

Biological & Trace Evidence

for the Crime Scene Investigator



Illinois Edition
Presented by: *Imprimus Forensic Services, LLC*
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Biological & Trace Evidence Contents

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Quick online access to a variety of downloadable files including evidence collection forms, scene sketch forms, and popular publications.

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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)

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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 touched or handled by persons associated with the scene should be considered a source of biological and DNA evidence. This includes objects that would otherwise not be suitable for fingerprint processing.



Refer also to the article: *Trace DNA: A Review, Discussion of Theory, and Application of the Transfer of Trace Quantities of DNA Through Skin Contact* (Under Tab 3 – This Binder).

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 infections. 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

Key Points

- Nuclear DNA
- Genetic blueprint
- Consistent throughout the body
- Consistent from birth to death
- 50% from mother; 50% from father
- Unique to each individual except identical siblings
- Stable if not exposed to heat, moisture or bacteria

DNA is found cells throughout the body including:

- Blood
- Muscle
- Bones
- Hair roots
- Vaginal secretions
- Saliva
- Sperm
- Teeth
- Skin

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DNA Technologies

The STR DNA process is the technique used by all crime labs today. STR stands for Short Tandem Repeats and has a number of benefits over the older RFLP technology including:

- Uses small amounts of DNA – can be degraded
- Very high discriminating power
- CODIS capabilities
- Can determine gender

The mitochondrial DNA process is a technology that analyzes DNA from the mitochondria of a cell rather than the nucleus. From the standpoint of criminal investigations, this process is used on recovered hairs that do not have a root. Benefits of the mitochondrial process include:

- Inherited maternally
- Uses small amounts of DNA
- Hair shaft instead of hair root
- FBI conducts Mitochondrial DNA analysis on a case by case basis

The Y-STR DNA process has the ability of looking at the male profile only in a mixed DNA sample such as what may be found in a sexual assault case. For more information on the use and benefits of Y-STR technology, see the article included under Tab 3 of this binder as well as another article included on the student CD-ROM.

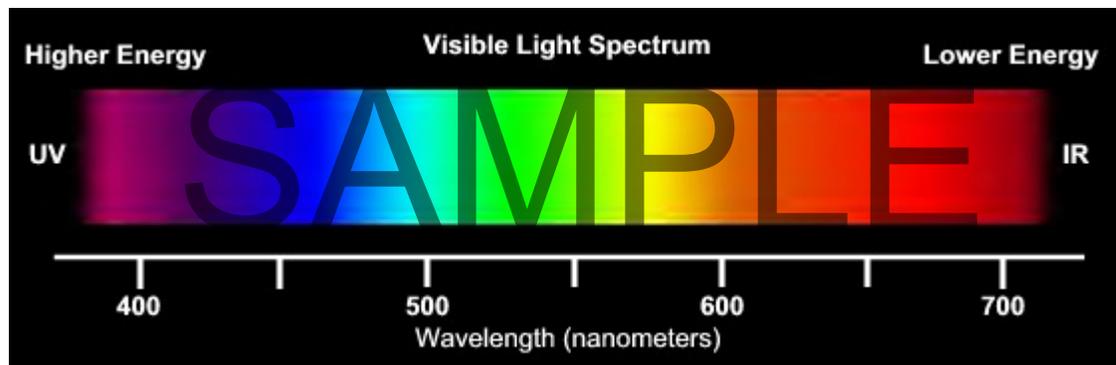


Overview

Forensic light sources can be used as an aid in locating biological fluids. The reader must be aware however that in most cases, the best and cheapest light source to use for locating suspected stains, is a bright white flashlight.

Theory of Light Application

Biological fluids can be broken into two categories; those that fluoresce or brighten under certain wavelengths of light and those that absorb or darken under certain wavelengths. Success in using light to locate biological fluids is generally dependant on the intensity of the light source and the ability to select a specific wavelength of light.



Fluorescence

Light is a form of energy. Light energy, when applied to certain materials, will cause the molecules of those materials to vibrate. This vibration of molecules in turn results in the substance re-emitting the light energy that has been absorbed. This newly emitted light has less energy than the light initially used for the excitation, and will be a different color – shifted toward the red end of the spectrum.

Substances that re-emit light only while they are being excited by light sources are said to be fluorescent. Take the light source away, and the re-emission of light stops. Body fluids that may fluoresce when illuminated with certain wavelengths of light are:

- Semen
- Saliva
- Urine
- Vaginal Secretions
- Sweat

Biological Stains Documentation Techniques

All stains should be documented through

- ✓ Photography
- ✓ Sketches
- ✓ Notes

Documentation should include

- ✓ Stain location
- ✓ Number of stains
- ✓ Approximate size and shape of stain
- ✓ Stain directionality

Biological Evidence Collection Techniques

- ✓ Photograph stains prior to collection
- ✓ Collect entire object when possible
- ✓ Swab the bloodstain using sterile swabs moistened with distilled water
The amount of water you use to moisten the swab is dependent on the size and concentration of the stain. If you have a small or dilute stain – only use one drop of water to moisten the swab. If the stain is more concentrated or large, use more water to moisten the swab
- ✓ Avoid scraping the stain
Scraping the stain increases your exposure to bloodborne pathogens
Scraping also increases contamination
- ✓ Collect the most amount of the stain as possible
- ✓ Collect the stain prior to any fingerprint enhancement or blood enhancement techniques when possible

Packaging Biological Evidence

- ✓ Air dry all biological evidence before packaging
- ✓ Only use clean paper products (do not “recycle” paper bags)
This includes cardboard boxes for swabs and knives. Do not put these objects in plastic tubes
- ✓ Package each item separately
- ✓ Label each package with a Biohazard sticker
- ✓ Label each package with the case number, your initials, date, exhibit number AND the location the item was found (or from who the item was collected)

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

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

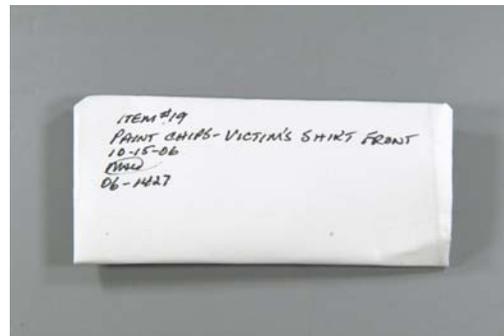
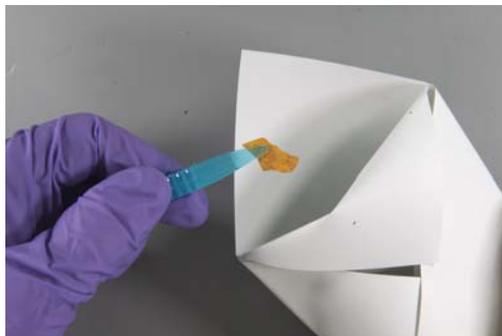
- Hair
- Fibers
- Gunshot Residue
- Dirt
- Glass
- Paint / Ink
- Arson Debris
- Insect (entomological) evidence
- Fingernail Scrapings
- Cosmetics
- Feathers
- Building Materials
- Biological Fluids
- Plant Materials

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 - FACID

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**

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.
- Illinois law regarding the submission of DNA samples collected from victims of homicide
- Resource List

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Post Trial Motions

(725 ILCS 5/116-3)

Sec. 116-3. Motion for fingerprint or forensic testing not available at trial regarding actual innocence.

(a) A defendant may make a motion before the trial court that entered the judgment of conviction in his or her case for the performance of fingerprint or forensic DNA testing on evidence that was secured in relation to the trial which resulted in his or her conviction, but which was not subject to the testing which is now requested because the technology for the testing was not available at the time of trial. Reasonable notice of the motion shall be served upon the State.

(b) The defendant must present a prima facie case that:

- (1) identity was the issue in the trial which resulted in his or her conviction; and
- (2) the evidence to be tested has been subject to a chain of custody sufficient to establish that it has not been substituted, tampered with, replaced, or altered in any material aspect.

(c) The trial court shall allow the testing under reasonable conditions designed to protect the State's interests in the integrity of the evidence and the testing process upon a determination that:

- (1) the result of the testing has the scientific potential to produce new, noncumulative evidence materially relevant to the defendant's assertion of actual innocence;
- (2) the testing requested employs a scientific method generally accepted within the relevant scientific community.

(Source: P.A. 90-141, eff. 1-1-98.)

(725 ILCS 5/116-4)

Sec. 116-4. Preservation of evidence for forensic testing.

(a) Before or after the trial in a prosecution for a violation of Section 12-13, 12-14, 12-14.1, 12-15, or 12-16⁴ of the Criminal Code of 1961 or in a prosecution for an offense defined in Article 9⁵

⁴ ILCS Sections: 12-13 Criminal Sexual Assault; 12-14 Aggravated Criminal Sexual Assault; 12-14.1 Predatory Criminal Sexual Assault of a Child; 12-15 Criminal Sexual Abuse; 12-16 Aggravated Criminal Sexual Abuse

⁵ Article 9 covers assorted homicide offenses.

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

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