Unit 5: Serology

**Objective 1:** Identify the components and chemical properties of blood.
- List the components of blood.
- Identify the antigens and antibodies that determine the ABO blood types and the Rh factor.
- Predict patterns of inheritance of blood types using a Punnett square.

**Objective 2:** Describe how to use blood and blood spatter to reconstruct a crime scene.
- Describe the different ways blood stains are identified at a crime scene.
- Describe how to collect a wet stain and a dry stain.
- Demonstrate how to collect a large object in reference to blood evidence collection (i.e. sheets, blankets, clothing, etc.)
- Explain a presumptive blood test.

**Objective 3:** Examine and analyze blood spatter.
- Illustrate size, shape, and directionality of blood spatter in a laboratory experiment.
- Compare and contrast low, medium, and high velocity blood spatter.
- Examine different types of blood spatter patterns (gunshot, cast off, arterial spray, expired, void patterns, contact/transfer patterns, flows, pools, drip-trail)

Keywords:
- Erythrocytes
- Leukocytes
- Thrombocytes
- Plasma
- Antigen
- Rh Factor
- Antibody
- Coagulate
- Agglutination
- Grid Method
- Perimeter Ruler Method
- Origin of Impact
- Impact Spatter
- Forward Spatter
- Back Spatter
- Velocity
- Tail
- Satellite Spatter
- Build-Up
- Angle of Impact
- Point of Convergence
- Passive Spatter Pattern
- Skeletonization
- Transfer Spatter Pattern
- Feathering
- Projected Spatter Pattern
- Peroxidase
- Luminol
- Bluestar
- Precipitin Test

**Serology Unit**

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<tr>
<th>Date</th>
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<td>11/26</td>
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<td>12/11</td>
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</table>
Objective: Students will be able to describe the components of blood and blood typing and use Punnett Squares to predict patterns of heredity of blood type.

Warm-Up:

1. When is your unit test?

2. What are two things that I want you to know at the end of this unit?

An Introduction to Blood

Components of Blood

Solid portion of the blood

1. ____________________________
   - Red blood cells (____)
   - Contain ____________________ that transports the Oxygen and Carbon Dioxide
   - Concave in structure
   - Approximately 30 trillion in the blood.

2. ____________________________
   - White blood cells (____)
   - Provide ____________ for the body and produce _____________________.
   - There are _____ types of white blood cells.
   - Approximately 430 billion in the blood.

3. ____________________________
   - Platelets (pieces of large cells)
   - Responsible for starting the ____________________ process by making ______________ to form a clot.

Liquid Portion of the Blood

1. ____________________________
   - ____________________ portion of the blood that carries the RBC, WBC, and platelets.
   - 55% of blood is in the plasma.
   - Made up of 90% ______________ and 10% __________________ (salt, ions, and proteins).

Blood Type

ABO blood Classification System

1. ____________________________
• _______________ found on the surface of every RBC.
• There are over 100 different antigens in the human blood.
• Two of the antigens, labeled as _____ and______, are the ones used on the RBC surface to determine blood type.
  a. If antigen A is present, a person is ____ blood type.
  b. If antigen B is present, a person is ____ blood type.
  c. If both antigens A and B are present, a person is ________ blood type.
  d. If neither antigens A and B are present, a person is ________ blood type.
  e. Fill in the following table.

<table>
<thead>
<tr>
<th>RBC Type</th>
<th>Group A</th>
<th>Group B</th>
<th>Group AB</th>
<th>Group O</th>
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<td>Antibodies Present</td>
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<tr>
<td>Antigens Present</td>
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2. ____________
• Manufactures by some of the WBC and found in the blood serum.
• Function is to attack any invader (______________) that enters the bloodstream that does ________________ in your system.
• A person has antibodies again antigens that are ________ found on the surface of their own RBC.

3. ________________ (Rhesus factor)
• Antigen found on the surface of a RBC.
• If a person has the Rh antigen they are Rh ________________(Rh+).
• If a person does not have the Rh antigen they are Rh ________________(Rh-).

Determination of Blood Type
• Your blood is tested by adding blood cells of a ________________ type.
• Remember, your blood has antibodies for the other antigens. These antibodies will cause the blood to ________________ if the type you added doesn’t ________________ the type of the blood you are testing.
• For example, if you add type _______ red blood cells to type _______ blood, it will agglutinate.
• So, if you add a known blood type to a sample and it doesn’t agglutinate-you know the blood types are the ________________.

Determine Genetic Probabilities Using Blood Types
• ________________: A parent passes on one of two genes for blood type to the offspring. One of two genes is also passed on for the Rh factor.
• In order to be recessive in type or Rh, ________________ genes must be recessive.
• Using a Punnet square can determine if a blood type is ________________ in an offspring.
• Genotypes:
  • ________________ -the genes are different (one dominant and one recessive)
• __________________________-the genes are the same (either both are dominant or both are recessive)

Example: If a child’s blood type is AB (IAIB), the mother’s type is AB (IAIB) and the father’s type is O (ii), could the “father” be the genetic father?

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Genetic Probabilities
Typical blood typing distribution in the United States.

<table>
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<th>Percentage</th>
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<td>Rh+</td>
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<td>Rh-</td>
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11/27/18

Objective: Students will be able to determine the blood type of an unknown sample using the blood typing technique and known samples of biological material.

Warm-Up:
1. Explain why we are only able to use blood typing to rule someone out-not to identify a suspect.
2. Describe how antibodies and antigens determine one’s A-B-O blood type.

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Objective: Students will be able to describe how we document and collect blood spatter from a crime scene and then characterize that spatter by velocity of impact.

Warm-Up: None
Objective: Students will be able to describe how we document and collect blood spatter from a crime scene and then characterize that spatter by velocity of impact.

Warm-Up: Predict the blood type of the offspring in the following matches using a Punnett Square.

1. The father is type A homozygous and the mother is type AB.
   Father’s genotype: 
   Mother’s genotype: 
   Possible offspring genotype(s): 

2. The father has type AB blood and the mother is type O.
   Father’s genotype: 
   Mother’s genotype: 
   Possible offspring genotype(s): 

Introduction to Blood Spatter

What is blood spatter?
• __________________________________________________________________________________: is the examination of the shapes, locations, and distribution patterns of bloodstains, in order to provide an __________________________________________________________________________________of the physical events which gave rise to their origin.

• Based on the premise that all bloodstains and bloodstain patterns are characteristic of the forces that have created them.

What do we use blood spatter for?
• The determinations made from bloodstain patterns at the scene or from the clothing of principals in a case can be used to:
  ◦ Confirm or refute assumptions concerning ________________ and their sequence: Position of victim. (standing, sitting, lying)
    Evidence of a struggle. (blood smears, blood trails) n
  ◦ Confirm or refute ________________ made by principals in the case: Are stain patterns on a suspect's clothing consistent with his reported actions? Are stain patterns on a victim or at a scene consistent with accounts given by witnesses or the suspect?
Documentation of Blood Spatter

At a crime scene, the blood spatter patterns are________________________and________________________before the blood is collected so that the suspects account can be proved or disproven. The photographs will allow for an________________________and________________________of what happened.

- ____________________________: shows the whole pattern and the relationships between individual stains within the pattern.
- ____________________________: show the dimensions of individual stains and should be taken with a scale apparent in the photograph.

Methods of Documenting Blood Stains

- ____________________________:
  - Strings and stakes are used to create squares of known dimensions over the entire pattern.
  - Photographs are then taken with and without the grid.
- ____________________________:
  - A rectangle border of rulers is made around the pattern to show the overall scale in medium range photographs
  - Small rulers are placed next to each stain to show the scale in the close-up photographs.

Factors that can help reconstruct the scene

- ____________________________:
  - Harder and Nonporous surfaces (glass, smooth tile) result in less spatter.
  - Rough surfaces (concrete floor, wood) result in irregularly shaped stains with serrated edges, possible satellite spatter.
- ____________________________
  - Helps determine where the blood was projected from-shows the position of the victim or suspect when the even took place
  - Can also determine how many times an object came into contact with the source of blood
  - ____________________________and________________________of blood splatter
  - Shape of the mark where it lands reveals the direction in which the drop was traveling and the amount of force it was projected with.
  - Established from the geometric shape of the bloodstain.
- Classifying the type of blood__________________________
  - Can help investigators to determine what type of__________________________was used, if the victim was__________________________, where the suspect went after the crime, if objects were moved during the crime, etc.
- ____________________________of blood splatter
  - The__________________________the drop the__________________________the movement of the blood.
- Classifying the type of blood stain
  The most common type of blood stain pattern found at a crime scene is_________spatter.
  This type of pattern occurs when an object comes into contact with a source of blood.
  - ____________________________: spatter projected outward and away from a source
Classifying Impact Splatter

- We classify the type of impact spatter by looking at the velocity with which a blood drop moves.
  - Impact spatter is the speed at which something travels with a direction.
  - **Impact splatter (LVIS)**
    - Caused by impact or force to a blood source.
      - Examples: gravity alone, minimal force, an object dropping into and splashing blood from a blood pool.
    - Velocity may be up to 5 feet per second or 1.5 meters per second.
    - Large separate or compounded drops with a diameter than 4 millimeters.
  - **Impact splatter (MVIS)**
    - Caused by impact or force to a blood source.
      - Examples: Blunt force trauma, beating or a stabbing.
    - Velocity is about 25 feet per second or 1.5-7.5 meters per second.
    - Drop size or stain of millimeters.
  - **Impact splatter (HVIS)**
    - Caused by impact or force to a blood source.
      - Examples: Gunshot, explosive devices, a cough or sneeze.
    - Velocity may be 100 feet per second or 30 meters per second.
    - Drop size is a like appearance forming drops millimeter.

Using droplet size is a useful tool that give investigators an insight into the general nature of a crime but it cannot give .

Blood stain analysis should include observations of stain size, shape, location, and distribution to accurately reconstruct what happened.

Objective: Students will be able to illustrate size, shape, and directionality of blood spatter in a laboratory experiment. Students will also be able to compare and contrast low, medium, and high velocity blood spatter.

Warm-Up:

1. Investigator Pricilla Wright arrives at a murder scene and finds the body of a victim who suffered a gunshot wound but sees no blood spatter on the wall or floor behind the victim. What should she conclude from this observation?

2. Describe the type of spatter pattern the officer in the previous question should be looking for. How is this different from low velocity blood spatter?
12/3/18

Objective: Students will be able to illustrate size, shape, and directionality of blood spatter in a laboratory experiment. Students will also be able to compare and contrast low, medium, and high velocity blood spatter.

Warm-Up:

1. Inner and Outer Circles Vocabulary Game

12/4/18

Objective: Students will be able to determine the direction blood spatter came from, the angle of impact, and the point of origin by using calculations.

Warm-Up:

1. Why is it important to sketch and photograph a scene before you start taking samples or making calculations?

2. In general, as both the force and velocity of impact increase, what happens to the diameter of the resulting blood drops?

Blood Spatter Calculations

Directionality of Blood Spatter

- You can figure out the direction that the blood was traveling by looking at the ____ of the drop.
- The distorted or disrupted edge of an elongated stain indicates the ____ the blood came from.
  - The pointed end of the bloodstain is called the _____. The tail will always point in the direction of travel.
  - ____ around parent stains will have the pointed end facing the direction of travel also.

Angle of Impact

Shape of Blood Drops at an Angle

- When a droplet of blood strikes a perpendicular surface (90-degree angle), the resulting bloodstain will be ____.
  - That being the length and width of the stain will be ____.
  - There will be no tail and no build-up of blood.
- Blood that strikes a surface at an angle less than 90 degrees will be ____ or have a tear drop shape.
• Blood that strikes a surface at more than 90 degrees will have more ________________ of blood.

Calculating Angle of Impact
• ____________________________ is the acute angle formed between the direction of the blood drop and the plane of the surface it strikes.
• We can use a trigonometric formula to determine the angle of impact.
• Formula:

• Example:
   Length = 22mm
   Width = 11mm

Point of Origin and Convergence

Point of Convergence
• The common point, on a 2-dimensional surface from which the drops ________________.
• The point of convergence can be found by drawing a straight ________________ through the long axis of several individual bloodstains, following the line of their tails.
• The __________________________ of these lines is the area of convergence.

Area of Origin
• The three-dimensional space from which the blood was projected.
• This will show the __________________________ of the victim or suspect in space when the stain-producing event took place.
• In general, impact stains that are __________________________ to the source of the blood will appear __________________________ and impact stains that are __________________________ from the source of blood will appear __________________________.

String Method to Determine Area of Origin
1. Find the __________________________ for the stain pattern.
2. Place a pole or stand as an __________________________ coming from the area of convergence.
3. Attach one end of a string next to each __________________________. Place a protractor next to each droplet and lift the string until it lines up with the determined angle of impact of the drop. Keeping the string in line with the angle, attach the other end of the string to the axis pole.
4. View the area of origin of the drops where the strings appear to ________________.
5. Secure the strings at this area.

12/5/18

Objective: Students will be able to determine the direction blood spatter came from, the angle of impact, and the point of origin by using calculations in a laboratory experiment.

Warm-Up: (2 Questions)
1. How can an investigator tell the direction of travel of blood from the shape of a bloodstain?
2. Define the terms area of convergence and area of origin. Explain what each reveals to an investigator.

Vocabulary Builder: Vocabulary Scramble

Use the definition to unscramble the vocabulary word.

<table>
<thead>
<tr>
<th>Vocabulary Word</th>
<th>Scrambled Word</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>otryohmtebcsl</td>
<td>Platelets that are responsible for producing fibrin to form a clot.</td>
<td></td>
</tr>
<tr>
<td>naibtody</td>
<td>Manufactured by the white blood cells to attack any antigen that does not belong.</td>
<td></td>
</tr>
<tr>
<td>ethugeorozys</td>
<td>The genes are different.</td>
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<tr>
<td>trytcyehrsoe</td>
<td>Red blood cells that contain hemoglobin and transports gases through the body.</td>
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<tr>
<td>irdgeomtdh</td>
<td>Strings and stakes are used to create squares of a known dimension over the entire spatter pattern.</td>
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<tr>
<td>oymhosoazgu</td>
<td>The genes are the same.</td>
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<tr>
<td>laapms</td>
<td>The fluid portion of the blood that carries the solid components and is made up of water and metabolites.</td>
<td></td>
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<tr>
<td>eetorhmrpel</td>
<td>A rectangle border of rulers is made around the pattern to show the overall scale with small rulers by each drop to show the scale of individual drops.</td>
<td></td>
</tr>
<tr>
<td>oalagcuet</td>
<td>Blood changing from a liquid to a semi-solid state.</td>
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<tr>
<td>uekcyloest</td>
<td>White blood cells that provide immunity and produce antibodies.</td>
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<tr>
<td>lgouinnaagtti</td>
<td>Red blood cells clumping together due to antibodies in the blood.</td>
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<tr>
<td>agninte</td>
<td>Identification proteins that are found on the surface of every red blood cell.</td>
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</table>

Objective: Students will be able to describe passive, transfer and projected patterns and be able to give examples and describe the examples for each.
Warm-Up: After looking at the bloodstains in the figure below, answer the following questions:

1. Which three drops struck the surface closest to a 90-degree angle? Explain your answer.

2. Which three drops struck the surface farthest from a 90-degree angle? Explain your answer.

3. In what direction were drops 2 and 7 traveling when they struck the surface? Explain your answer.

Blood Spatter Patterns

Blood spatter patterns are generally classified into three categories:

- Passive
- Transfer
- Projected

Passive

Passive bloodstains are drops created by or formed by the force of ________________ acting alone.

- ________________: patterns made by drops or large amounts of blood flowing by the pull of gravity.
  - Remember, the blood will flow towards the ground because of gravity so the ________________of the flow can tell us a lot about the position of the body or object
    - Ex: if the body or object was moved, sequence of events, time between the flow and if it was interrupted, etc.

- ________________: occur when blood collects in a level (not sloped) and undisturbed place.
  - Blood that pools on an ________________material (like a mattress or couch) will cause the pool to be much ________________than the original pool because of diffusion.
  - The approximate drying time of a pool can be determined through experimentation and can tell investigators an approximate ________________that has passes since the blood was deposited and when it was found.
• When the edges of a stain dry to the surface creating a ring.
  ▪ Usually occurs within ______ seconds and can be used to see if the activity occurred shortly after it was deposited or later. It is important to help classify the source of the original stain.

• A series of drops that are separate from other patterns, formed by blood dripping off an object or injury.
  o The stains form a kind of ________________or path, usually made by a suspect after injuring or killing a victim.
  o They can show:
    ▪ ________________of movement of the victim or suspect
    ▪ Lead to a discarded ________________
    ▪ ________________of a suspect through DNA
    ▪ ________________of movement
      ▪ Circular stains, close together indicate ________________movement
      ▪ Stains far apart indicate ________________movement

• A blood stain pattern that results from blood dripping into blood.

• ________________: made from a stationary position due to the force of gravity.
  o Can show height of the source of blood

Transfer
A transfer bloodstain is created when a wet, bloody surface comes in ________________with a secondary surface.

• ________________: when an object makes contact with the surface and the object is removed without any movement.
  o Tool impressions, fingerprints, handprints, footprints, footwear prints, fabric prints
  o Can also show direction of movement when the transfers are separate (like footprints) because the patterns will start out ________________and then get ________________as you move ________________from the source.
    ▪ This can also be an indication of speed of movement as well.

• ________________: when a bloody object moves across a surface.
  o The pattern will generally lighten and “______________” as the pattern moves away from the initial contact point showing the ________________of movement.
  o However, feathering is also a function of ________________so you have to be careful when analyzing swipe patterns.

Projected
Projected bloodstains are created when an exposed blood source is subjected to an ________________or force, ________________than the force of ________________. (internally or externally produced)

• ________________: high velocity impact so most of the spatter is very fine droplets. Usually causes both forward and back splatter.
  o ________________spatter is from the exit wound
splatter can tie a suspect or gun to the victim and will depend on the location of the injury, the size of the wound created, and the distance between the muzzle of the weapon and the victim.

Back spatter on a suspect or gun can indicate the time the spatter was created

A blood stain pattern created when blood is released or thrown from a moving, blood bearing object.

Usually occurs between different parts of an object and will include a motion creating an arc.

By counting the number of strikes you can indicate the number of strikes. You can determine the size of weapon used by the width of the cast-off pattern because the size of the pattern is directly related to the size of the object that they were propelled from.

Direction of the strike: the pattern will point in the direction of the backward thrust, which is the direction of the blow. Could suggest which the blow was delivered with.

occurs when the victim suffers an injury to a main artery or the heart and the continuing pumping blood causes the blood to spurt out of the injured area.

Usually shows large spurted stains for each time the strike will leave the darkest pattern, and they will get smaller and lighter as the blood is drained. Vertical arcs or waves in the line show a blood pressure. Can include radial spikes, satellite spatter, or flow patterns because of the large amount of blood. Tends to be a red color.

a pattern created by blood that is expelled from the mouth or nose from an internal injury.

If the blood is under pressure, it will create high velocity spatter. If the blood in under pressure, it will create a cluster with irregular edges. Often includes the presence of and can be lighter in color due to dilution from .

an object blocks the deposition of blood spatter on a surface or object.

The spatter is deposited onto the or instead.
- It can give a clue about the size and shape of a ____________________ object or person.
- Can help to show the body ____________________ of the victim or assailant at the time of the incident.

12/7/18

Objective: Students will be able to describe the techniques forensic scientists use to determine if a stain is biological material, and the source of the biological material.

Warm-Up:

1. Describe the differences between drip trails made from a person who was running versus a person who was walking.

2. What is the difference between forward spatter and back spatter? What is more likely to be deposited on the object or person creating the impact?

Vocabulary Builder
Define the following vocabulary words (8 Words). Then, write a sentence using the word but instead of writing the word, draw a picture in its place.

| EXAMPLE |
| Word: Noble Gases |
| Definition: The elements in group 8A or 18 including Helium, Neon, Argon, Krypton, Xenon, and Radon. |
| Sentence: The ____________________ are called noble because they contain 8 valence electrons and do not react with other elements. |

| Word: Origin of Impact |
| Definition: |
| Sentence: |

| Word: Impact Spatter |
| Definition: |
| Sentence: |
Objective: Students will be able to demonstrate their knowledge of blood and blood spatter patterns on a unit review.

Warm-Up:

1. Go back to the front page of this packet and read through the essential outcomes. Put a question mark next to the topics that you still have questions about. Put a check mark next to the topics that you feel confident about.
2. How are you going to go about learning those topics that have a question mark next to them?
Vocabulary Builder: Vocab Bingo

Fill the following boxes with the vocabulary List on the front page of this packet.

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12/11/18

Objective: Students will be able to demonstrate their knowledge of blood and blood spatter patterns on a unit test.

Warm-Up:

1. Turn in your work.