

Biological & Trace Evidence

for the Crime Scene Investigator



Illinois Edition
Presented by: *Imprimus Forensic Services, LLC*
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CRIME SCENE - DO NOT ENTER

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Biological & Trace Evidence Contents

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Biological & Trace Evidence – Illinois Edition

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What is Biological Evidence?

Generally speaking, biological evidence may include any material from a living organism that can be used as evidence in a criminal or civil investigation. More commonly, biological evidence in criminal investigations will consist of body fluids or cellular material left at a scene by a suspect, victim or witness. Other types of investigations such as poaching or animal rights cases may center on the fluids or cellular material from animals. Even crime scenes involving humans may involve animal or plant materials that help link the suspect, victim and scene.

DNA is the individual genetic structure of our biology and DNA analysis has become the cornerstone of today's criminal investigations.

The most common types of biological evidence recovered from crime scenes include

- Blood
- Semen
- Saliva
- Sweat
- Urine
- Feces
- Vomit
- Trace Cellular Material (including hair)

Proper collection and preservation of these materials is crucial to successful completion of the investigation.

Identification of some of these materials at the scene can be facilitated through the use of appropriate presumptive tests. Presumptive tests are used to tentatively identify the nature of the material pending additional lab analysis.

Objects that may have in any way been touché or handled by persons associated with the scene should be considered a source of biological and DNA evidence.

Suggested Crime Scene Practices – Bloodborne Pathogens

Based on OSHA Bloodborne Pathogen Standard 29 CFR 1910.1030 (Revised 1996)

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Universal Precautions

Regardless of the source, individuals working with biological stains and/or other materials, should treat all material as if it was infectious. Proper safety equipment should be utilized and safety precautions followed at all times.

Bloodborne Pathogens

Bloodborne pathogens are micro-organisms that are present in human blood and can cause disease in humans. These pathogens include, but are not limited to,

- HIV – Human Immunodeficiency Virus
- HBV – Hepatitis B Virus
- HCV – Hepatitis C

Supplies

Safety Equipment

The below listed safety equipment is suggested as to equipment that should be readily available for use by forensic / crime scene personnel. Actual usage at a scene will be dictated by the nature of the scene and exposure hazard.

- Nitrile Gloves – Conventional
- Nitrile Gloves – Heavy Duty
- Dust / Mist Respirator with Organic Gas Pre-filter
- Dust Mask
- Safety Glasses or Face Shield
- Chemical Splash Goggles
- Liquid Resistant Coveralls
- Liquid Resistant Booties
- Hair Covers (Bouffant Caps)
- First Aid Kit
- Portable Eye Wash Station
- Waterless Antiseptic Hand Cleaner
- Paper Towels
- 10% Bleach Solution
- “Biohazard” Waste Box (burn box)
- Tongs / Forceps
- Imperviously-Backed Absorbent Paper

NFPA Hazards Label 704M Guide

Chemical: **ACETONE** CH₃COCH₃

DOT/UN No.: **1090** CAS No.: **67-64-1**

Hazard Codes:

X Irritant **F** Flammable

Safety Equipment:

Eye & Face Protection Protective Clothing Ventilation Extinguisher

TARGET ORGANS & EFFECTS
Central Nervous System
Eyes • Respiratory System
Skin

ROUTE OF ENTRY
Inhalation
Ingestion
Eye and Skin Contact

Consult corresponding MSDS for further information and instructions.

NALGENE® PolyPaper®
Right-To-Know Labels
Cat. No. 6317-0002

NFPA Code

Health Hazard: **1** Flammability: **3** Reactivity: **0**

Storage Color: **Red**

NFPA 704M LABEL

FIRE HAZARD

4 - Very Flammable
3 - Readily Ignitable
2 - Ignited with Heat
1 - Combustible
0 - Will not Burn

HEALTH HAZARD

4 - Deadly
3 - Extreme Danger
2 - Hazardous
1 - Slightly Hazardous
0 - Normal Materials

REACTIVITY HAZARD

4 - May Detonate
3 - Shock & Heat May Detonate
2 - Violent Chemical Change
1 - Unstable if Heated
0 - Stable

SPECIAL HAZARD

OXY - Oxidizer
ACID - Acid
ALK - Alkali
COR - Corrosive
-W- Use no Water

F **H** **R** **SPECIAL**

Storage Color Codes
Color indicates the appropriate storage area.

Blue: Material has potential to be a severe health risk. Primary route of entry can be inhalation, ingestion or skin absorption. Material should be stored in a secure poison area.

Red: Material is flammable, extremely flammable or combustible. Material should be stored in flammable-liquid storage cabinet or area. Keep away from strong oxidizers.

Yellow: Material is highly reactive. The material is classified as one or more of the following: (1) Explosive, (2) Water Reactive, (3) Strong Oxidizer, or (4) Pyrophoric. Material should be stored separately. Keep away from flammable and combustible materials.

White: Material is corrosive. Store in corrosion-proof cabinet or area.

Orange: Material poses minimal risk while being stored. Store in general chemical storage area.

Bottom Diamond
White: Health Warnings

AIR **W**

AIR-REACTIVE WATER-REACTIVE

Cancer **RADIOACTIVE**

CARCINOGENIC RADIOACTIVE

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Definitions

Presumptive Test: A presumptive test is a quick chemical test, usually involving a color change, which is used to determine if further testing is needed.

Catalytic Test: Catalytic presumptive tests are based on the principle that the heme in hemoglobin in blood possesses a peroxidase-like activity. This activity breaks down peroxide. If one of the reagents is present, the breakdown products of peroxide will oxidize the reagent and the reagent will change color.

Examples of catalytic presumptive tests include

- Luminol
- Phenolphthalein
- Tetramethylbenzidine (TMB)
- Hemastix® (TMB based)
- Leucomalachite Green (LMG)
- Leucocrystal Violet (LCV)
- Orthotolidine

Phenolphthalein Presumptive Test

Phenolphthalein Test: The phenolphthalein test is a catalytic presumptive test for blood and it is the most specific presumptive test for blood, reacting only with horseradish.

Order of Chemicals: Add the chemicals in the following order:

1. Distilled Water (optional)
2. Ethanol
3. Phenolphthalein
4. Hydrogen Peroxide

Positive Reaction: A quick color change to pink after the addition of hydrogen peroxide. Observe the color change within 10 seconds.



False Positive Reaction: The phenolphthalein presumptive test should be used as a three-step test: ethanol, phenolphthalein, and hydrogen peroxide. The three-step test will help eliminate any false positives. If the color change occurs after the second step – this is a false positive.

Scientific Summaries

Which Presumptive Test do I use?

The four presumptive tests researched in this study were: tetramethylbenzidine, orthotolidine, phenolphthalein and leucomalachite green

Most Sensitive Test: tetramethylbenzidine and orthotolidine

Most Specific Test: phenolphthalein and leucomalachite green

False Positives

	TMB	Phenolphthalein	Leucomalachite Green	Orthotolidine
Vegetables	✓			✓
Fruits	✓			✓
Horseradish	✓	✓	✓	✓
Rust	✓			✓

Best Presumptive Test: The single best presumptive test to use is phenolphthalein.

Cox, Milton, "A Study of the Sensitivity and Specificity of Four Presumptive Tests for Blood", *Journal of Forensic Sciences*, Vol. 36, No. 5, Sept. 1991, pp. 1503-1511.

Can you still find blood on clothing after it has been washed?

Yes, it is possible to detect blood on clothing after it has been laundered. Several factors need to be considered: Type of fabric, presumptive test and type of detergent and temperature of water.

Type of fabric: 100% acetate, 100% polyester and 100% nylon fabrics tested negative for blood after washing. 100% cotton and 50% cotton/polyester both tested positive for blood after being laundered.

Presumptive Test: Orthotolidine and phenolphthalein were used as the presumptive tests in this study. Orthotolidine was found to be more sensitive than phenolphthalein.

Type of detergent: Fabrics that were washed in a chlorine containing detergent were less likely to retain the bloodstains and test positive than fabrics that were washed in a non-chlorine detergent.

Temperature of water: Cold water was used in this study because it enhances the removal of bloodstains.

Cox, Milton, "Effect of Fabric Washing on the Presumptive Identification of Bloodstains", *Journal of Forensic Sciences*, Vol. 35, No. 6, Nov. 1990, pp. 1335-1341

Overview

Biological evidence can play an important role in the investigation of a variety of incidents. This type of evidence can be used to:

- Identify suspects, victims and even witnesses
- Link suspects / victims to a scene
- Links suspects / victims to each other
- Place a suspect of a victim within a scene
- Support or refute statements made by parties involved

Blood evidence is the most commonly encountered type of biological material although semen, urine, saliva, hair and fecal material may also be found.

Some examples of this type of evidence and its relation to various scenes include:

- Blood or hair evidence used to place individuals inside a motor vehicle at the time of a crash
- Blood left at a crime scene whenever sharp edged objects (knives, broken glass, etc.) are involved
- Saliva deposited on food or drink vessels (eating / drinking at burglary scenes)
- Semen, vaginal secretions, saliva and hair recovered after a sexual assault

Bloodstain Patterns

Properly done, the examination of bloodstain patterns present at a scene can provide valuable information that will aid the investigation. Important aspects of bloodstain pattern examination include:

- The condition of the stains when first observed
- The nature of the stain
- The surface that the stain is on
- A detailed description of the scene
- The size of the stain
- The shape of the stain
- The distribution of a group of stains within a pattern
- The specific location of a stain within a scene

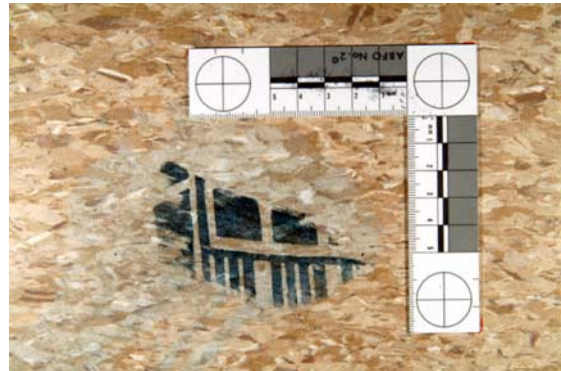
to enhance the visualization. Most commonly used on non-porous surfaces, protein stains can do an excellent job of revealing individual characteristics in an impression.

Since protein stains are not presumptive tests for blood, a presumptive test should be conducted on a portion of the impression that is not believed to have sufficient detail for comparison.

The examples at right illustrate the benefits that can be gained by enhancing an impression to increase contrast against the background.

Chemical Formulations

Information on chemical formulations, storage and shelf life for some of these enhancement techniques is available in Appendix C.



General Considerations

When objects or persons come in contact with one another during a criminal act, material is frequently transferred between them (Locard's Principle). Many of these transfers will be in the form of trace evidence.

Trace evidence is best defined as evidence that exists in minute or barely noticeable quantities. While various types of trace evidence may be visible with the naked eye, many can only be located using magnification or microscopic examination.

Examples of trace evidence include

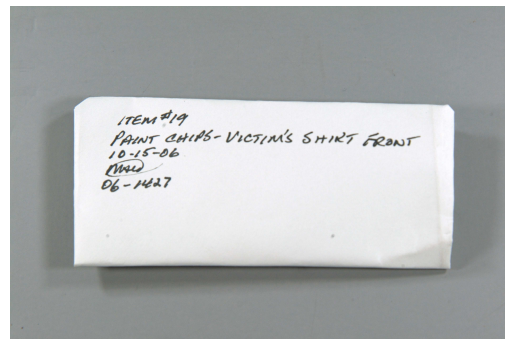
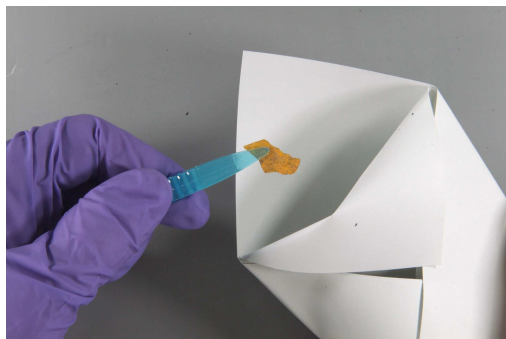
- Hair
- Fibers
- Gunshot Residue
- Dirt
- Glass
- Paint / Ink
- Arson Debris
- Insect (entomological) evidence
- Fingernail Scrapings
- Cosmetics
- Feathers
- Building Materials
- Biological Fluids
- Plant Materials

The best receptors for trace evidence are

- Clothing (or other fabric material)
- Hair
- Crevices in shoes, tires, objects

Because trace evidence can be easily lost or unintentionally transferred between items, care is needed in handling. Best practices include

- Submit the entire object when possible
- Handle items carefully - dry over paper
- Package items individually
- For immovable objects - pick materials off carefully / package in paper bindles (pharmacy folds)



Investigative Resources: Forensic Databases

Forensic Automotive Carpet Fiber Identification database

An in-progress work by the FBI utilizing over 700 types of fibers collected from automobiles and various vehicle manufacturers.

For more information visit

http://projects.nfstc.org/trace/docs/final/williams_diane.pdf

Glass Evidence Reference Database

This is a database containing more than 700 glass samples from various manufacturers. It is maintained by the Technical Support Working Group which is an interagency group that includes the U.S Department of State and the U.S Department of Defense. This database is used primarily to assess the frequency that two glass samples from different sources would contain the same elemental profile.

Additional information on this database can be obtained by e-mailing the group at **isfsubgroup@tswg.gov**

Ignitable liquids Reference Collection – ILRC

An online reference database maintained by the National Center for Forensic Science that allows lab personnel to conduct searches using various ignitable liquid parameters. It exists primarily for use as screening tool.

For more information visit **www.ncfs.org**

International Ink Library

Working together, the U.S. Secret Service and the Internal Revenue Service maintain a database of more than 7,000 inks. New specimens are submitted yearly by pen and ink manufacturers and supported by specimens obtained on the open market.

In addition to identifying possible writing implements, this database may also be used to establish the earliest date that writings could have been made.

For more information, contact the U.S. Secret Service at 202-406-5708.

National Automotive Paint File

The FBI maintains a database of more than 40,000 samples of automotive paint from various manufacturers. Established in 1935, paint chips from scenes can be compared against samples in this database.

More information on the FBI laboratory services can be found at **www.fbi.gov/hq/lab/labhome.htm**

Paint Data Query – PDQ

This database is maintained by the Royal Canadian Mounted Police and contains the chemical compositions of paint from domestic and foreign car manufacturers. The database primarily covers vehicles marketed in North America after 1973. The PDQ contains information on more than 13,000 vehicles, with a library of over 50,000 layers of paint.

More information on the PDQ database is available at www.rcmp-grc.gc.ca/factsheets/fact_pdq_e.htm

Terminology

This section contains some terminology associated with biological evidence. It is by no means a comprehensive work and the student is encouraged to read and research additional material. Additional terms and definitions are available under Tab 2, in the OSHA Standard 29 CRF 1910.1030.

AA: Atomic Absorption: A method of gun shot residue analysis in which an atomic absorption spectrometer is used to detect lead, barium or antimony. This technique uses radiation passed through the sample and measures the amount of light absorbed.

Acid Phosphatase: Enzyme that is found in cells throughout the body. AP is found in high levels in the prostate. The AP test is a presumptive test for semen.

Allele: A DNA coding sequence that occupies a particular locus on a chromosome. Allele coding can be either genetic or non-genetic. An example of a genetic coding would be the DNA sequence that controls the color of a person's eyes.

Amido Black: A common protein stain used to enhance the appearance of bloodstains against a substrate. Amido black will dye the blood impression a dark blue-black color and is best suited for light backgrounds.

Amylase: A starch digesting enzyme found in saliva. Identifying areas with a high concentration of amylase generally indicates the presence of saliva.

Antigen: A molecule that sometimes stimulates an immune response.

Blood: A mixture of various cells and dissolved substances. Blood is comprised of two parts –

Liquid; That portion of blood containing nutrients, antibodies, proteins and enzymes. The liquid portion is also called plasma or serum and is generally clear with a yellowish tint.

Cellular; That portion of the blood containing red blood cells, white blood cells and platelets.



Buccal Cells: Cells that line the insides of the cheeks.

The current practice for collecting DNA standards is to swab the insides of the cheeks and collect the buccal cells that have sloughed off.

This appendix contains the following information:

- Illinois law regarding retention / destruction of fingerprint and / or biological evidence.
- Resource List

Appendix C - Sample Forms

This section contains copies of various forms that the crime scene investigator may encounter when collecting certain types of evidence.

Forms Included in this section are

- Consent to Collect Biological Evidence
- John Doe Warrant Example
- Gunshot Residue collection
- Sexual Assault Collection Kit