

Unit 5: BLOOD and BLOOD SPATTER

Skill 1: Composition of Blood

Blood is a circulating tissue consisting of three types of cells:

1. _____ blood cells
2. _____ blood cells
3. _____

These cells are suspended in a liquid known as _____. Plasma is similar to _____ water in composition. It carries dissolved proteins, such as antibodies, hormones, and clotting factors, and nutrients such as glucose, amino acids, salts, and minerals.

A. Blood Cells

Each blood cell performs a different function.

- Red Blood Cells: carry the gases

_____ and _____

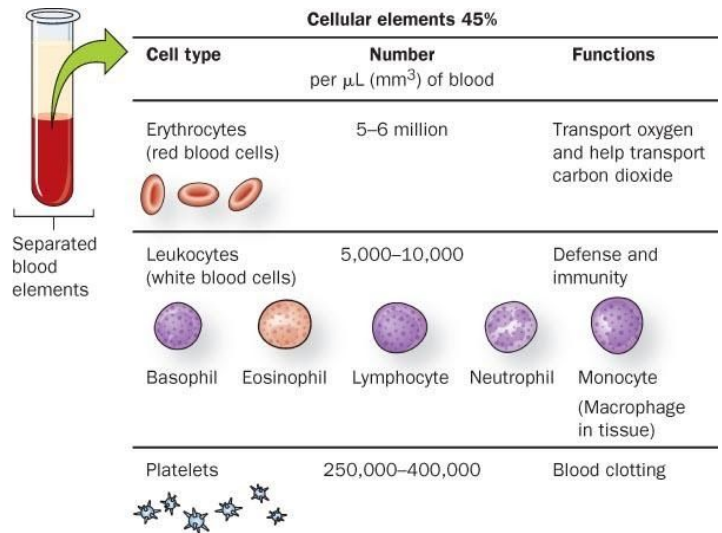
- Hemoglobin in red blood cells

is responsible for transporting _____ to cells and for the _____ color of blood

- White Blood Cells: Fight _____ and _____

- Antibodies: _____ which assist in the immune response (fighting bacteria, viruses, parasites)

- Platelets: aid in blood _____ and are involved in repairing damaged blood _____



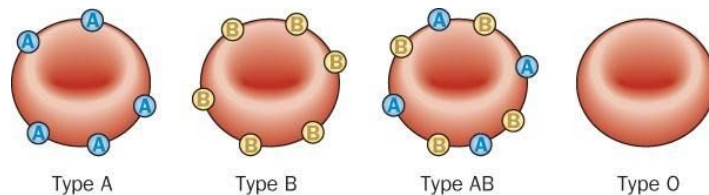
Skill 2: Blood Typing...always B+!

Because many different people share the same type of blood, blood evidence is considered to be _____ evidence. By typing the blood found at a crime scene, it is possible to line a suspect to a crime scene or to exclude a suspect.

However, matching blood types does _____ prove guilt.

1. A and B Proteins: Distinguishing Type

- A and B proteins are found on the _____ of some red blood cells. If a person's blood contains only protein A, he/she has type _____ blood.
- If a person's blood contains only protein B, he/she has type _____ blood.
- If a person's blood contains both protein A and B, he/she has type _____ blood.
- If a person's blood lacks protein A and B, he/she has type _____ blood.

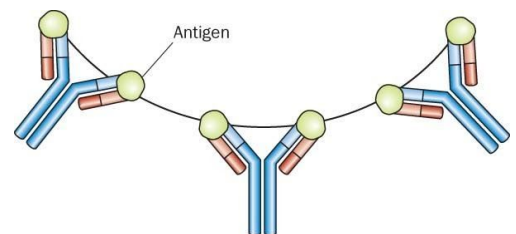


2. Rh factor

This is another type of protein associated with the red blood cells. 85% of the human population has a protein called Rh factor on their red blood cells. Blood that has the Rh factor is designated _____ while blood that does not have this factor is designated _____.

3. Antibodies

White blood cells identify foreign proteins and secrete antibodies. The antibodies are _____ shaped protein molecules that bind to the molecular shape of an _____, fitting like a puzzle.



When a foreign invader is recognized, an attack is launched. This is called the _____ - _____ response.

4. Blood Typing Tests

Blood typing is a way to identify and match blood samples. When blood is tested and types, the presence of three red blood cell proteins are looked for: _____, _____ and _____

5. Probability and Blood Types

Given the frequency of different genes within a population, it is possible to determine the probability or chance that a particular blood type will appear within a particular population.

ABO

| Type | Percent | Fraction |
|------|---------|----------|
| A | 42% | 42/100 |
| B | 12% | 12/100 |
| AB | 3% | 3/100 |
| O | 43% | 43/100 |

MN

| Type | Percent | Fraction |
|------|---------|----------|
| MM | 30% | 30/100 |
| MN | 48% | 48/100 |
| NN | 22% | 22/100 |

Rh

| Type | Percent | Fraction |
|------|---------|----------|
| Rh + | 85% | 85/100 |
| Rh- | 15% | 15/100 |

What percentage of the population would have Type A+ blood?

What percentage of the population would have Type O-, MN?

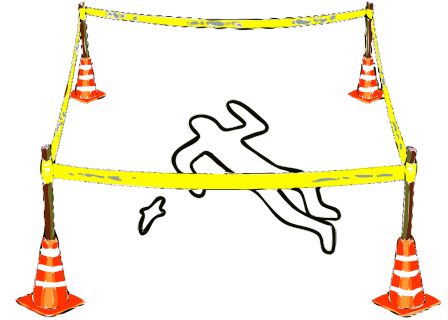
What percentage of the population would have Type B+, NN?

Skill 3: Crime-Scene Investigation of Blood

In an attempt to hide evidence, a perpetrator may try to remove blood evidence by cleaning the area. Although a room may look perfectly clean and totally free of blood after a thorough washing of the walls and floor, blood evidence still remains...

To detect hemoglobin:

1. an investigator mixes _____ powder with _____ in a spray bottle.
2. The mixture is then sprayed on the area to be examined for blood. The _____ from the hemoglobin, acting as a catalyst, speeds up the reaction between the peroxide and the Luminol.
3. As the reaction progresses, _____ is generated for about 30 seconds on the surface of the blood sample.



To process a blood stain:

1. Confirm the stain is blood.
 - Kastle-Meyer test: If blood is present, a dark _____ color is produced.
 - Leukomalachite green: This chemical undergoes a color change, producing a _____ color in the presence of blood.

2. Confirm the blood is human.

ELISA test (Enzyme Linked Immunosorbent Assay): involves an _____-_____ reaction.

3. Determine blood type.

Remember, the resulting match is considered _____ evidence. However, if the blood does not match, then a particular person may be excluded as a suspect.

4. Gathering DNA evidence

- a. Restriction Fragment Length Polymorphism (RFLP) DNA analysis/testing is commonly statistically individualizing (one out of several million or several billion) and it has withstood rigorous court challenges on its validity. The limits however, is that this method also usually requires a _____ sample size to obtain significant results.
- b. Polymerase Chain Reaction (PCR) DNA analysis-based testing works well on degraded samples and _____ samples (pinhead size). However this method is not as statistically individualizing as RFLP.

Skill 4: Blood Spatter

Blood Spatter Analysis:

- Recall that blood is a thick mixture of blood cells and plasma.
- When a person is injured and is bleeding, _____ acts on blood, pulling it downward toward the ground.
- The blood droplet has a tendency to become _____ than it is wide as a result of gravity.
- Blood is _____. This means that the blood mixture is attracted to similar blood mixtures and tends to stick together and not separate as it falls.
- The effect of the downward force of gravity combined with the cohesive force of the blood results in a net effect on the blood droplet as it falls. Thus, the blood maintains a _____ appearance.
- When a drop of blood falls on a flat surface, the blood drop will have a _____ surface. The blood drop does not totally flatten out. The reason for this shape is the cohesive nature of blood causing the blood to pull together and resist flattening out on a surface.

A falling drop of blood



The effect of gravity



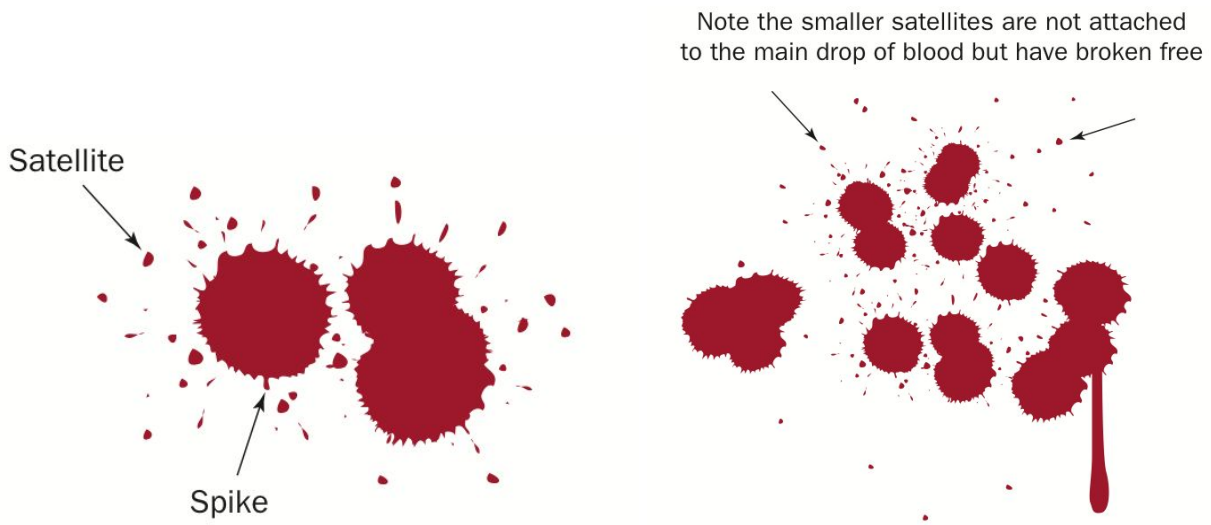
Cohesive forces



Cohesive forces resist



- ❑ If any of the blood does overcome cohesion and separate from the main droplet of blood, it will form small secondary droplets known as _____.



- ❑ Smooth Surface: (i.e. glass or marble) the edge of the blood drop appears _____ and _____.
- ❑ Porous surface: (i.e. wood or ceiling tile) then the edge of the drop of blood may form small _____ or _____.

Blood Spatter Patterns:

1. Blood falling directly to the floor at a 90-degree angle will produce circular drops, with secondary satellites being more produced if the surface hit is textured. This is known as a _____ fall.
2. _____ spurts or gushes typically found on walls or ceilings are caused by the pumping action of the heart.
3. _____ are shaped like exclamation points. The shape and position of the spatter pattern can help locate the position of the victim at the time of the attack.
4. _____ are left by a bleeding victim depositing blood as he or she touches or brushes against a wall or furniture.

5. _____ of blood can be left by a bleeding victim as he or she moves from one location to another. The droplets could be round or smeared or even appear as spurts.

6. _____ of blood form around a victim who is bleeding heavily and remains in one place. If the bleeding victim moves to another location, there may appear to be droplets or smearing connecting the first location with a second.




Blood Spatter Interpretation:

- 1) **Direction:** The _____ and _____ of blood droplets help identify the direction from which the blood originated.
 - Round droplets, for example, are caused by blood dripping downward at a 90-degree angle. Blood droplets with tails or satellite droplets help us determine the direction from which the blood originated.

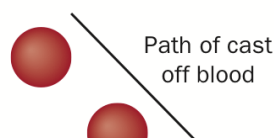
- 2) **Type of Wound:** Spatter patterns can help the investigator determine the type of wound.
 - A _____ spatter pattern is produced by a high-velocity impact, such as a gunshot wound.

 - A beating with a pipe will produce blood _____ with a lower-velocity pattern.

 - Voids (empty spaces) in the spatter pattern could help determine the presence of a person or object _____ after the attack.

| Velocity | Size of Droplets (mm) | Visual Image | Velocity of Blood | Examples of Injuries |
|----------|-----------------------|---|-------------------|----------------------|
| High | Less than 1 |  | 100 ft/sec. | Gunshot wounds |
| Medium | 1-4 |  | 25 ft/sec. | Beating, stabbing |
| Low | 4-6 |  | 5 ft/sec. | Blunt object impact |

4. Angle of Impact:



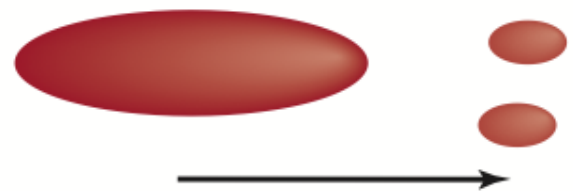
By using the spatter pattern to determine the angle of impact of various blood droplets, the examiner can determine the point of impact or convergence, a two-dimensional representation of the location of the victim at the time of the injury.

- A circular drop of blood indicates that the blood fell straight down. _____ degree angle.
- When a blood drop is _____ (longer than it is wide), it is possible to determine the direction the blood was traveling when it struck a surface.
- When blood comes into contact with another surface, the blood tends to adhere or stick to it. As a result, the point of impact may appear to be darker and wider than the rest of the drop of blood spatter.

5. Direction of Movement:

As blood droplets move away from their source, the blood droplet elongates and may produce a _____ tail-like appearance.

- **The tail points in the direction of blood's movement.**



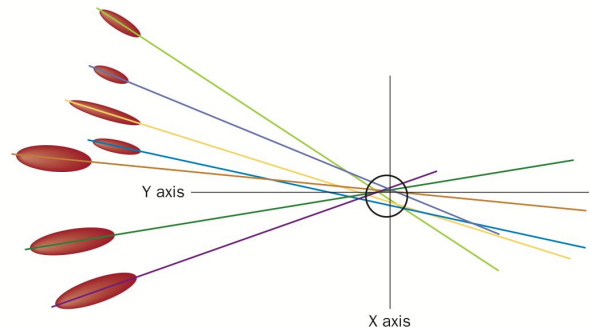
Direction blood is traveling

- _____ drops: blood that breaks away from the main drop of blood. These satellites will appear in front of the moving droplet of blood.
 - Note that satellites are NOT connected to the main drop of blood.

6. Lines of Convergence:

- The _____ of the source of blood can be determined if there are at least _____ drops of blood spatter.

- By drawing straight lines down the long _____ of the blood spatter and noting where the lines _____, this will indicate the lines of convergence.
- When there are numerous blood spatters, the area where the lines of convergence meet is where the source of blood _____.
- One can draw a small _____ around this intersecting area to note the area of convergence...this **identifies, in a two-dimensional view, the location of the source of the blood.**



What can blood spatter analysis tell us?

- Using all the information that can be determined by drops of blood, one can determine the height at which the blood spatter fell from.
- By noting the shape of the droplet of blood, you will be able to note the direction in which the blood was moving.
- The size of the blood spatter will provide some indication of the velocity of the blood when it hit a surface.
- By examining at least two drops of blood spatter, you will be able to determine where the injured person was located when the injury occurred in two dimensions (lines of convergence).
- By measuring the width and length of a single drop of blood, you can determine the angle of impact.
- By using the Law of Tangents, you can calculate the height from which the blood fell, or the point of origin for the blood.