Crime Scene Bloodstain Pattern Analysis

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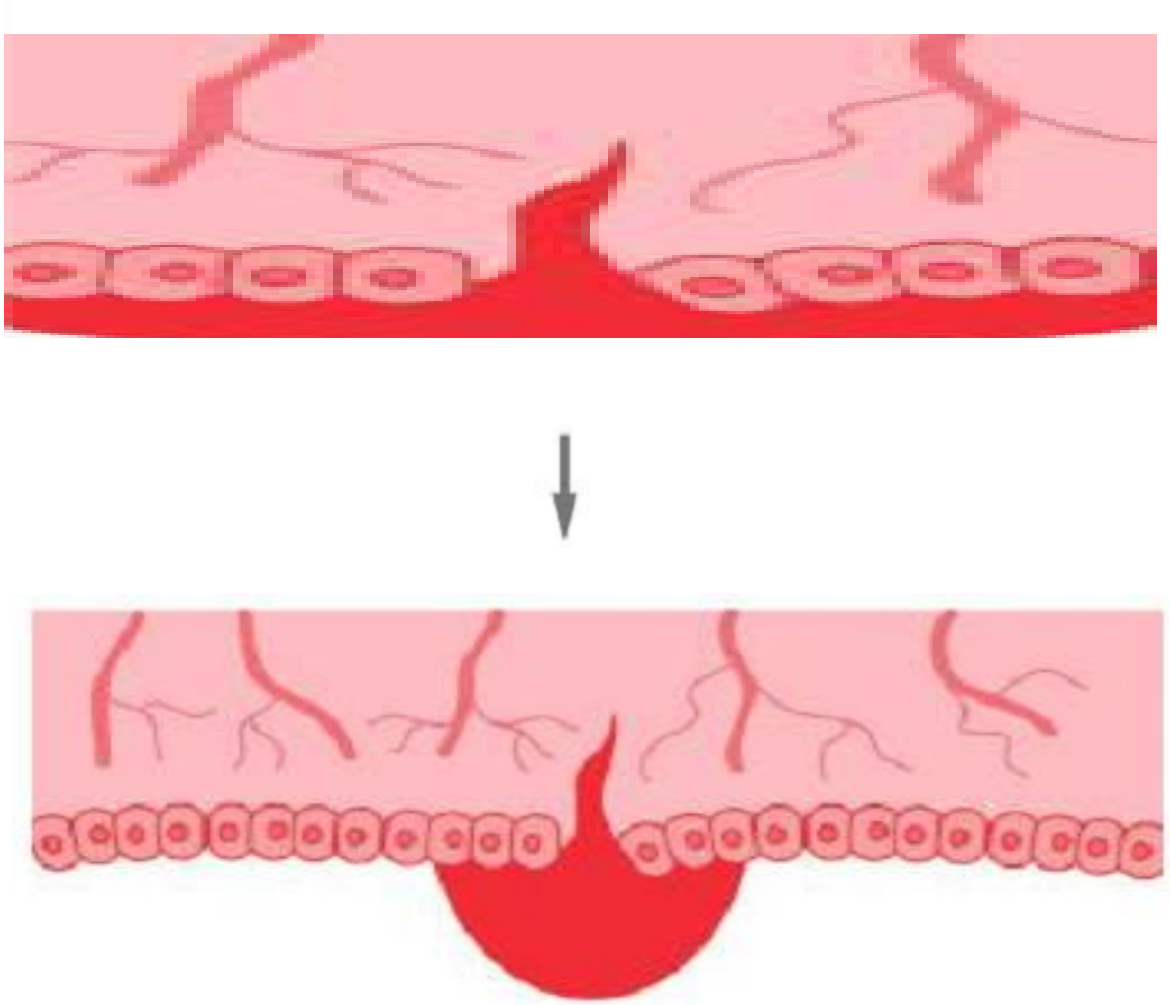
Bloodstain pattern analysis

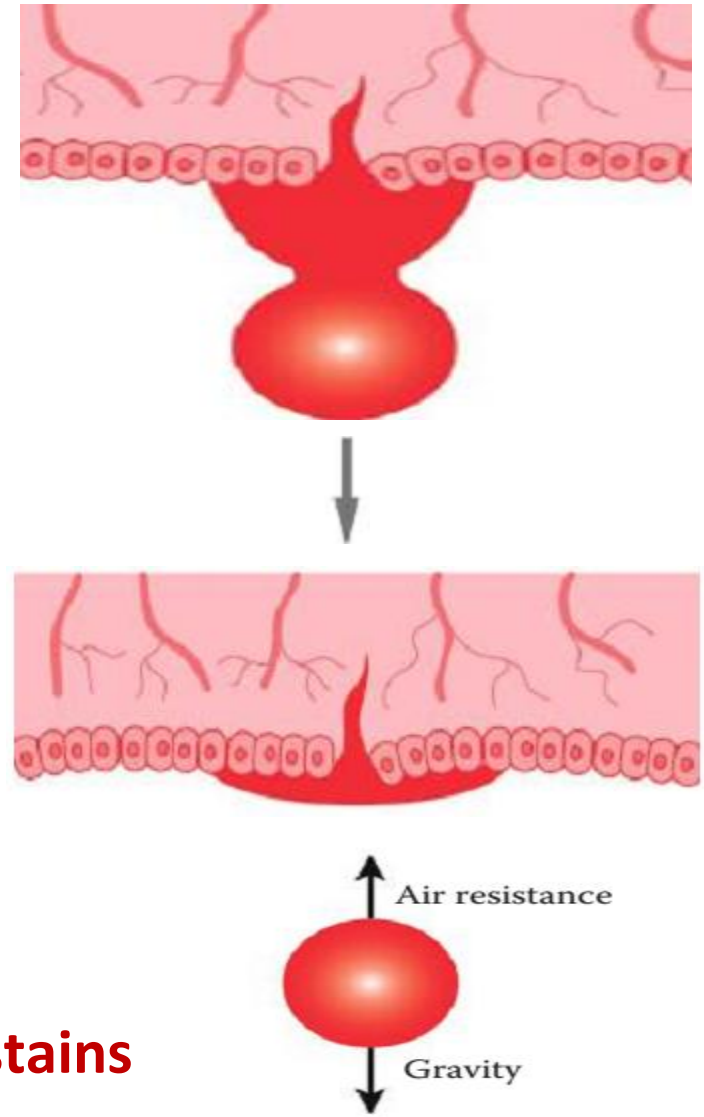
Bloodstain pattern analysis is the application of scientific knowledge to the examination and the interpretation of the morphology, the sequence, and the distribution of bloodstains associated with a crime.

Basic Biological Properties of Human Blood

- Blood is a bodily fluid circulating within the body.
- An average adult has a blood volume of approximately 8% of his or her body weight.
- Blood consists of a cellular portion as well as a liquid portion known as plasma.
- The cellular portion consists of blood cells and platelets.
- The plasma is mostly composed of water and other substances such as proteins, inorganic salts, and other organic substances.
- The normal coagulation time for 1 mL of venous blood in a glass tube is 5–15 min

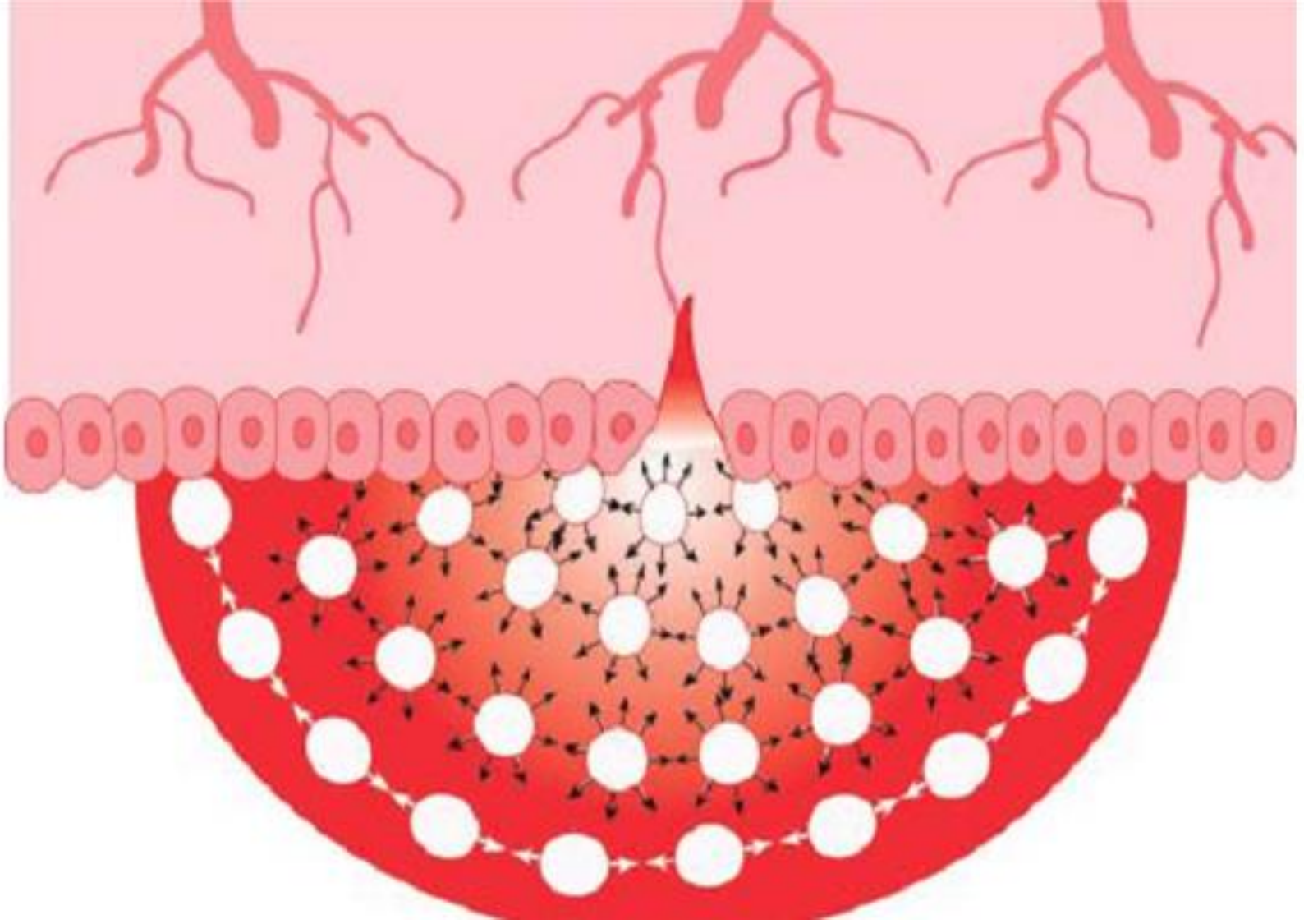


Formation of Bloodstains

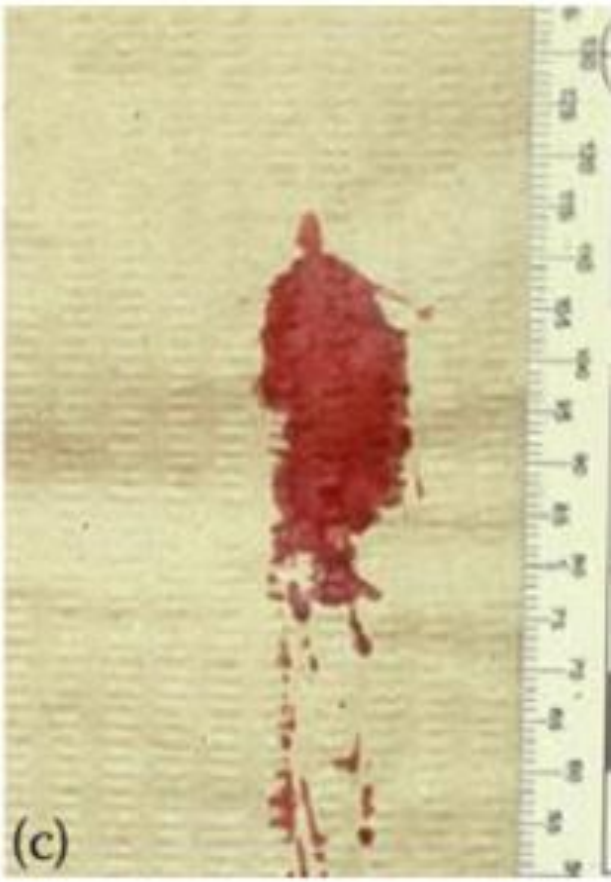


Formation of Bloodstains

Forming a blood drop from a blood source. The blood that leaks out of the blood source forms a pendant drop of blood. As the volume of the pendant drop increases, the drop stretches in a downward direction. Eventually, the drop detaches and falls. The falling drop is largely influenced by the force of gravity and air resistance.



The particles of blood are attracted to each other by cohesive forces that are responsible for surface tension. As a result, a formed blood drop is spherical in order to minimize its surface area. Black arrow, cohesive force; white arrow, surface tension.



Formation of Bloodstains

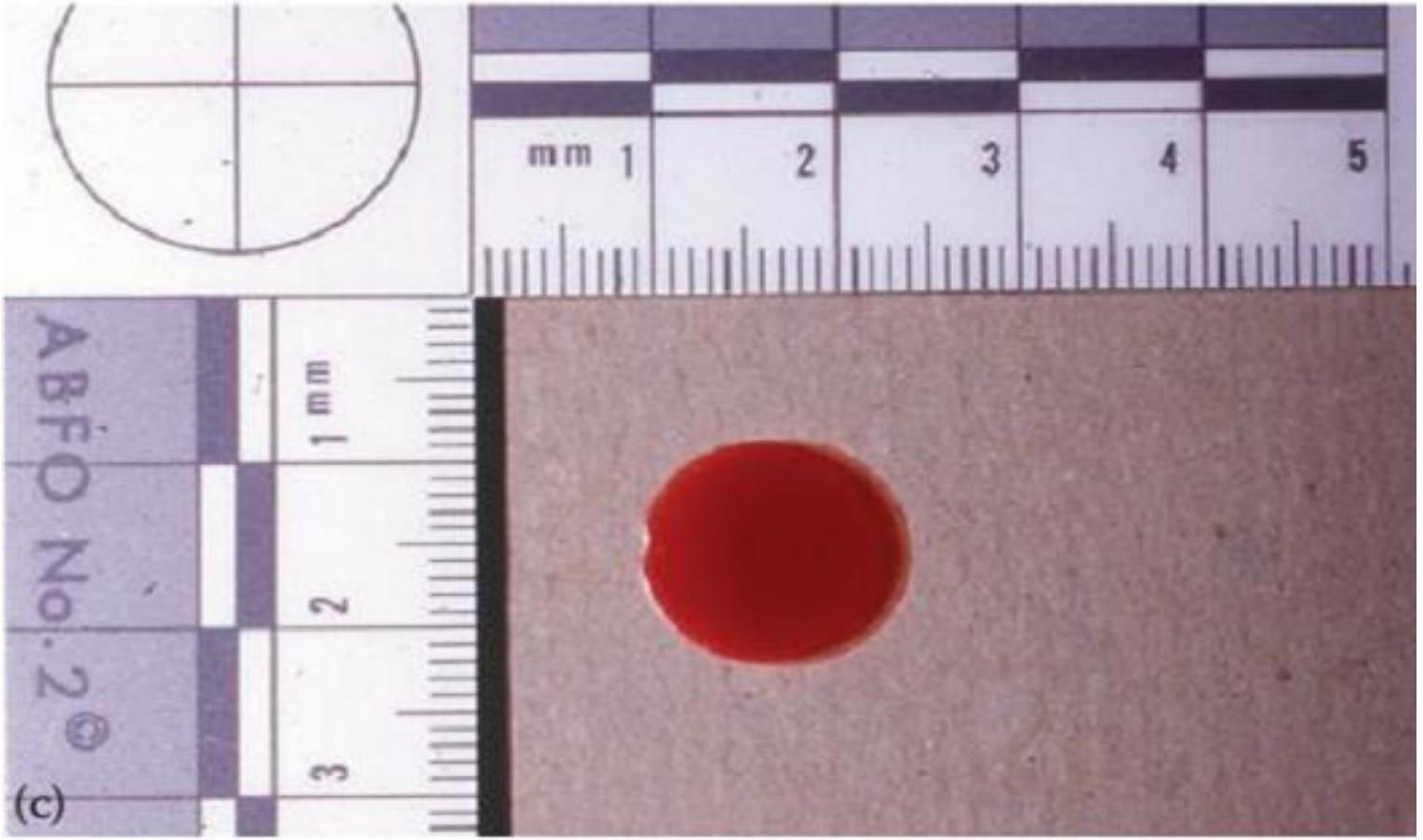
The respective morphologies of falling blood drops that land on surfaces with different textures at a 30° angle. (a) Tile, (b) cardboard, and (c) paper towel.

Chemical Enhancement and Documentation of Bloodstain Evidence

(a) Overall photograph

(b) Midrange photograph

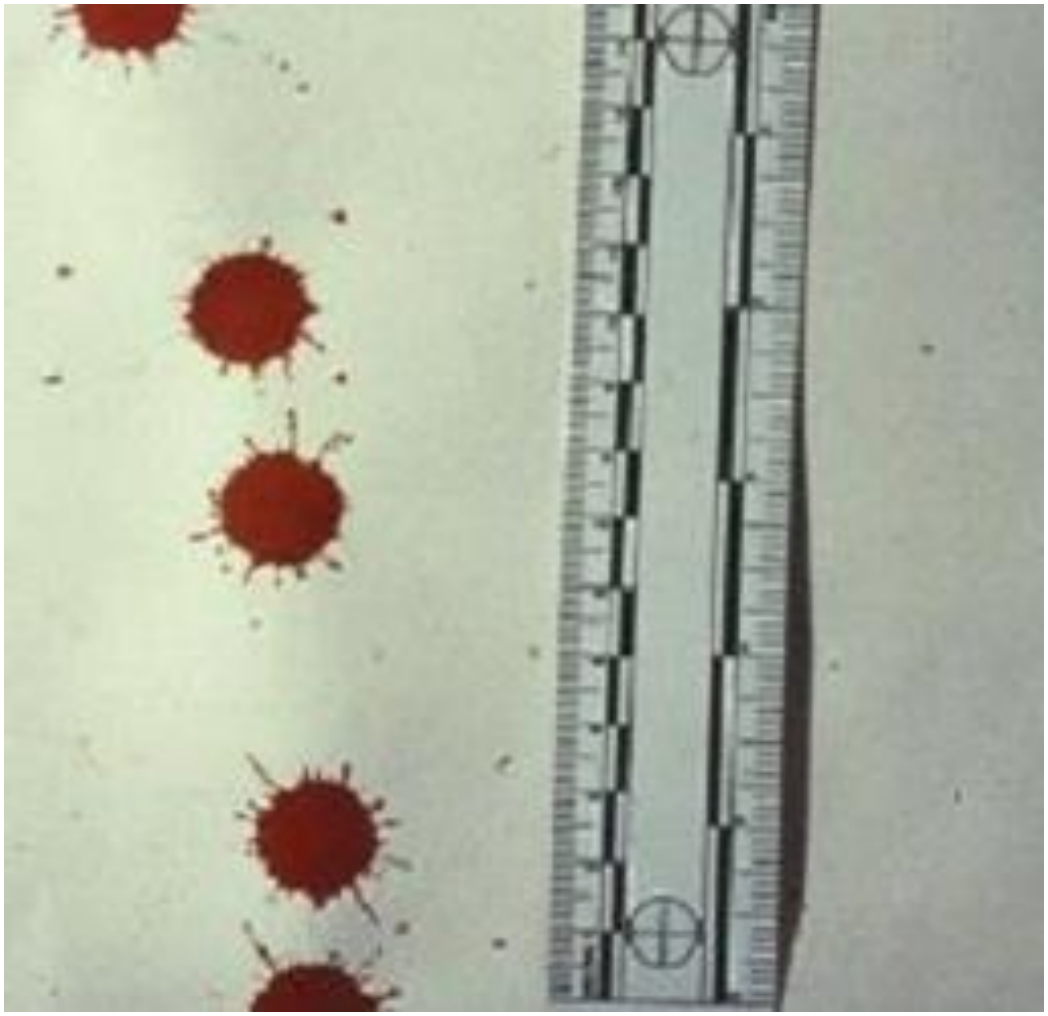
A commonly used chemical reagent is luminol, which can be used for locating bloodstains at the scene.



(c) close-up photographs.

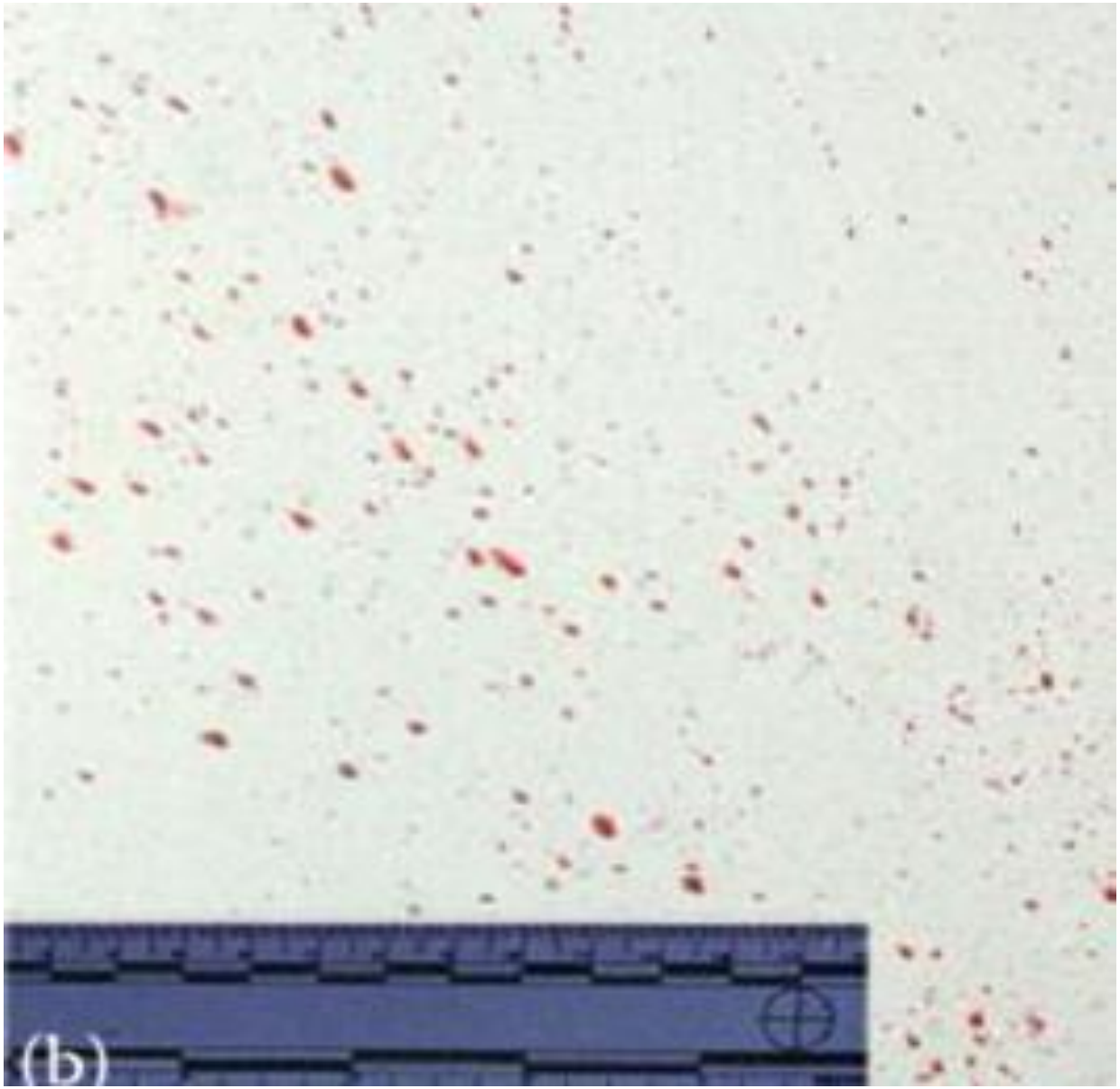
Analyzing Spatter Stains

A spatter stain, based on the recommended terminology of the Scientific Working Group on Bloodstain Pattern Analysis (SWGSTAIN), is "a bloodstain resulting from a blood drop dispersed through the air due to an external force applied to a source of liquid blood."



Velocity of Blood Droplets

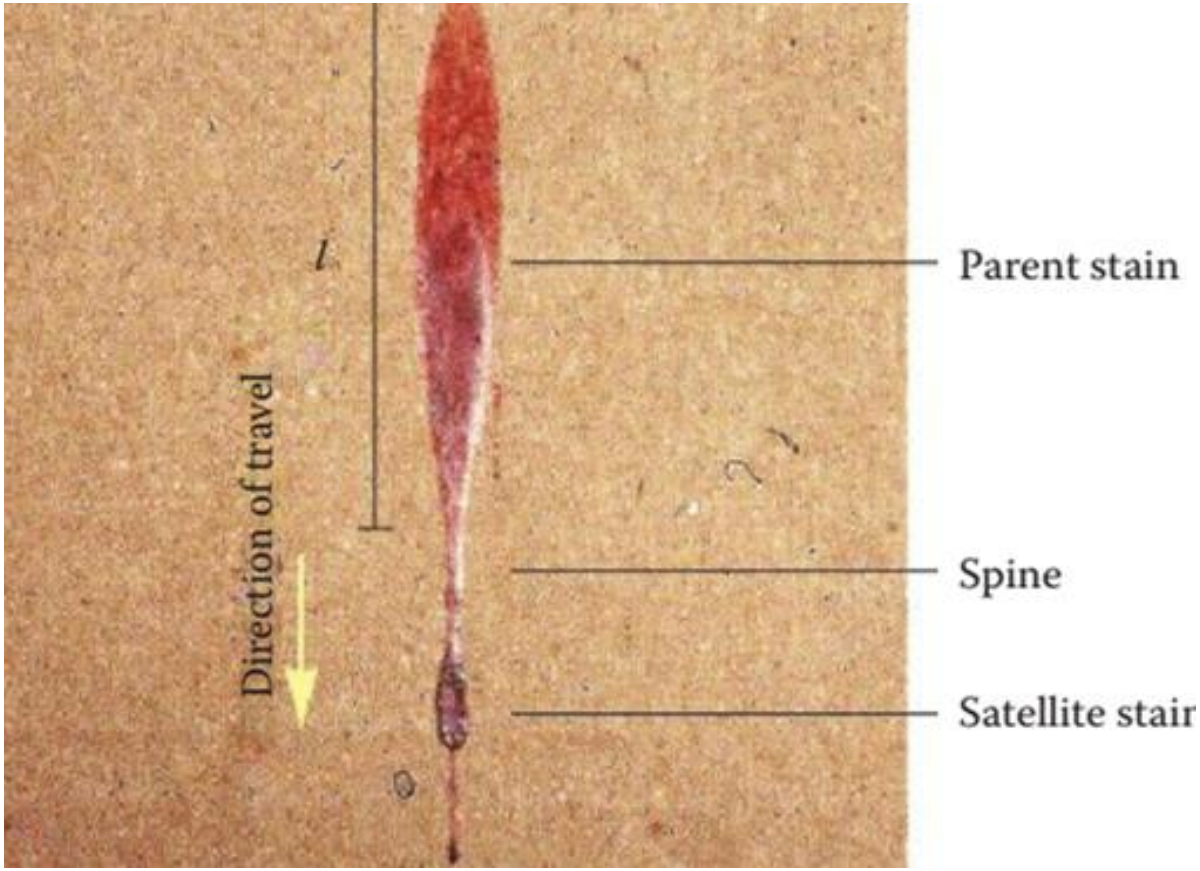
Low-velocity impact spatter is formed when a blood droplet is travelling at <1.5 m/s. The resulting stains are usually >4 mm in diameter



Medium-velocity impact spatter is formed when a blood source is subjected to a force associated with beatings or stabbings. The resulting stains range from 1 to 4 mm in diameter

Determining the Directionality of the Stains

- SWGSTAIN defines the directionality to be “the characteristic of a bloodstain that indicates the direction blood was moving at the time of deposition.”
- This analysis is applicable when the blood source is projected onto a surface at an angle of between 0° and 90°
- Under this condition, the resulting spatter stain is an elongated ellipse which is known as the **parent stain**.
- As defined by SWGSTAIN, a **satellite stain** is “a smaller bloodstain that originated during the formation of the parent stain as a result of blood impacting a surface.”
- More importantly, a **spine** is observed, which is the pointed edge away from the parent stain.

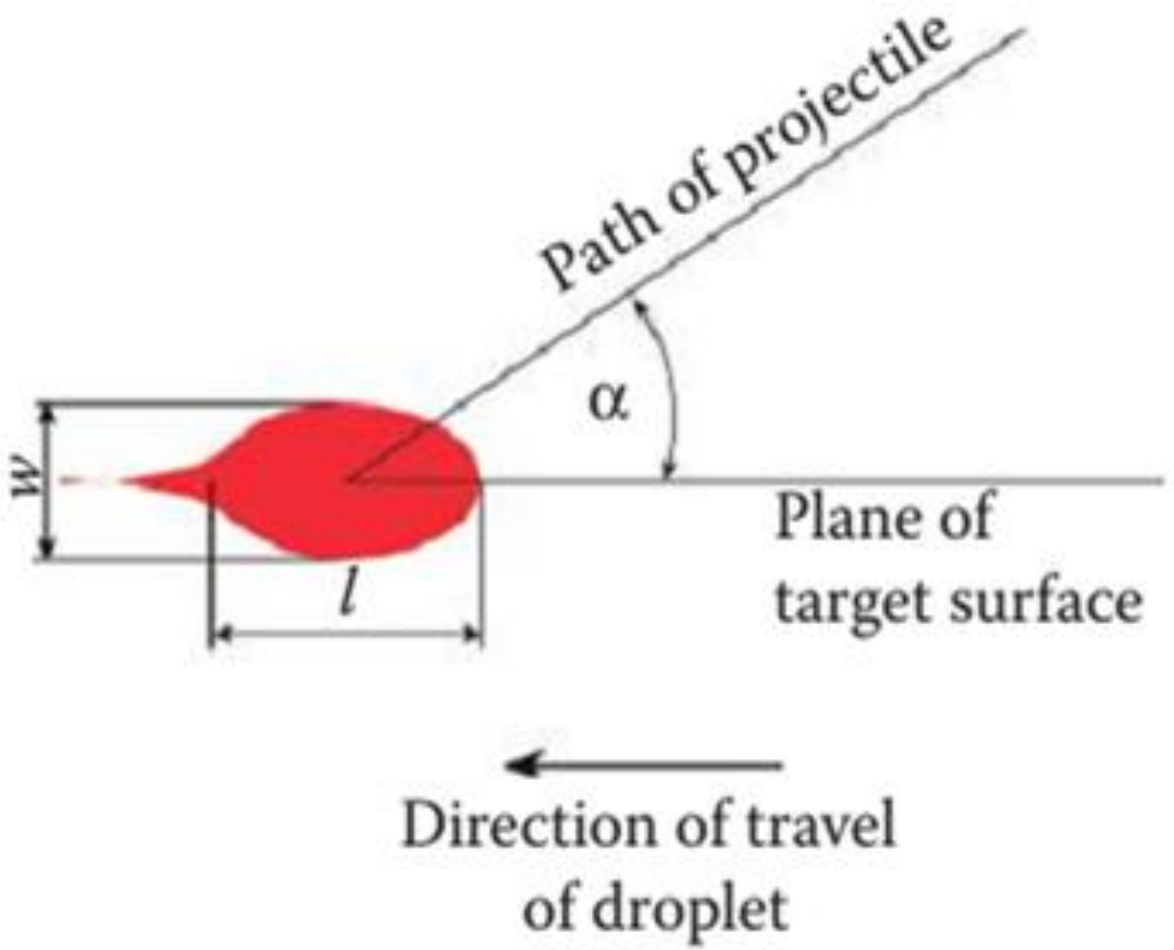


The morphology and directionality of a blood spatter stain. The arrow indicates the direction of travel.

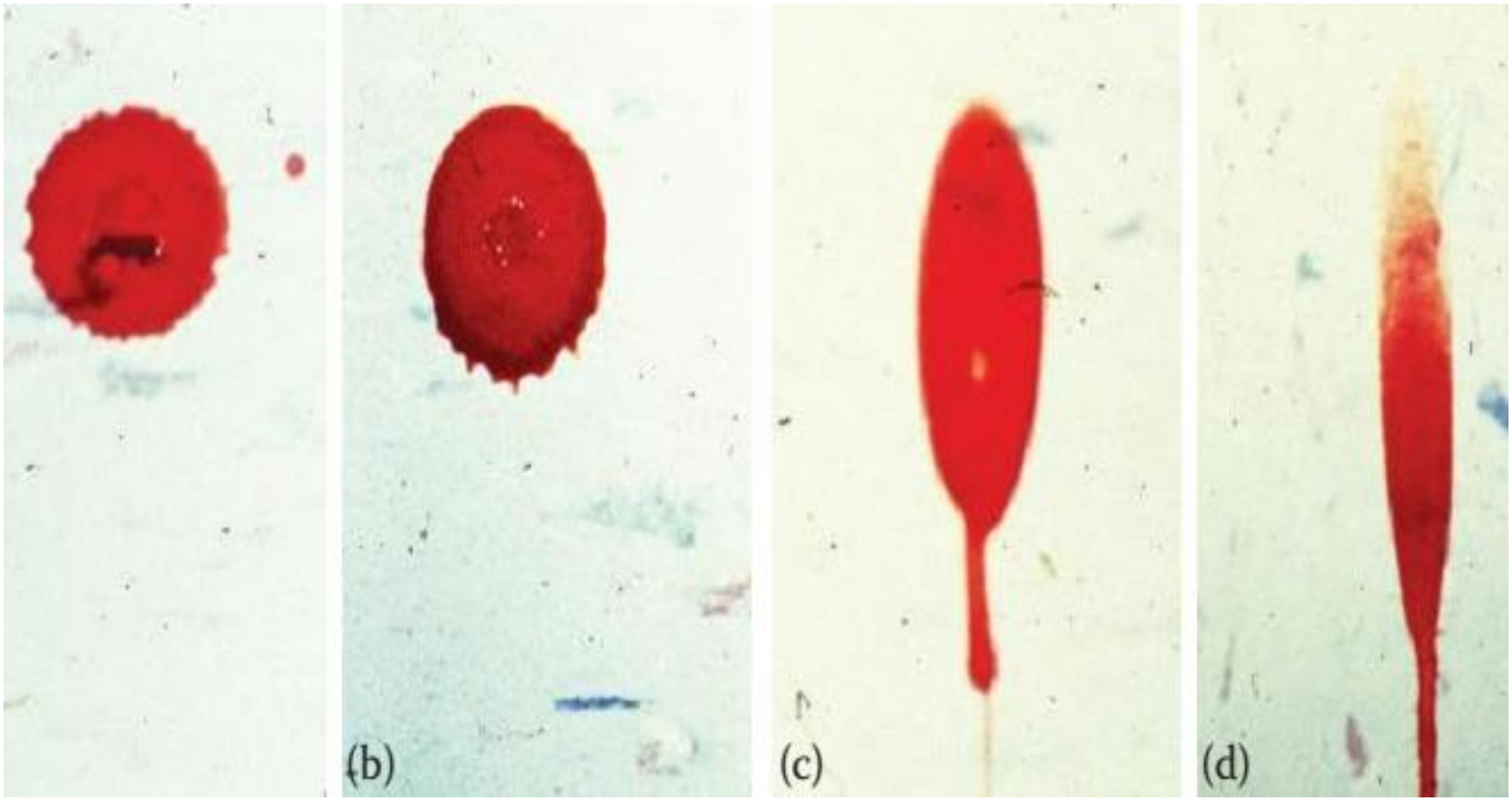
Determining Angles of Impact

- SWGSTAIN defines the angles of impact to be “the acute angle (alpha), relative to the plane of a target at which a blood drop strikes the target.”
- The shapes of the spatter stains are affected by the angle of impact.
- It is observed that the ratio of the width and the length of the parent stain is proportional to the sine of the impact angle, which is summarized in the following trigonometric equation:

$$\sin \alpha = w/l$$



Impact angle. The angle between the path of a projectile and the plane of the target surface is shown.



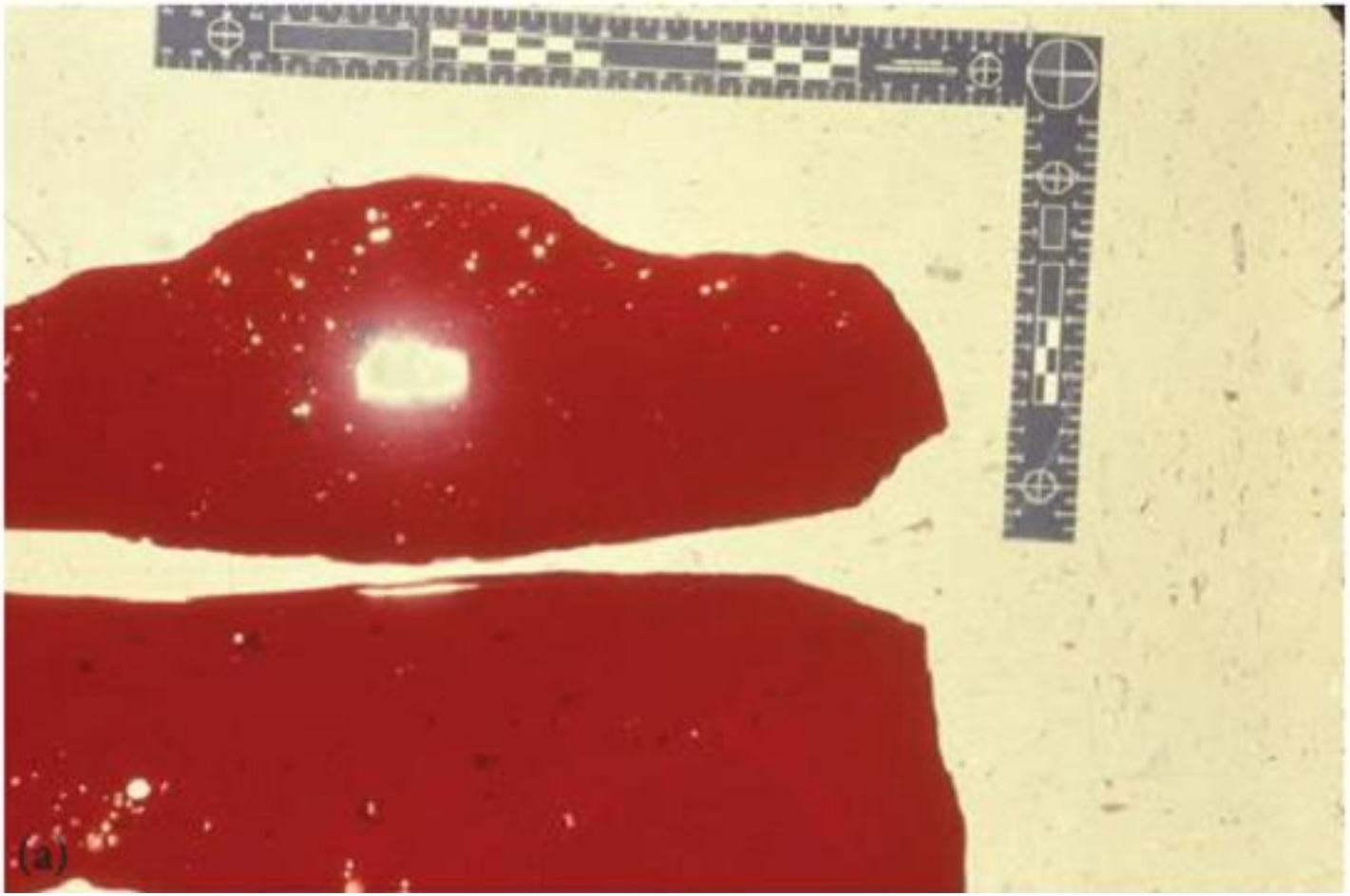
The effects of the impact angle on the shapes of blood spatter stains. Spatter stains are projected onto the surface of a ceramic tile at: (a) 90°, (b) 50°, (c) 20°, and (d) 10°.

Types of Bloodstain Patterns

- Passive Bloodstains: A passive bloodstain is formed due to bleeding from wounds, and the blood is deposited on a surface by the influence of the force of gravity alone.
- For example, a **drip stain** is formed when a falling drop of blood from an exposed wound or a blood-bearing object lands on a surface.
- A **drip pattern,** which is distinct from a drip stain, is formed when a liquid drips into another liquid, where one or both of the liquids are blood.
- A **splash pattern** is formed when a volume of blood spills onto a surface.

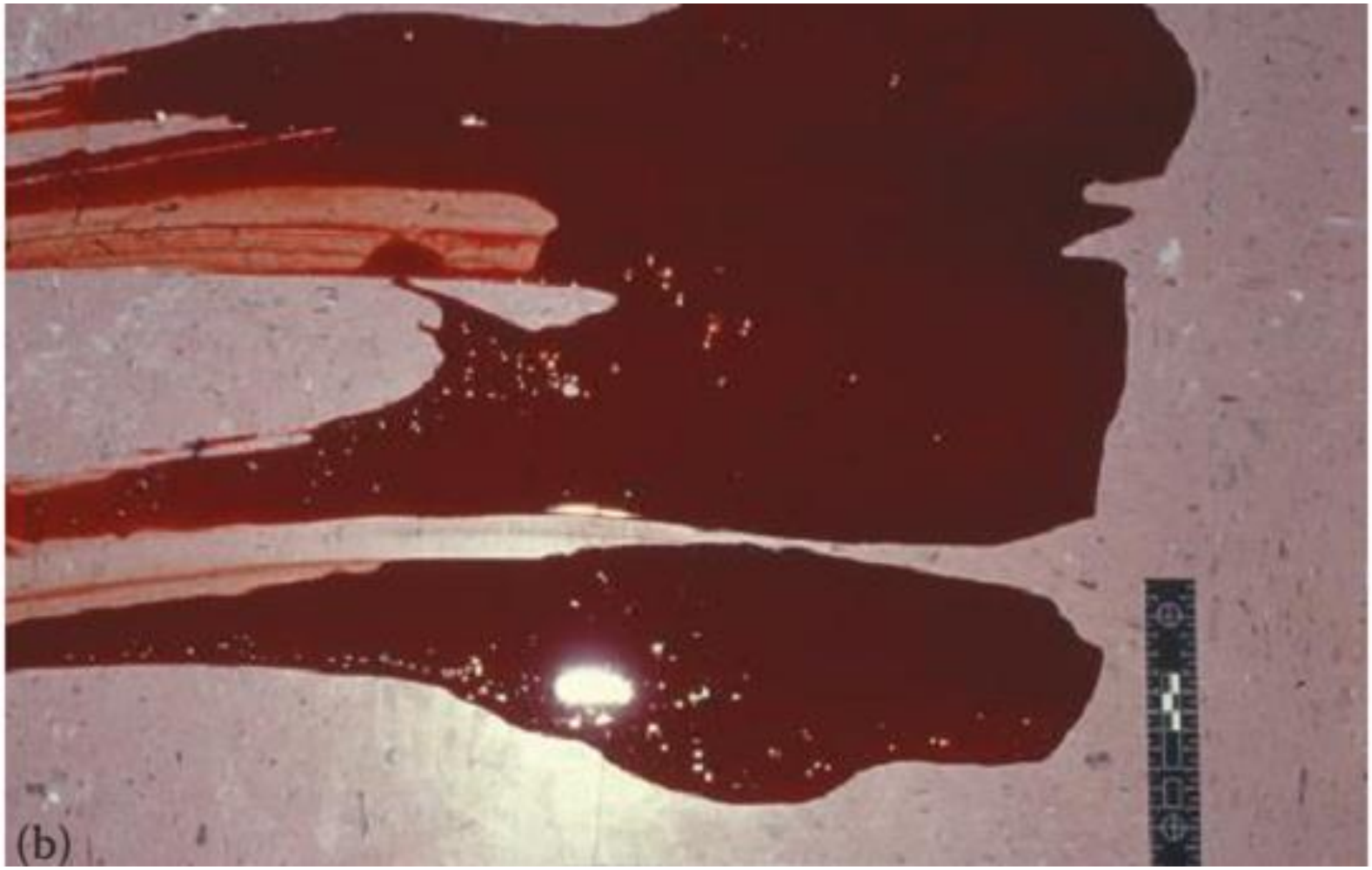
A drip pattern. The secondary spatter stains are shown

A splash pattern. Peripheral, elongated bloodstains are shown.



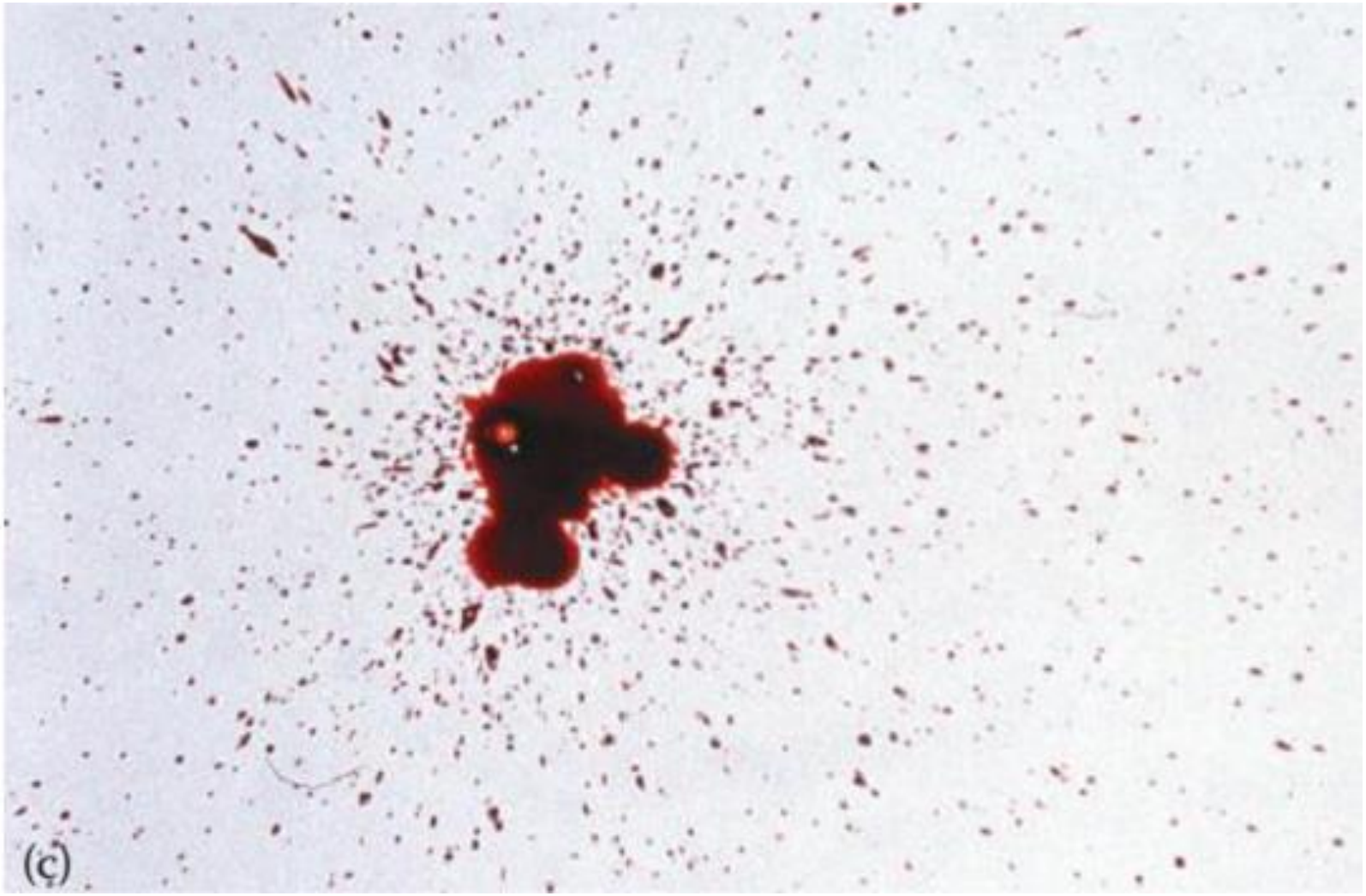
(a) A pool pattern

A pool is a bloodstain resulting from the accumulation of liquid blood on a surface



(b) A disturbed pool pattern

A flow pattern is caused by the movement of a large volume of blood on a surface either due to gravity or to the movement of the target such as a victim or postmortem disturbance.



(c) a splash pattern with a bubble ring

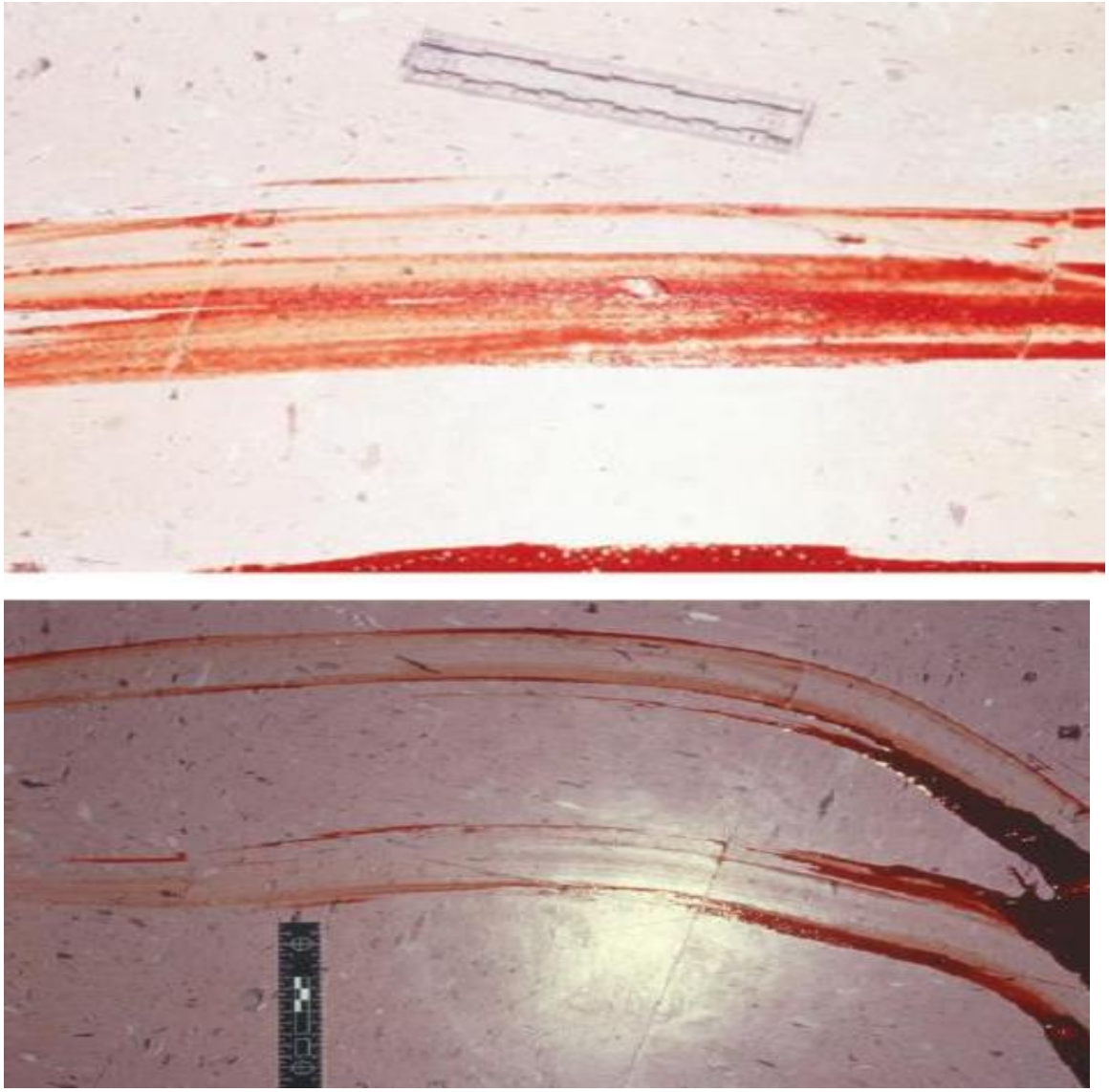
Sometimes, air bubbles in the blood may cause a bubble ring pattern

Transfer Bloodstains

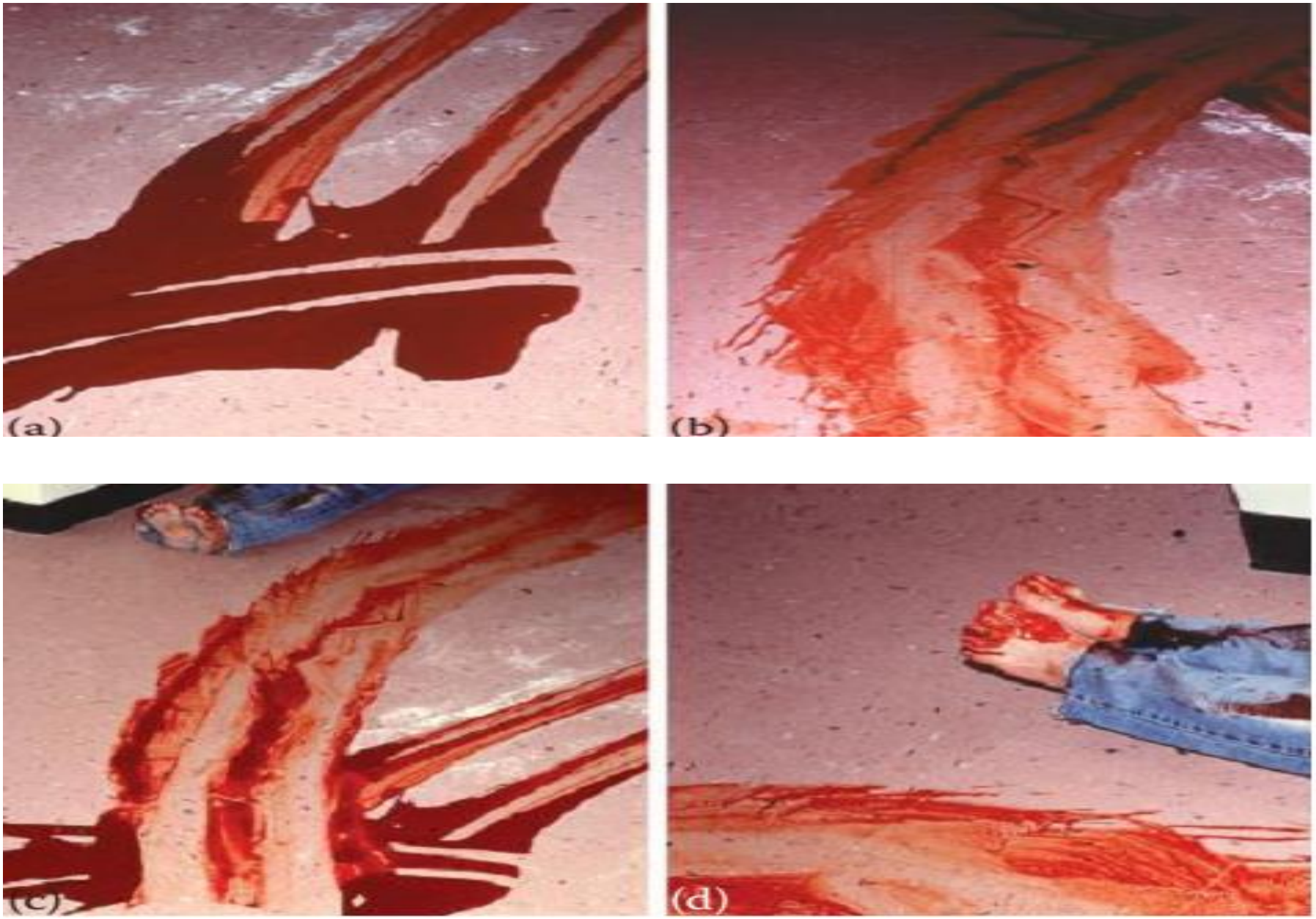
- A transfer bloodstain, based on SWGSTAIN, is “a bloodstain resulting from contact between a blood-bearing surface and another surface.”
- For example, a swipe pattern is “a bloodstain pattern resulting from the transfer of blood from a blood-bearing surface onto another surface, with characteristics that indicate relative motion between the two surfaces.”
- For example, bloody impressions can provide information about the shape, the size, and the pattern of the objects such as finger ridges, hands, and shoe soles.

Bloody impressions. Bloody handprints are present on (a) a wall and (b) fabric.

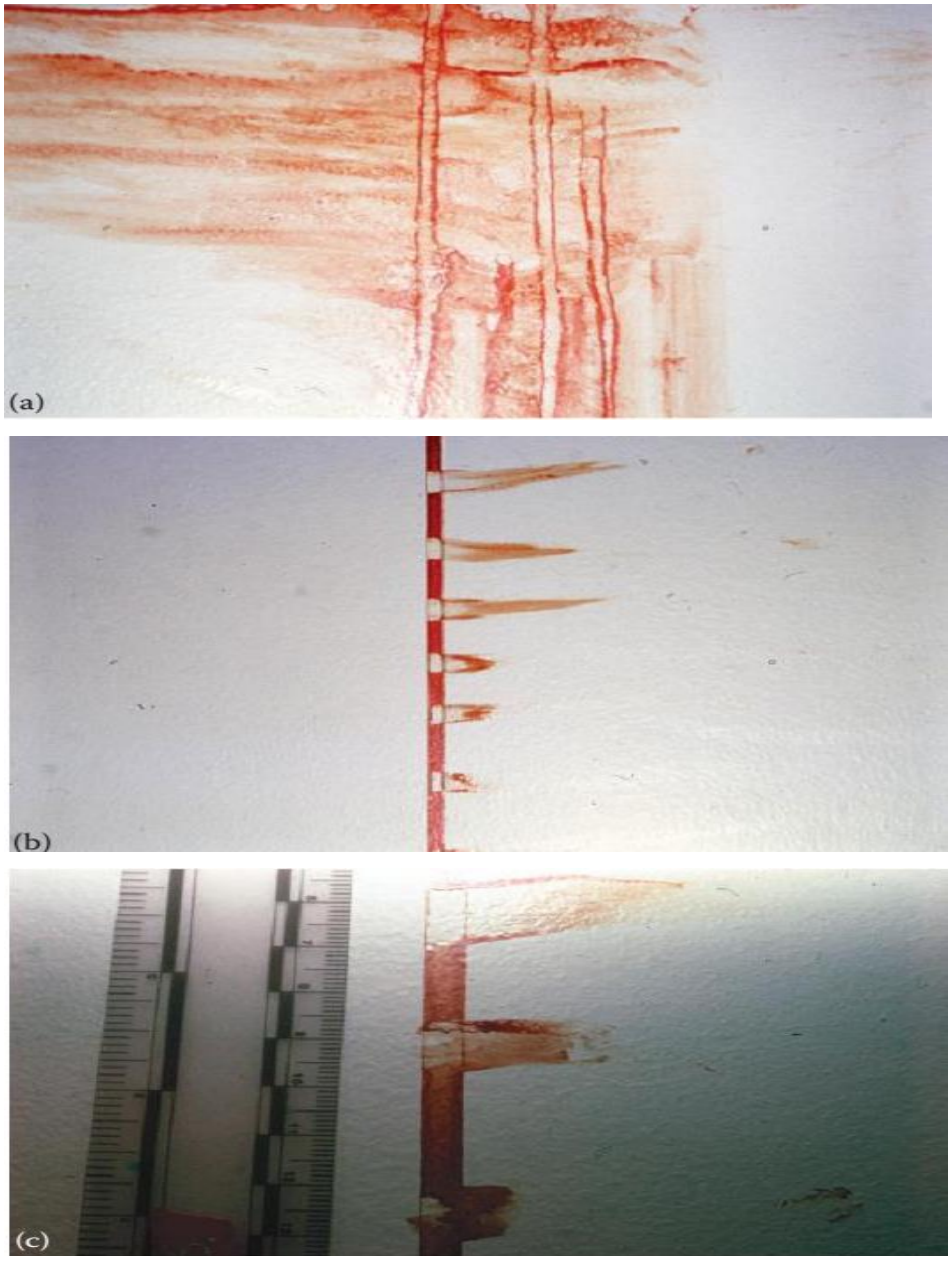
Bloody impressions. Bloody shoe prints on (a) paper and (b) fabric; and (c) bloody footprints on tile.



A wipe pattern is “an altered bloodstain pattern resulting from an object moving through a preexisting wet bloodstain.”



A wipe pattern caused by dragging a body through a pool of blood. (a) A pool of blood. Sections of the wipe pattern caused by dragging are shown in (b), (c), and (d).



A perimeter stain, a type of wipe pattern, is a bloodstain that is disturbed before it is dried but it maintains the peripheral characteristics of the original stain.

Projected Bloodstains

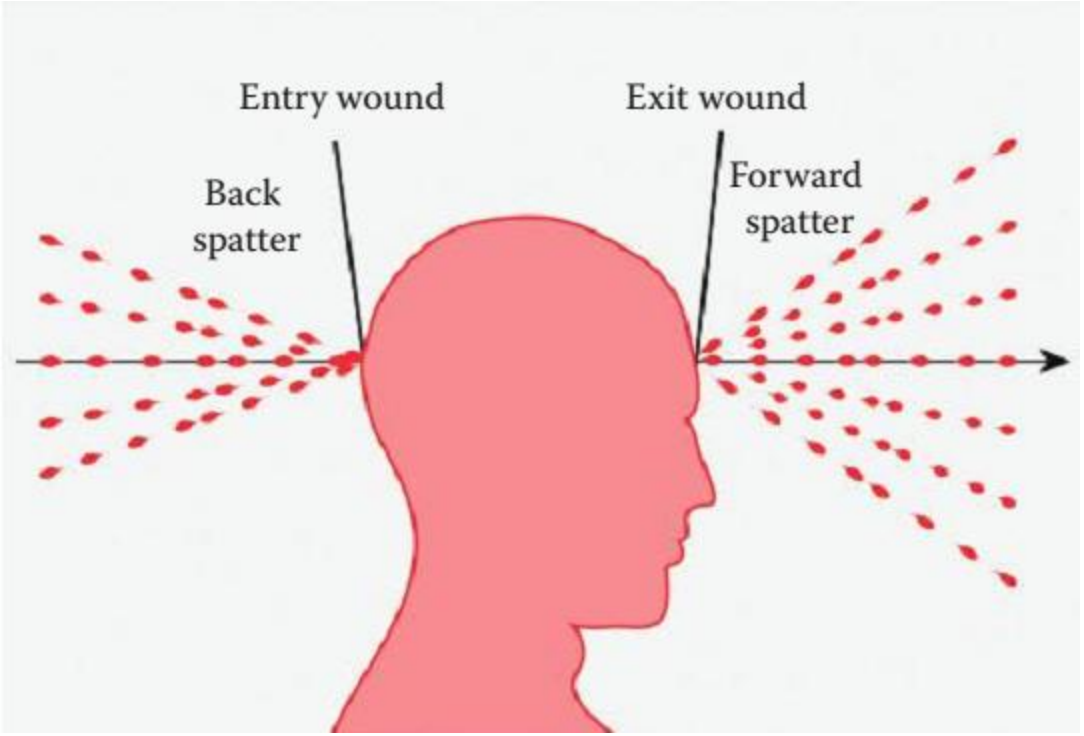
A projected bloodstain is formed when a volume of blood is deposited on a surface under a pressure or a force that is greater than the force of gravity.

For example, an impact pattern is formed when an object strikes liquid blood.

A **cast-off pattern** is formed when blood drops are released from a moving blood-bearing object.

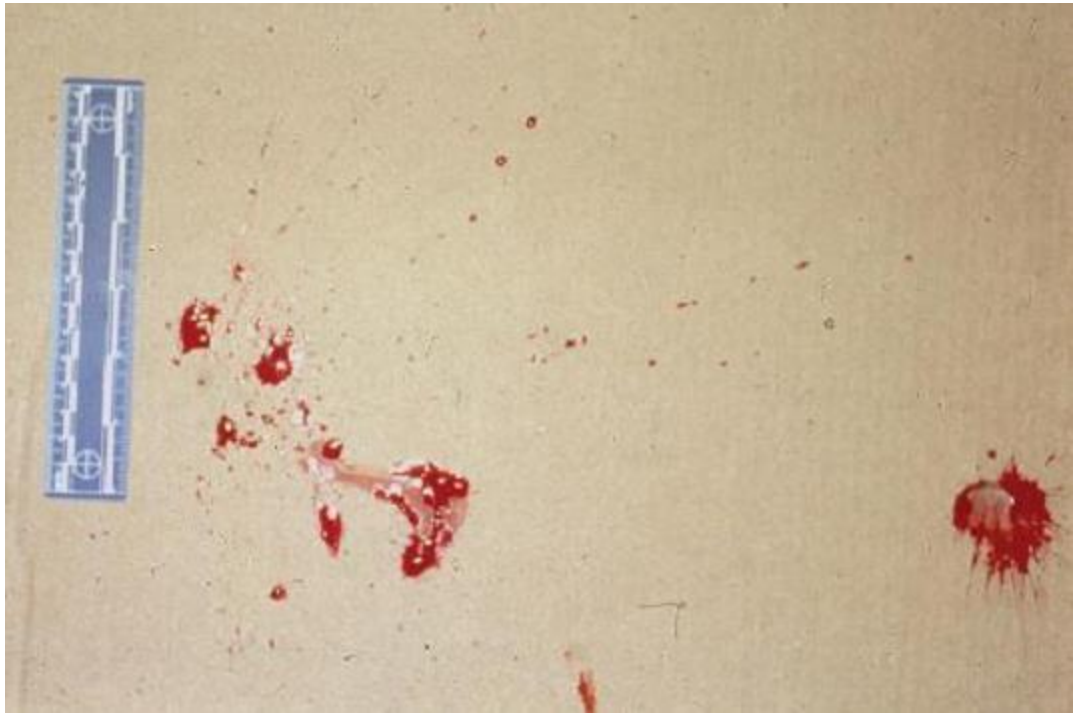
Cast-off patterns. Spatter stains are projected onto (a) a covered wall and (b) a lab coat.

Some spatter patterns are often associated with a wound penetrated by a projectile. A forward spatter is formed when blood drops travel from an exit wound in the same direction as a projectile, while a back spatter is formed when blood drops travel from an entry wound in the opposite direction of a projectile.



Forward and back spatter patterns. Arrow, the direction of a projectile.

An **expiration pattern** is formed when blood is forced by airflow through the trachea and out of the nose or mouth.



An expiration pattern.