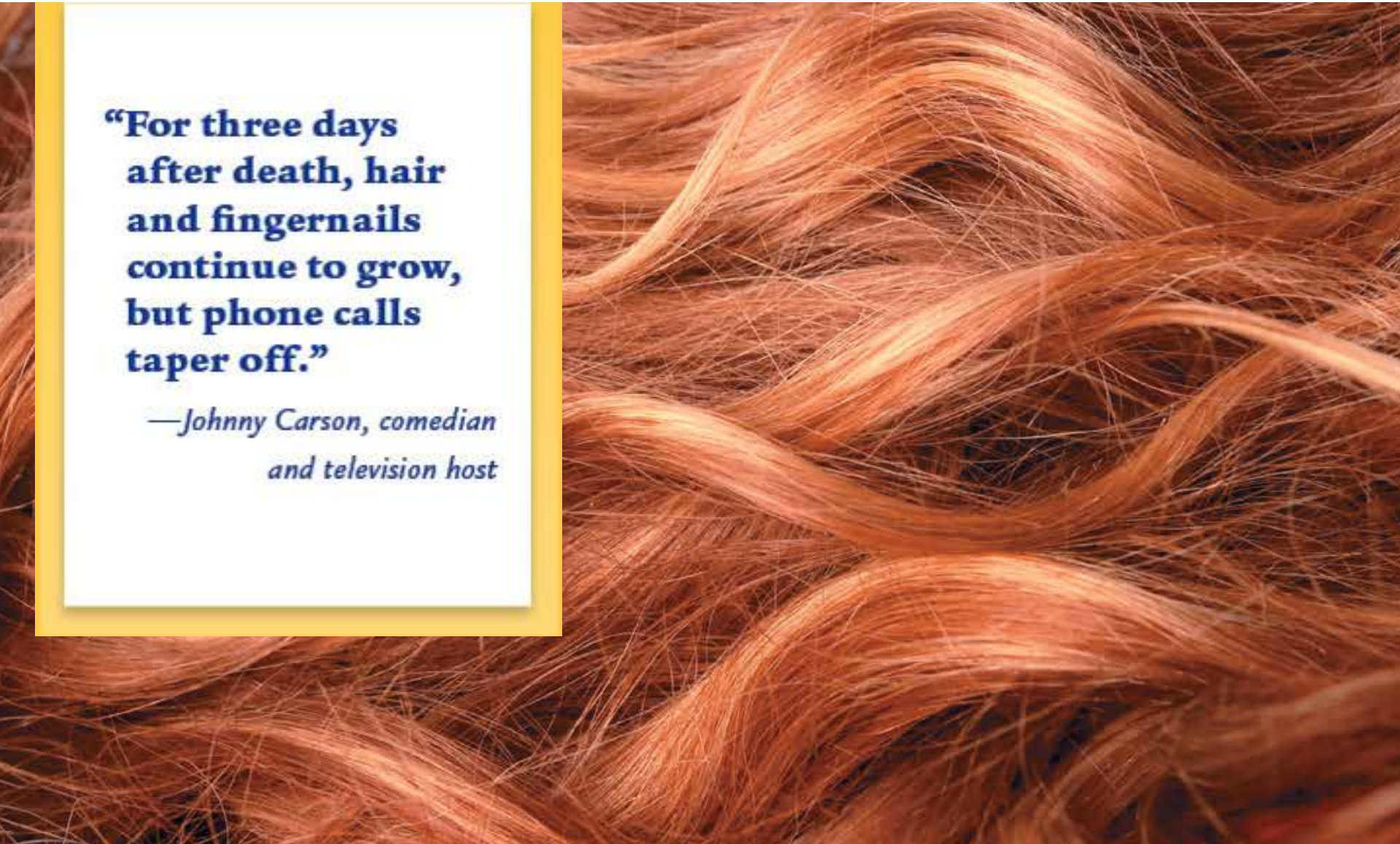
Prevents trace being transferred to other objects.

Trace > Collection

These 3 methods can be done at the crime scene or in the crime lab.

1. Visual Inspection
2. Tape Lift
3. Vacuum

Hair


"For three days after death, hair and fingernails continue to grow, but phone calls taper off."
—Johnny Carson, comedian and television host

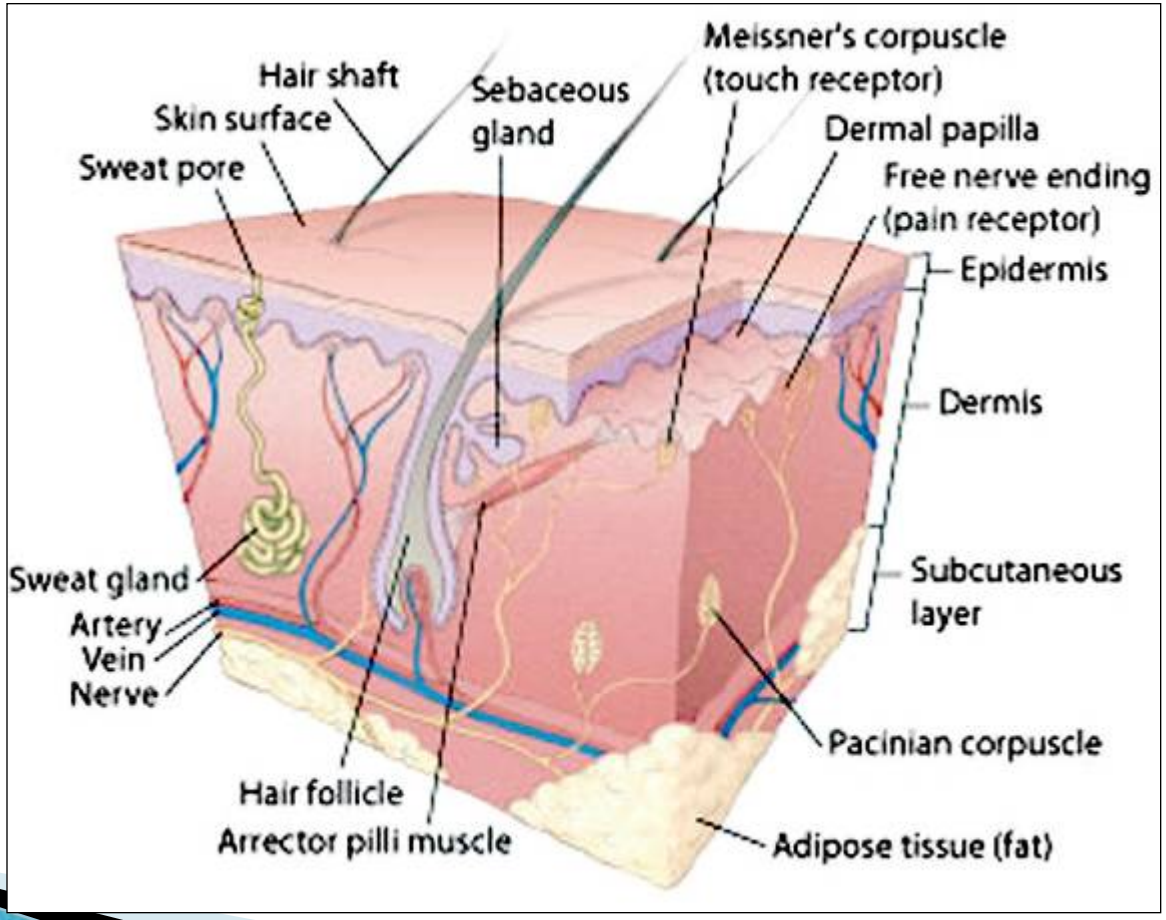
Introduction

Human hair is one of the most frequently found pieces of evidence at the scene of a violent crime. It can provide a link between the criminal and the crime.

From hair, one can determine:

- If the source is human or animal
- Race (sometimes)
- Origin of the location on the source's body
- Whether the hair was forcibly removed
- If the hair has been treated with chemicals
- If drugs have been ingested

Skin Structure



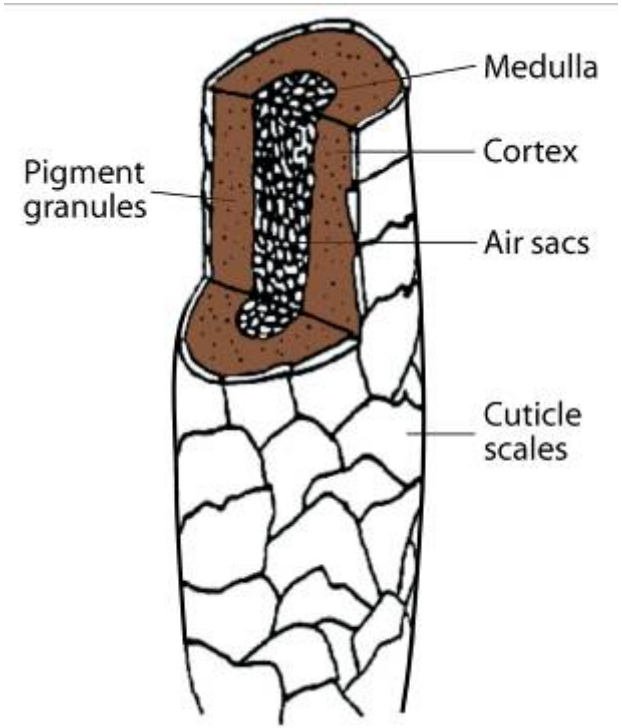
Hair Shaft

Composed of:

Cuticle—outside covering, made of overlapping scales

Cortex—inner layer made of keratin and embedded with pigment; also contains air sacs called cortical fusi

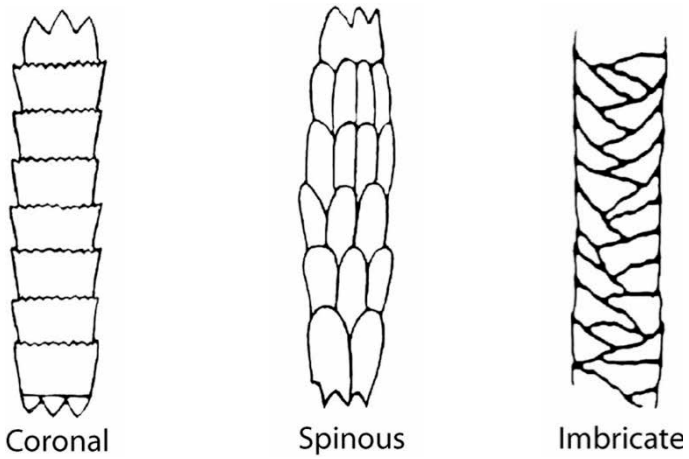
Medulla—inside layer running down the center of the cortex



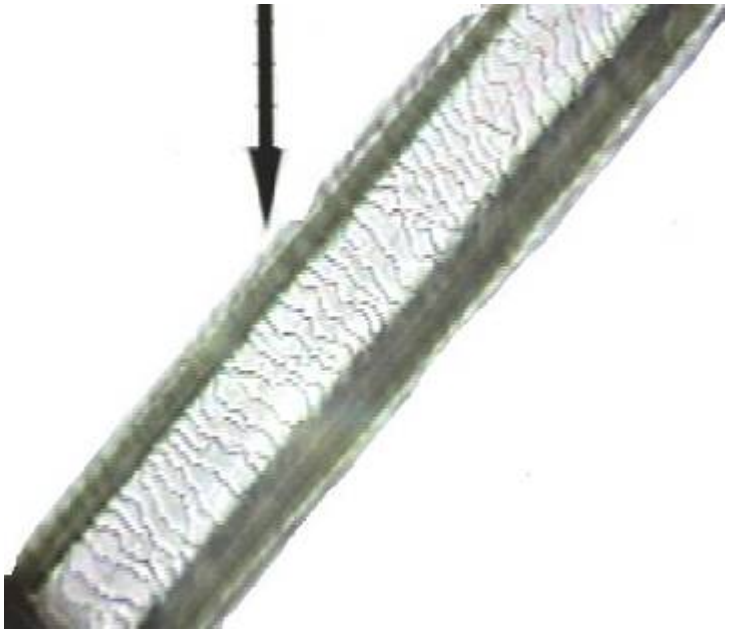
The Cuticle

The cuticle is the outermost layer of hair which is covered with scales. The scales point toward the tip of the hair. Scales differ among species of animals and are named based on their appearance. ***The three basic patterns are:***

- Coronal
- Spinous
- Imbricate



Human Scales



In order to visualize the scales:

Paint clear fingernail polish on a glass slide.

When the polish begins to dry, place a hair on the polish.

The Medulla

The medulla is the hair core that is not always visible. The medulla comes in different types and patterns.

Types:

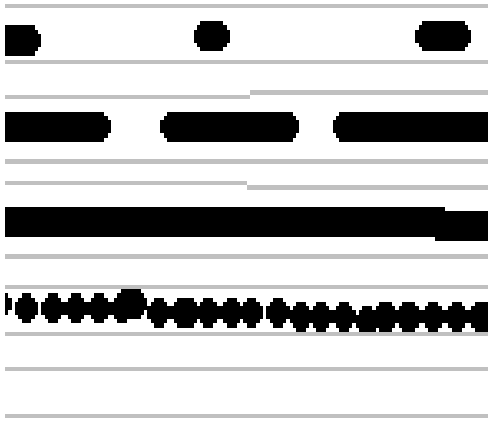
Intermittent or interrupted

Fragmented

Continuous

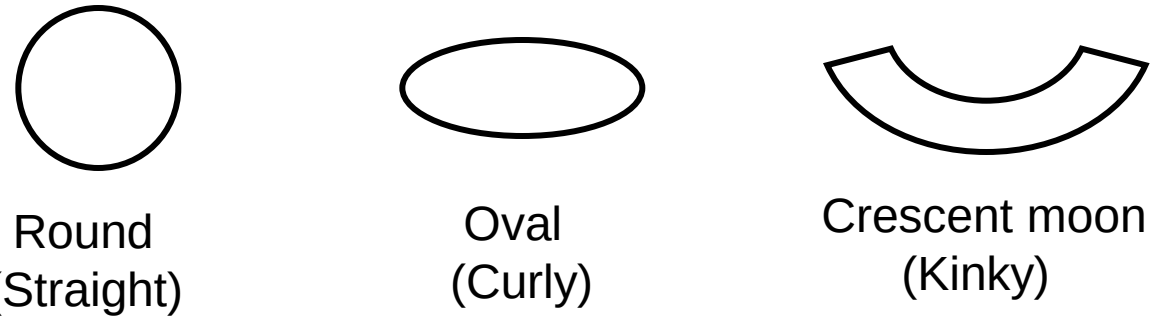
Stacked

Absent—not present



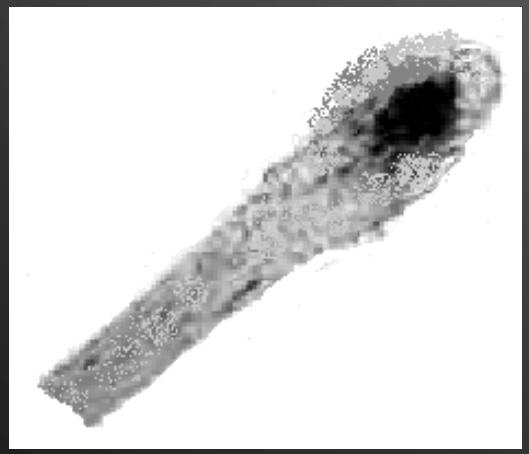
Hair Shape

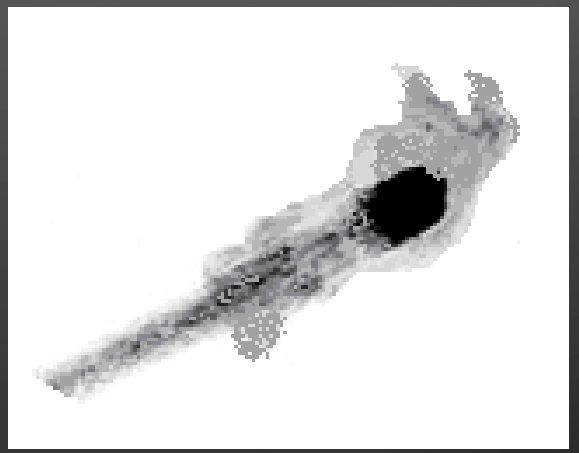
Can be straight, curly, or kinky, depending on the cross-section, which may be round, oval, or crescent-shaped.



The Root

Human roots look different based on whether they have been forcibly removed or they are telogen hairs and have fallen out. Animal roots vary, but in general have a spear shape.





DNA from Hair

The root contains nuclear DNA. If the hair has been forcibly removed, some follicular tissue containing DNA may be attached.

The hair shaft contains abundant mitochondrial DNA, inherited only from the mother. It can be typed by comparing relatives if no DNA from the body is available. This process is more difficult and more costly than using nuclear DNA.

Collection of Hair

Questioned hairs must be accompanied by an adequate number of control samples.

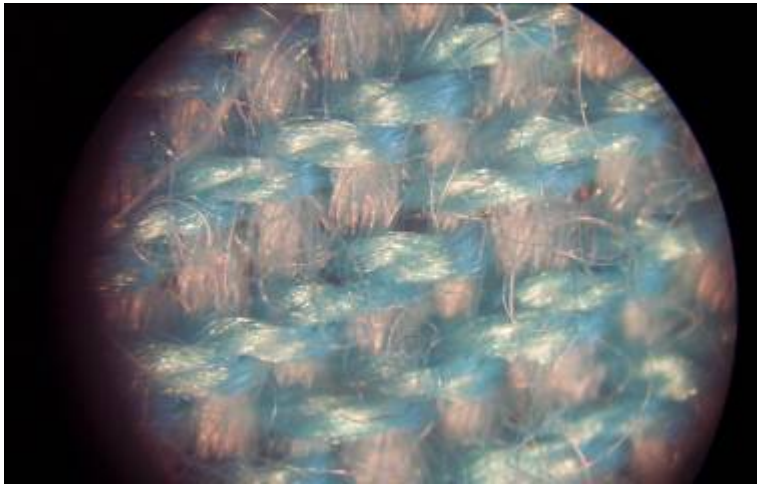
- From victim
- From possible suspects
- From others who may have deposited hair at the scene

Control sample

- 50 full-length hairs from all areas of scalp
- 24 full-length pubic hairs

Fibers

Are common trace evidence at a crime scene



Types of Fibers

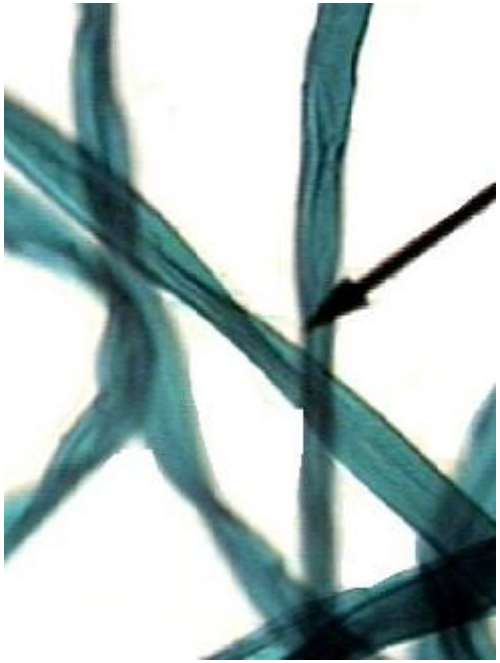
Synthetic

- Rayon
- Nylon
- Acetate
- Acrylic
- Spandex
- Polyester

Natural

- Silk
- Cotton
- Wool
- Mohair
- Cashmere

Fiber Comparison



Can you describe the difference(s) between the cotton on the left and the rayon on the right?

Testing for Identification

Microscopic observation

Burning—observation of how a fiber burns, the odor, color of flame, color of smoke, and the appearance of the residue

Thermal decomposition—gently heating to break down the fiber to the basic monomers

Chemical tests—solubility and decomposition

Testing for Identification

Density—the mass of an object divided by the volume of the object

Refractive index—measurement of the bending of light as it passes from air into a solid or liquid

Fluorescence—absorption and reemission of light; used for comparing fibers as well as spotting fibers for collection

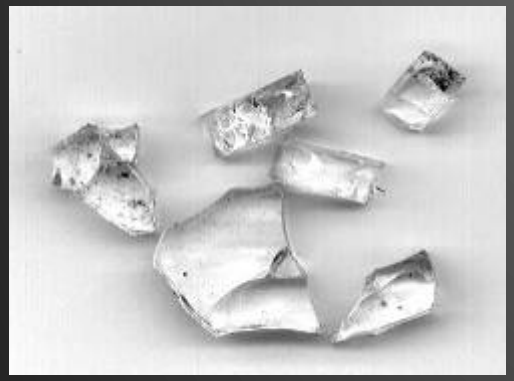
Collection of Fiber Evidence

Bag clothing items individually in paper bags. Make sure that different items are not placed on the same surface before being bagged.

Make tape lifts of exposed skin areas and any inanimate objects.

Removed fibers should be folded into a small sheet of paper and stored in a paper bag.

Trace Evidence



Trace evidence is physical evidence found in small amounts at a crime scene. Common examples would be hair, fiber, paint chips, body fluids, stains, powders, explosive residue, glass particles, vegetative matter, metal particles, and soil. It may also include more unusual types of evidence.

Physical and Chemical Properties

Physical property: A characteristic that does not involve a change in the identity of a substance, such as odor, color, boiling point, density, refractive index

Chemical property: A characteristic that determines how a substance will change into another substance with different physical properties

Metal Analysis

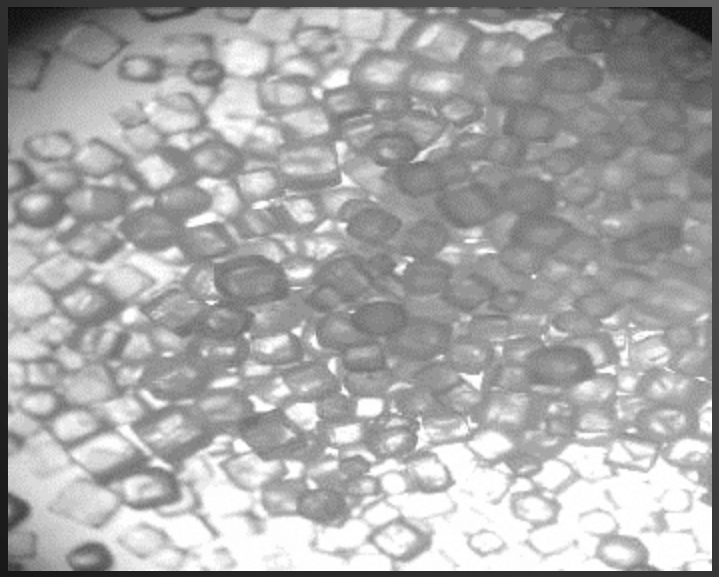
Bits of metal can be identified from their physical and chemical properties.

Solid particles—microscopic examination, magnetism, malleability, density, color, solubility, reactivity

Dissolved metals—separation by chromatography with comparison of R_f values to known metals, specific reactions, and color tests

Qualitative Analysis

Microscopic Examination



Protection of crime scene-

All unauthorized person should be kept up to certain distance from the crime scene(including Press, Media and Photographers).Then it should be covered with guards, flags and marking.

Goals of Evidence Packaging

Protects evidence against:

- Loss
- Contamination
- Cross-transfer
  - A-Suspect to victim
  - B-Victim to suspect
  - C-Scene to scene
  - D-Item to item
- Deterioration

Collection and packing is based on condition and Location

Certain types of evidence may need to be dried before it packaged:

1- Wet biological samples

2- Fresh plant material

When Biological Evidence is Packaged Wet condition

Evidence “leaks” through to the exterior of the container

Resulting in

- Sample deterioration
- Sample loss
- Contamination issues

Elements of packaging evidence

Generally two types elements used for the purpuse of packing

A- Plastic
- v Envelope
- v Bag

B-Paper
- v Envelopes
- v Bag
- v Boxes

What type of packaging is optimal?

Size of container is important –

- Too small and the packaging is likely to fail over time
- Too big and evidence can be dispersed throughout container and difficult to recover (e.g. powder, trace evidence)

Elements of Packaging Evidence

This envelope is too small for the evidence it is holding

Effect of Improper Packing/ if glass fragments deposited into large envelop

Small glass fragments can be lost from poorly sealed envelopes Ideally, these fragments would be packaged into a bindle first

Sealing of Evidence

- Sealing of evidence properly is a requirement of most crime labs issues:

v Type of seal

v Need for identifying mark

v Where seal(s) is to be placed

Ways evidence can be sealed

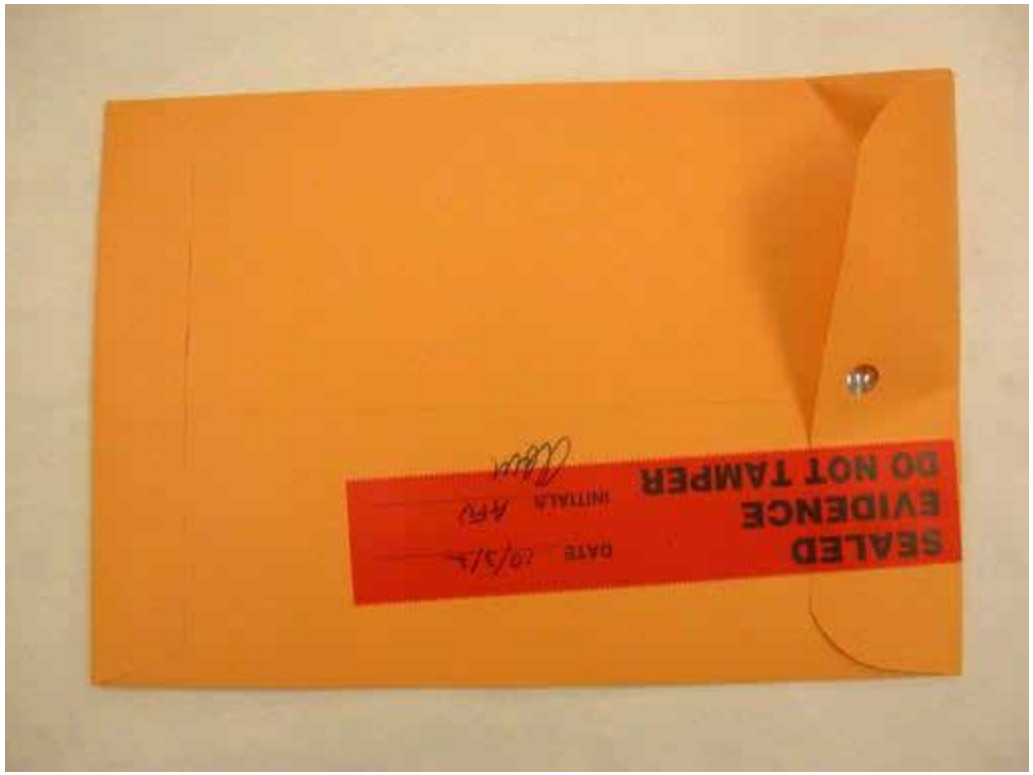
v Heat seal

v Tape seal

v Lock seal

All seals must be initialed to document the person sealing the evidence and dated to indicate when the evidence was sealed

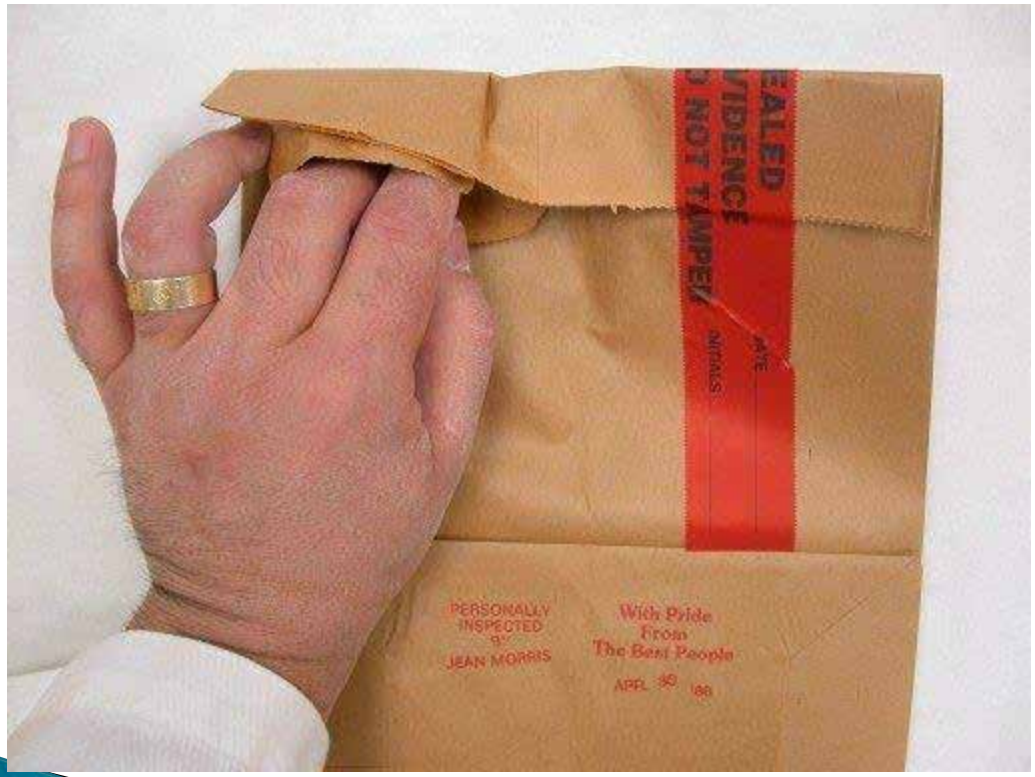
Example of Improper Sealing



- Seal should completely seal envelope flap

Continue….

Example of Improper Sealing



Seal should

completely seal

bag flap

Example of Improper Sealing

Staples are not an appropriate evidence “seal”

Correctly Way of Sealing Evidence

Tape seal across entire Flap of envelope Seal is initialed and dated

Correctly Way of Sealing Evidence

Tape seal across entire “flap” of bag Seal is initialed and dated

Biological Evidence

Packaging of Biological Evidence

- Insure the sample/Exibits is **dry**
  - **Do not dry** in a **heated** air stream
- Use paper containers
- Immobilize evidence when necessary
  - "sharps": knifes, broken glass
  - when stain could be dislodged

Recommendations for Collection and Packing of Biological Evidence

- Collect and package stains separately--do not allow separate stains to come into contact with one another
- Sheets of paper can be used to minimize contact of stains on a bloodstained garment
- Consider packaging all biological samples separately
  - A bloodstain swab and its control can be separately packed into two coin envelopes and then both envelopes can be placed into the same larger envelope

Recommendations for Collection and Packing of Biological Evidence

To minimize the chance of cross transfer of adhering evidence; different clothing items should NOT be packaged in the same container No!

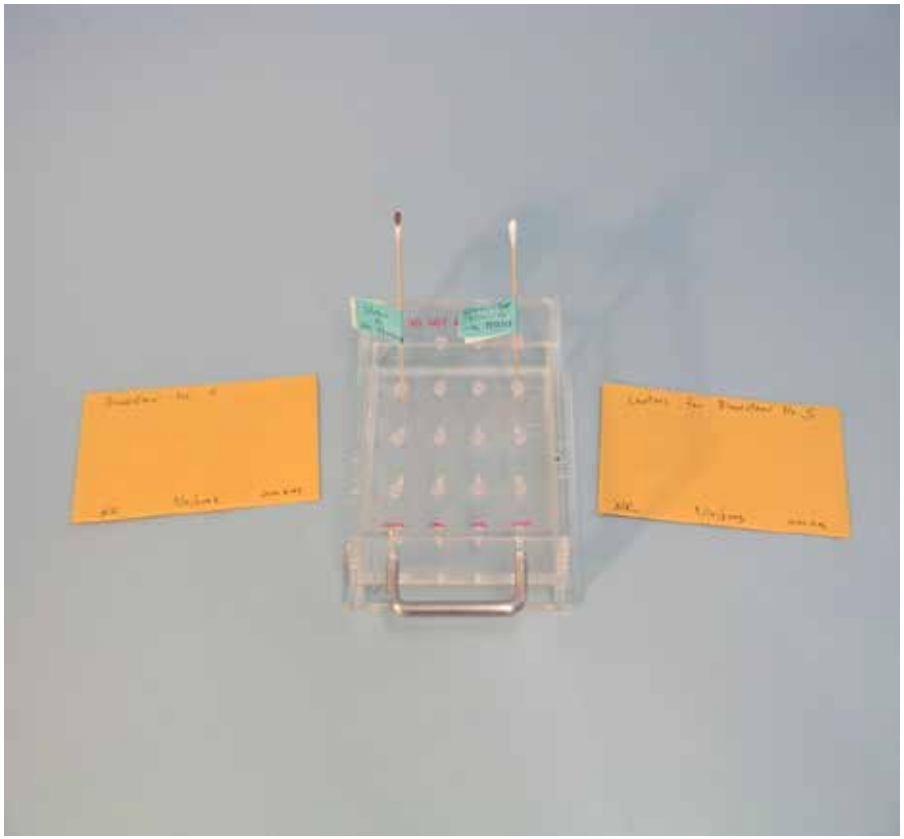
v Recommendations for Handling Biological Evidence

Attempt to insure that anything that contacts biological samples during collection is free of anything that might contain human DNA

A- Work on clean surfaces

B- Wear gloves and change when necessary

Packaging a Wet Bloodstain On a Swab

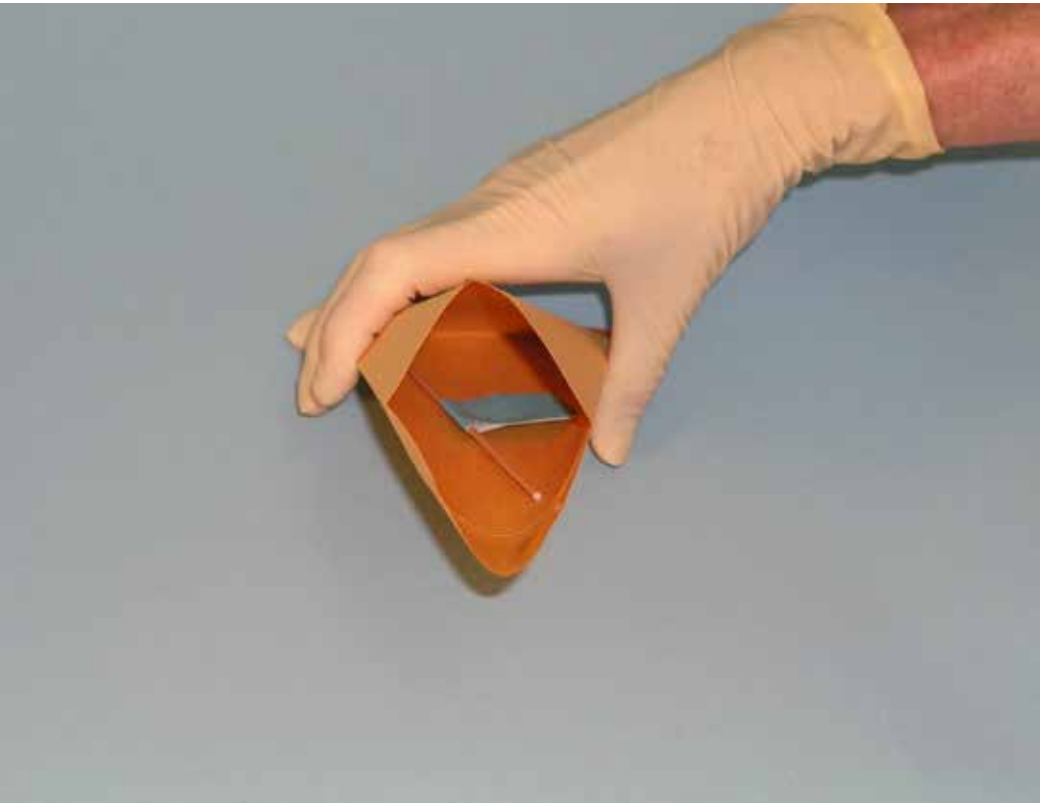


After samples are **dried, package the** bloodstain sample and the control into separate coin envelopes

How NOT to Package a Wet Bloodstain

Do not use any packaging device that limits air exchange Biological samples will deteriorate if it takes too long for them to dry

Packaging of Dry Bloodstain



Once the sample is dried it can be safely placed into a paper envelope and sealed

Packaging of Blood wearing Cloths

Attempt to allow bloodstains to dry as much as possible Place clothing onto a piece of clean paper

Packaging of Blood wearing Cloths

Place paper between stained areas so as to prevent stain transfer

Packaging of Blood wearing Cloths

Place paper between stained areas so as to prevent stain transfer

Packaging of Blood wearing Cloths

Seal and dated

package with

bloody loaded shirt

Insert paper

package into

larger paper bag

This is NOT the proper way to package a bloody knife

Although paper is good packaging for bloodstained evidence

This knife needs to be immobilized because…

This is NOT the proper way to package a bloody knife

It can easily pierce the paper envelope and endanger any one who handles this evidence

In addition, blood from the blade can be easily lost

How to Properly Package a Bloody Knife

Use a cardboard box (not airtight)

Immobilize knife to protect both personnel & the blood sample on blade

Packaging of Trace Evidence

- Trace evidence is small evidence which can be easily lost
- Examples of trace evidence:
  1- Hairs
  2- Glass fragments
  3- Paint flakes
  4- Fibers

Packaging of Trace Evidence

If it is necessary to remove and package trace evidence, its nature and location must be documented before the evidence is altered

Packaging of Trace Evidence

Items must be visually examined and trace evidence identified

A- Trace evidence can be removed with tweezers and placed into appropriate packaging

B- Trace evidence can also be removed with tape lifts

Packaging must be appropriately sized & designed so that this small evidence cannot fall out of the container

Glass Fragments

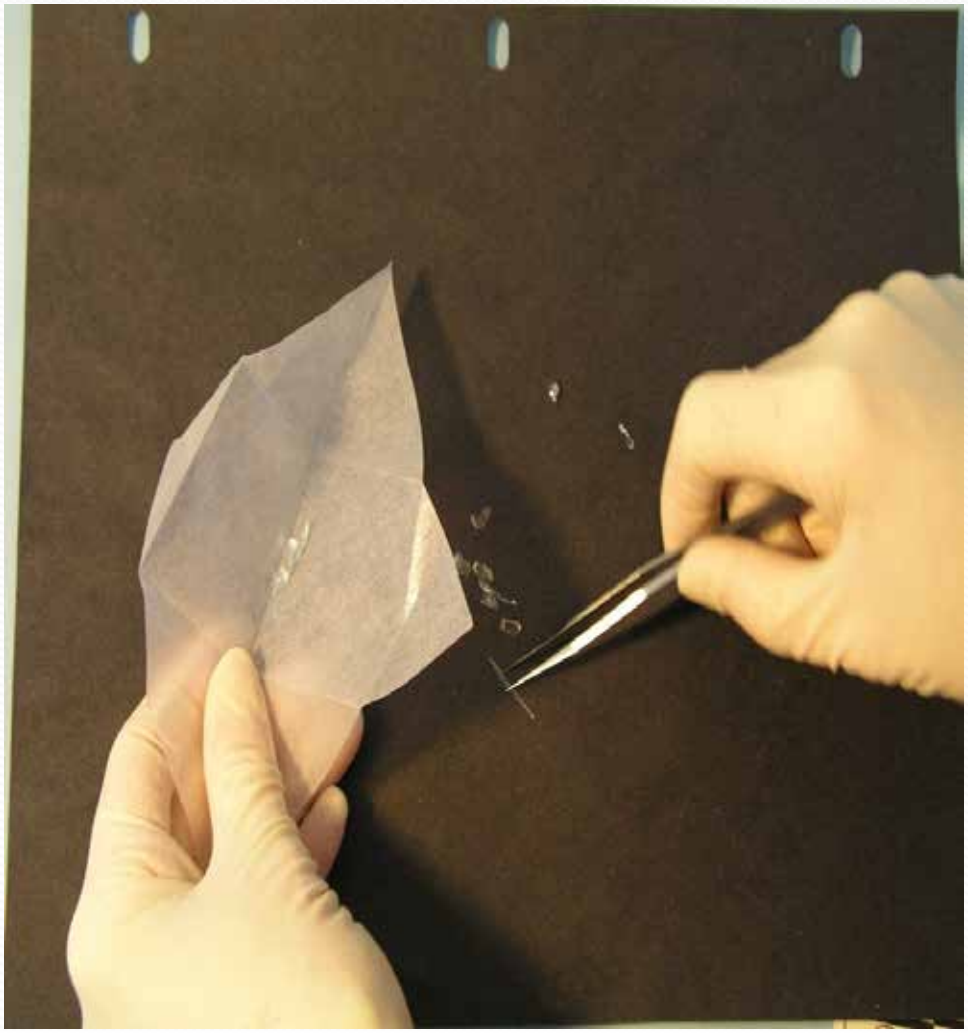
Glass fragments are small and can be lost from poorly sealed envelopes

Glass Fragments Deposited into Large Envelope

Small glass fragments can be lost from poorly sealed envelopes

These fragments need to be packaged into a bindle before being placed into envelope

First Step: Placing Glass Evidence into a Bindle

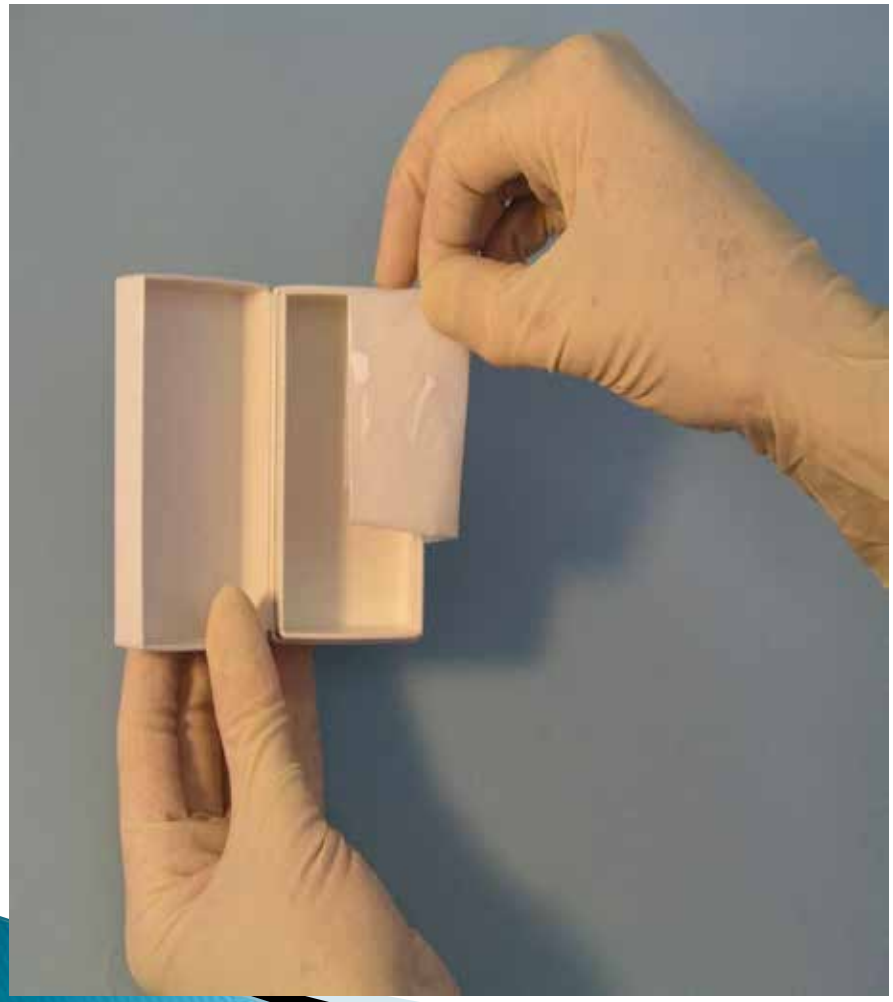


The glass is collected and placed into a paper bindle The bindle is then sealed before it is inserted into an envelope

Packaging of Paint Fragments

Bindles can also be used to package Paint fragments

Packaging Paint Fragments



Rigid boxes can then be used to hold paper bindle with Fragile paint fragments Box is then placed into paper evidence envelope

FIREARMS EVIDENCE

Packaging of Firearms Evidence

Record all necessary information about condition of firearm:

- Position of hammer, safety, & other controls
- Number and location of fired and unfired cartridges
- Presence of powder residue “halos” on revolver cylinder face
- Blood or trace evidence visible on gun exterior

Handling of Firearms Evidence

This weapon is loaded and ready to fire

NEVER PACKAGE A LOADED WEAPON

Remove the magazine & make sure chamber is empty

Handling of Firearms Evidence

Firearms can be handled by any surface which does not take fingerprints

Serrations on slide

Checkered stocks

How NOT to Handle Firearms Evidence

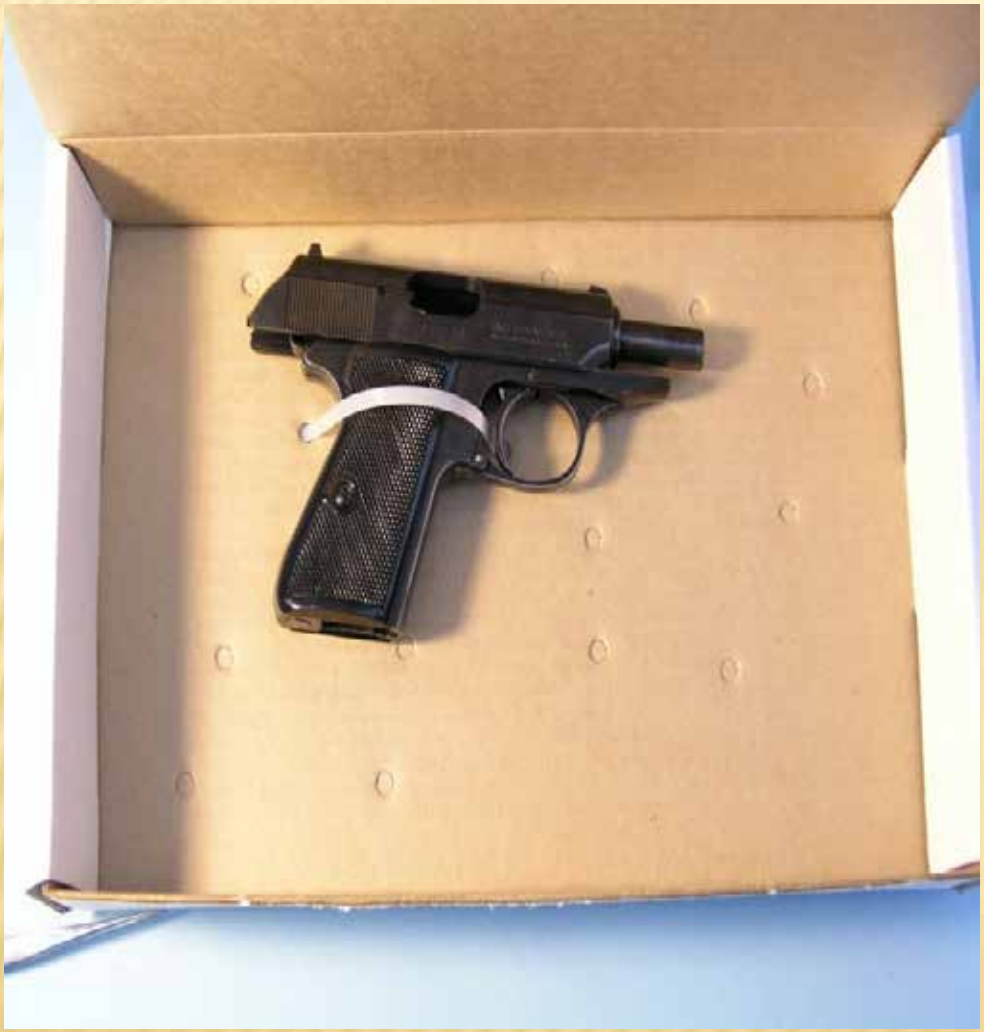
- Do NOT insert anything into the barrel
- EXTREMELY UNSAFE!
- Could alter the firearm
- Could remove blood or trace evidence

Handling of Firearms Evidence

Once the firearm has been rendered Safe, it can be placed into a cardboard box and

- Immobilized with a plastic tie
  - Make sure the tie goes BEHIND the trigger

Handling of Firearms Evidence



This packaging will permit fingerprint, blood and trace evidence to be recovered

The evidence now needs to be appropriately labeled and sealed

Write “Unloaded” notification on outside of container

Handling of Firearms Evidence

Fired bullets need to be carefully handled to protect critical markings on the Bullet surface and any adhering trace evidence

Do NOT mark bullet

Handling of Firearms Evidence

This type of evidence requires some internal packaging

Paper bindles or soft tissue can be used

Handling of Firearms Evidence

The wrapped bullet can now be placed into an appropriate size container

This container must be labeled and then

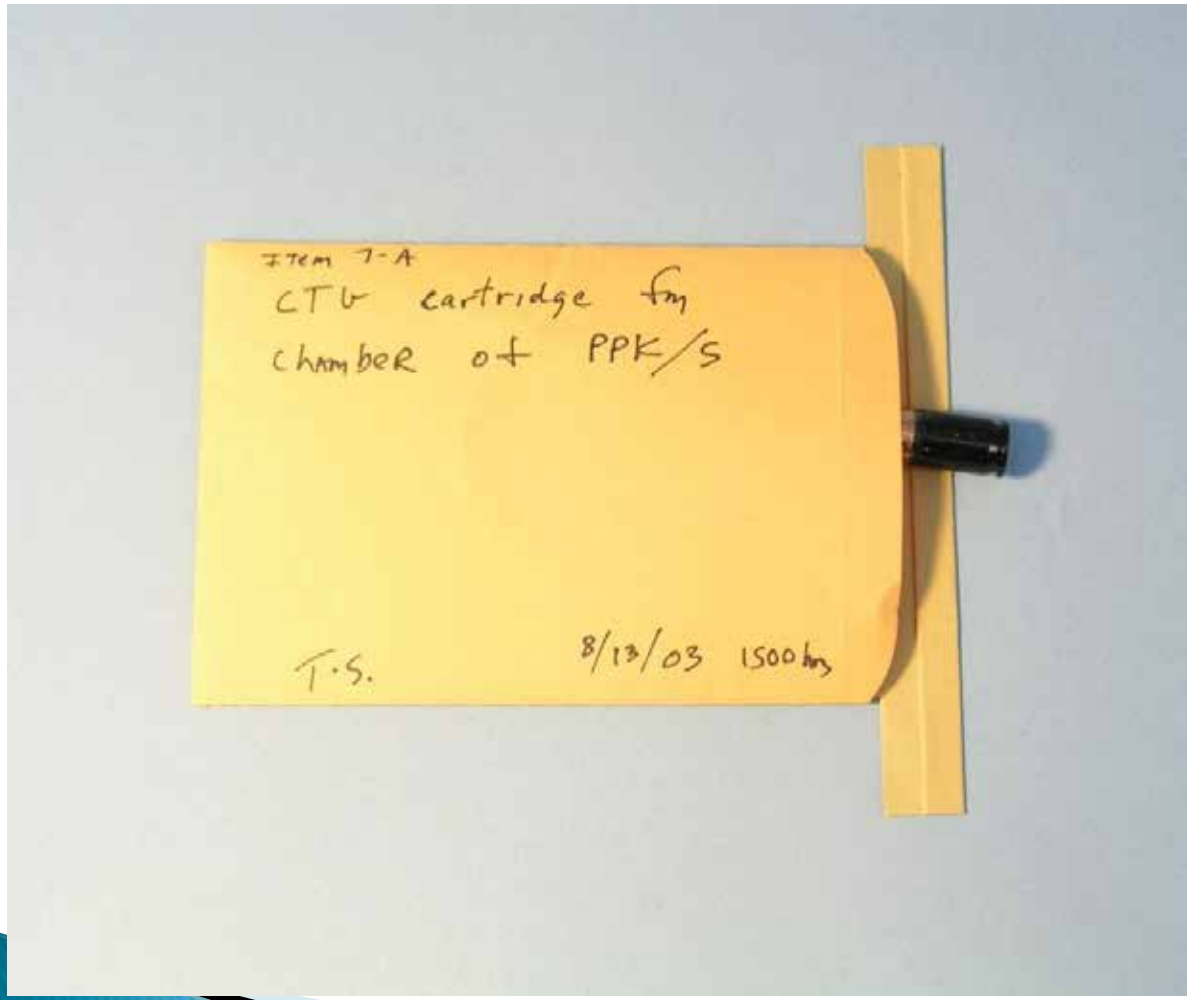
Placed into a large evidence container

Handling of Firearms Evidence

No need to remove cartridges from the magazine at scene

The magazine with cartridges can be placed into an appropriate sized paper envelope

Handling of Firearms Evidence



Package loose cartridges in paper envelopes