Common forensics techniques: Blood Identification and Characterization of Blood and Bloodstains
Introduction to Blood

Red Blood Cells = No DNA

White Blood Cells = DNA in nucleus
Common forensics techniques: Blood Detection, Splatter and Characterization

Types of blood stains: Passive; Transfer; Splatter
Blood Detection and Characterization

Visual examination of evidence – what does blood at a crime scene tell us?

1. Presumptive screening test (Indirect method)
2. Confirmation test (Direct method)
3. Determine species origin (human blood?)
4. Identify the blood (whose blood is it?)
Forensic Analysis of Blood

Visual examination of evidence – what does blood at a crime scene tell us?

1. **Presumptive screening test (Is it blood?)**
2. Confirmation test (Seriously, is it blood?)
3. Determine species origin (human blood?)
4. Identify the blood (whose blood is it?)
Presumptive Screening Tests

- Presumptive tests produce a color reaction, release of light, or produce oxygen.
- Tests rely on catalytic properties of blood (hemoglobin presence or component).
Presumptive Screening

Tests

Oxidative Tests
- Apply oxidizing agent (hydrogen peroxide)

Color Tests
- Apply chromogen (color changing chemical)

Rapid color change or creation of oxygen is a positive result. This means the stain could be blood.
Presumptive Screening

Tests

Color Tests

Remember, other non-blood substances might catalyze the reaction also.

- Chemical Oxidants
- Plant materials

**False Positive** – A positive result given by a substance that is not blood.
Presumptive Screening

Tests

5 Types of Color Tests
- Benzidine – carcinogen no longer used
- Phenolphthalein
- O-Tolidine – carcinogen no longer used
- Tetramethylbenzidine (TMB)
- Leucomalachite Green (LMG)
Presumptive Screening

Tests
Phenolphthalein
- Positive result = pink
- Some other substance produce colors other than pink (not blood)
- Hemoglobin in blood has an enzyme that converts colorless form into pink form of phenolphthalein
Presumptive Screening

Tests

Tetramethylbenzidine (TMB)
- Positive result = Blue-green
- Most common test for blood

Rub stain with moist swab
Add TMB
Add peroxidase

Look for quick blue color
Presumptive Screening

Tests

Tetramethylbenzidine (TMB)
- Positive result = Blue-green
- **Most common** test for blood

Rub stain with moist swab
Add TMB
Add peroxidase

Look for quick blue color
Presumptive Screening
Tests: Non Color tests

Chemiluminescence and Fluorescence

- Chemiluminescence – light is emitted as a product of the chemical reaction
- Fluorescence – light is emitted when a substance is exposed to a shorter wavelength of light
Presumptive Screening

Tests

Chemiluminescence and Fluorescence
- More sensitive than color tests
- May damage blood stain (no blood/DNA typing)

Used to locate and define areas of blood
- old blood stains
- cleaned floor
Presumptive Screening

Tests

Luminol
- Method similar to color test
- Luminol is combined with oxidant and sprayed over area thought to contain blood
- Emits a blue-white to yellow green glow
Presumptive Screening Tests

Luminol
Forensic Analysis of Blood

Visual examination of evidence
Presumptive screening test (Is it blood?)
Confirmation test (Direct Method)
Determine species origin (human blood?)
Identify the blood (whose blood is it?)
Common forensics techniques:

- Blood is a tissue – connective tissue - a group of cells with common structure and function.
- Blood consists of several cell types suspended in a liquid matrix called plasma.
Confirmatory Tests

- Due to the possibility of false positives with the presumptive tests, confirmatory tests are necessary
- Confirmatory tests involve making crystals that detect the presence of hemoglobin
Introduction to Blood

Hemoglobin picks up and drops off oxygen
Confirmatory Tests

Takayama Test

- Small amount of blood added to microscope slide
- Chemical solution is added
- Slide is heated to form crystals
- Crystals viewed under microscope
Forensic Analysis of Blood

- Visual examination of evidence
- Presumptive screening test (Is it blood?)
- Confirmation test (Seriously, is it blood?)
- Determine species origin (human blood?)
- Identify the blood (whose blood is it?)
Species Origin

Most methods test for **serum proteins**

- Serum proteins are found in all animals, but are slightly different
- Species ID methods based on antigen/antibody interactions
Species Origin

Antibody is in antiserum

Antigen (serum protein) is in blood sample

- Human antiserum will only attach to human blood sample
- Rabbit antiserum will only attach to rabbit blood sample
- Dog antiserum will only attach to dog blood sample
Species Origin

Ring Precipitin Test

- Blood sample (dilute) in top layer
- Precipitate means blood and antiserum species match
- Antiserum in heavy bottom layer
Species Origin

Ring Precipitin Test

Yes line = Yes human blood

Human Antiserum
Forensic Analysis of Blood

- Visual examination of evidence
- Presumptive screening test (Is it blood?)
- Confirmation test (Seriously, is it blood?)
- Determine species origin (human blood?)
- Identify the blood (whose blood is it?)
Introduction to Blood

Type "AB" Blood

- ○ = A antigen
- △ = B antigen
- □ = Rh antigen

ABO blood groups found on outside of cell
Blood Group Markers

ABO Markers (antigen and antibodies)
- A person will have antibodies (A or B) to whatever blood group he/she doesn’t have
- Otherwise, a person’s blood would clump up and cause death
### Blood Group Markers

<table>
<thead>
<tr>
<th>Blood Type</th>
<th>Antigen (Blood Group)</th>
<th>Antibody</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>A</td>
<td>Anti-B</td>
<td>40</td>
</tr>
<tr>
<td>B</td>
<td>B</td>
<td>Anti-A</td>
<td>10</td>
</tr>
<tr>
<td>AB</td>
<td>A &amp; B</td>
<td>none</td>
<td>5</td>
</tr>
<tr>
<td>O</td>
<td>H</td>
<td>Anti-A &amp; Anti-B</td>
<td>45</td>
</tr>
</tbody>
</table>

**ABO Markers (antigen and antibodies):**

- **Rh+**: No Rh Antibodies
- **Rh-**: Rh Antibodies

**Blood Type Specifics:**
- **A**: Can only donate to A, AB, O
- **B**: Can only donate to B, AB, O
- **AB**: Can donate to AB
- **O**: Can donate to all types

*Ryan O- can donate to everyone.*
Common forensics techniques: Characterization

<table>
<thead>
<tr>
<th>(a) Phenotype (blood group)</th>
<th>(b) Genotypes (see p.258)</th>
<th>(c) Antibodies present in blood serum</th>
<th>(d) Results from adding red blood cells from groups below to serum from groups at left</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>$I^A I^A$ or $I^A i$</td>
<td>Anti-B</td>
<td>![Images showing reaction results for A blood group]</td>
</tr>
<tr>
<td>B</td>
<td>$I^B I^B$ or $I^B i$</td>
<td>Anti-A</td>
<td>![Images showing reaction results for B blood group]</td>
</tr>
<tr>
<td>AB</td>
<td>$I^A I^B$</td>
<td>—</td>
<td>![Images showing reaction results for AB blood group]</td>
</tr>
<tr>
<td>O</td>
<td>$ii$</td>
<td>Anti-A Anti-B</td>
<td>![Images showing reaction results for O blood group]</td>
</tr>
</tbody>
</table>

ABO Blood types.
Blood Group Markers

ABO Markers

- A cells clump with anti-A
- B cells clump with anti-B
- AB cells clump with both
- O cells do not clump
Genetic Markers in Blood

- ABO blood typing and protein analysis may help eliminate a suspect.
- Since there are only a small number of types (ABO = 4 types), a match does not mean the stain definitely came from a certain person.
- DNA testing can identify a person, and is becoming just as easy as the above tests.
Common forensics techniques: DNA identification

- BLOOD, CHROMOSOMES, AND DNA ANALYSIS

Dominant vs Recessive

Homozygous vs Heterozygous

Punnet Square Review
Common forensics techniques: DNA identification

- BLOOD, CHROMOSOMES, AND DNA ANALYSIS

Mendal’s Pea
Yellow Round seed x green wrinkled seed

Di hybrid cross

Blood Analysis Activity
Parents: Bloodtype
Heterozygous A

IA i x Heterozygous B

I^A i

? x

I^A i

\begin{array}{c|c}
IA & IB \\
\hline
IA & IA \\
IB & ii \\
\end{array}

25% AB
25% A
25% B
25% O
Heterozyg. A Heterozyg. Rh x O-

\[ I^A^iRr \xrightarrow{i}

\begin{array}{c|c|c|c}
  \text{IR} & \text{IA}rr & \text{iR}r \\
  \hline
  \text{IA} & \text{IA}rr & \text{iAr}r \\
  \text{iR} & \text{iRr} & \text{irr} \\
  \text{ir} & \text{irr} & \text{irr} \\
\end{array}

\text{A+ 25\%} \quad \text{A- 25\%} \quad \text{Extra Credit}

\text{Rr > Rh+} \quad \text{rr Rh-}