Forensic Science
Chapter 12

- Bell-Ringer (5 Points)
- Blood in the arterial vasculature is what color?
- Blood in the venous vasculature is what color?
- What element in blood accounts for its color?
- Before you leave: A) Bell-Ringer, B) Journal and P/U experiment #35.
Bloodspatter

Patterns of blood
Withdraw blood → Place in tube → Centrifuge

**PLASMA 55%**

<table>
<thead>
<tr>
<th>Constituent</th>
<th>Major functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>Solvent for carrying other substances</td>
</tr>
<tr>
<td>Salts (electrolytes)</td>
<td>Osmotic balance, pH buffering, and regulation of membrane permeability</td>
</tr>
<tr>
<td>Sodium</td>
<td></td>
</tr>
<tr>
<td>Potassium</td>
<td></td>
</tr>
<tr>
<td>Calcium</td>
<td></td>
</tr>
<tr>
<td>Magnesium</td>
<td></td>
</tr>
<tr>
<td>Chloride</td>
<td></td>
</tr>
<tr>
<td>Bicarbonate</td>
<td></td>
</tr>
<tr>
<td>Plasma proteins</td>
<td>Osmotic balance, pH buffering, clotting of blood, defense (antibodies), and lipid transport</td>
</tr>
<tr>
<td>Albumin</td>
<td></td>
</tr>
<tr>
<td>Fibrinogen</td>
<td></td>
</tr>
<tr>
<td>Globulins</td>
<td></td>
</tr>
</tbody>
</table>

**Formed Elements (cells) 45%**

<table>
<thead>
<tr>
<th>Cell type</th>
<th>NUMBER (per mm³ of blood)</th>
<th>FUNCTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Erythrocytes (red blood cells)</td>
<td>4–6 million</td>
<td>Transport oxygen and help transport carbon dioxide</td>
</tr>
<tr>
<td>Leukocytes (white blood cells)</td>
<td>4,000–11,000</td>
<td>Defense and immunity</td>
</tr>
<tr>
<td>Platelets</td>
<td>250,000–500,000</td>
<td>Blood clotting</td>
</tr>
</tbody>
</table>
What is it?

- A tool to help understand what took place and what did not take place
- Helps in interrogations
- Reconstruction
- Exonerate the accused
- Interpretation only as good as the information and the person using the information
Bloodspatter became important in 1955

Dr. Paul Kirk - Ohio v. Samuel Sheppard

Remember - The Fugitive

This was an important case in blood evidence by the American Legal System
What is Blood?

- Circulates through the heart, arteries, veins, capillaries
- Transports $O_2$, $CO_2$, electrolytes, nourishments, hormones, vitamins and wastes
- Fluid portion- plasma- contains cellular components- RBC, WBW, platelets
- 45% of total volume
How much blood do you have?
- 4.5-6L

When it clots, fluid portion of clotted blood is pushed out of clot- called serum

What is in blood?
- RBC - no nucleus
- WBC - source of DNA
- Platelets - clotting
ABO Blood Types

• When certain blood types mix- they clump- this can be a PROBLEM

• Antigen- surface proteins- on the RBC
• Antibodies- in the plasma- proteins

• Blood Typing
<table>
<thead>
<tr>
<th>Blood Type</th>
<th>Antigens on RBC</th>
<th>Antibody in plasma</th>
<th>Can donate to Type</th>
<th>Can receive from Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>A</td>
<td>Anti-B</td>
<td>A and AB</td>
<td>A, O</td>
</tr>
<tr>
<td>B</td>
<td>B</td>
<td>Anti-A</td>
<td>B, AB</td>
<td>B, O</td>
</tr>
<tr>
<td>AB</td>
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<td>Neither</td>
<td>AB</td>
<td>A, B, AB, O</td>
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</table>
Physical Properties

- Acts in predictable manner
- Strong cohesive molecular forces = surface tension (force that pulls surface molecules inward, ↓ surface area, liquid resists penetration)
- To create spatter, external force must overcome the surface tension of the blood
- Shape of blood drop is spherical NOT tear drop shaped
- Viscosity- resistance to change in form or flow
- More viscous- move slowly
- Blood is 6X more viscous than water
- Blood drop falling will increase in velocity until the force of air resistance that opposes the drop is equal to the force of the downward gravitational pull
- Terminal Velocity= 25.1 feet/second after falling 20-25 feet
What is the typical blood volume of an:

- Adult Male
- Adult Female

Turn in your Bell-Ringer and Journal before the end of the period.

Pick up your next experiment: Blood Stain Pattern Geometry (Part B).
Diameter of bloodstain is a function of:

- Volume of the drop
- Surface texture it impacts
  - Rough
  - Smooth
- Distance fallen

Blood drop will not break into smaller droplets unless something disrupts the surface tension
Physical Nature of what it hits

- **Hard- smooth** – non-porous surface
- Little spatter
- **Rough texture** – plywood, tile
- Significant spatter
- **Rough, with protuberance** –
  - Spatter with irregularly shaped parent stain with spiny or serrated edges
Size, Shape, Direction of Bloodstains

- Geometry determines the direction of flight
- Narrow end points to the direction of travel
- After direction of several stains is determined, the POINT OF CONVERGENCE is established by drawing lines through the long axis of the stain
- Point where they converge represents the relative location of the blood source in 2 dimensions - X, Y axis
Arterial gushing

Very large gush, to very small spray pattern
Severity, size of artery, clothing
Body will show damage- autopsy will confirm
Castoff

First blow - nothing
Second blow - castoff created - blood accumulates in varying quantities on object producing injuries
IF centrifugal force is generated by the swinging of the weapon is greater than the adhesive force holding blood to the object, blood is flung
Blood dripping into blood

Satellite splatter- when multiple blood drops hit previous blood spots
Flow pattern
LVIS

Force is up to 5 fps
4mm in diameter or greater
MVIS

Force is 5-25 fps
1-3 mm in diameter
Force is 100 fps
Less than 1 mm in diameter
With GSW- spray is mist like
**Entrance Wound**- back spatter- blowback-found on weapon- shooters hand
**Exit Wound**- forward spatter
Swipe pattern
Hair swipe pattern
Transfer contact
Transfer finger
Transfer-contact screwdriver
Transfer contact- footwear
Wipe pattern
Look at the three patterns, what can you me about the blood stain?
Beating / Stabbing-
First blow-usually no spatter-need exposed blood
1-3 mm in diameter
Elongation Starts
(directionality noted)

90 Degree

In Line Stains
(acute angles)
90 Deg Stain
No Direction noted

Direction of travel
By accurately measuring the length and width of a bloodstain, the impact angle can be calculated using the SIN formula below.
By drawing a line through the long axis of a group of bloodstains the point of convergence can be determined. Where the lines of the group of stains intersect one another the convergence point can be established.
3-DIMENSIONAL [TOP VIEW] POINT of ORIGIN

= POINT of ORIGIN

CHAIR

BED

DRESSER
POINT OF CONVERGENCE AND ORIGIN DETERMINATION

The common point, on a 2 dimensional surface, over which the directionality of several bloodstains can be retraced.

Once the directionality of a group of stains has been determined, it's possible to determine a two dimensional point or area for the group of stains.

*By drawing a line through the long axis of a group of bloodstains the point of convergence can be determined. Where the lines of the group of stains intersect one another the convergence point can be established*
- Point or area of origin - helps determine where the crime occurred, what height the blood came from

- **Angle of Impact**
  - 90 degree drop - circular
  - Less than 90 degree drop - elliptical
  - Mathematical relationship exists between \( W \times L \)
  - \( W/L = \) ratio less than 1
  - Need the sine function - this gives us an angle
Then, go to the floor with a protractor, find the angle, and go up. This will give us a height that the spatter came from.

This height will be “taller” than the actual height due to gravitational pull.

Really, this gives us an idea if the victim was standing, lying down, or sitting.

This info also allows us to call hospitals and have the ER look for certain injuries at certain heights.

For example, knife cut to forearm.
Spatter determined by:
- Quantity of blood available
- Amount of force applied
- Created when force is greater than surface tension
- Varies with GSW, stabbing, beatings
Why ID and interpret spatter

- Determine the area / location of origin of blood source
- If found on suspect, may place at crime scene
- Determine mechanism by which it was created
Spatter

Impact
- GSW
- Beating
- Satellite

Projection
- castoff
- arterial
- expired

Spatter by combo of these
Splash Patterns

- Deflection from one surface to another
- Movement of victim or assailant
- Projected blood-force exceeds gravity
- Edges will exhibit numerous spike-like projections with narrow streaking of secondary spatter-vomit, then running through the blood
Expired (Exhaled) Blood

- Similar to GSW
- Blood fills mouth, nose, lungs
- You try to breathe and force the blood out
- Blood may have air bubbles
- Blood may be mixed with saliva
- But, what must I find on the body to substantiate this
  - Injury to head, neck, face
Altered Patterns

- If blood dries, then is wiped, or stepped in-skeletonized pattern
- This shows movement after injuries are inflicted
- Blood normally clots in 3-15 minutes
- Clot is a jelly like mass
- Coughing up clotted blood, shows postinjury survival time
- Void Patterns- no blood where it should be- big puddle, shoe image in center
Blood on Clothes or shoes

- Whose blood is it?
- What is the staining pattern?

- “I came in the room and found them lying there. I only touched them to see if they were alive.”
- Really?
- What if they have a transfer pattern?
  - Okay- seems reasonable
- What if they have spatter?
  - Oops- sorry, doesn’t match your story