Hutchison High School

Advanced Forensic

1st Period

Mrs. Beaty-Rogers

Week 2-5 Remote Learning Packet

April 6- May 3

Items included:

- **DNA Fingerprinting Lecture Slides
- **DNA Case Study Project
- DNA Science Doodles (Optional)
- **DNA Profiling Lecture Slides
- **Gel Electrophoresis Virtual Lab
- *DNA Fingerprinting in Forensic Activity Packet
- **20/20: Unfriended Video Link: https://www.youtube.com/watch?v=k99gSEyAj4o
- **DNA Profiling Quiz
- **Ballistics Lecture Slides

Agenda

(Suggested)

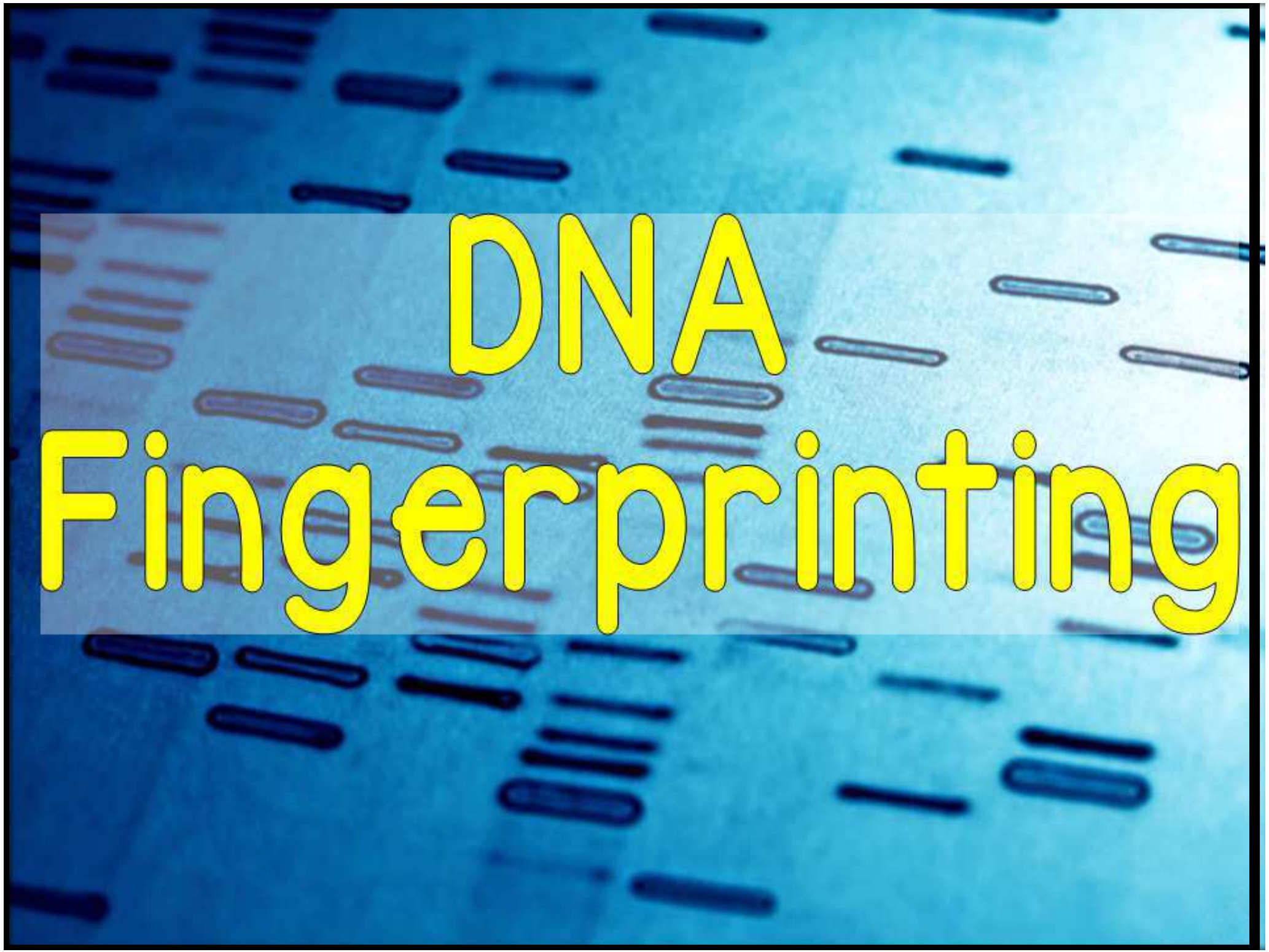
1. Monday
    a. Virtual Office Zoom Meeting
        i. This meeting is not mandatory. I will be available in the zoom meeting for anyone that may have questions.
        ii. Access to Zoom
            1. Dial: 699-900-6833
            2. Meeting ID: 941 983 261
            3. Password: 001438
    b. Get familiar with this week's assignments and develop a plan to ensure that you are organized and can complete them.
        i. Create a plan
        ii. Gather any needed supplies
        iii. Enjoy the rest of your day.
2. Tuesday
    a. Start going through the lecture and taking notes.
    b. Jot down any lingering question you may need to direct my way.
    c. Start the labs.
3. Wednesday-Friday
    a. Continue with lessons.
    b. Submit anything that may need to be submitted on Monday when you collect your new packet.

Video Links:

https://www.youtube.com/watch?v=Ezk-b9IBDD0&feature=emb_logo

https://www.youtube.com/watch?v=pzvzedIIIvc&feature=emb_logo

https://www.youtube.com/watch?v=yeAwJwuUQH8&feature=emb_logo
https://www.youtube.com/watch?v=cQJpRLthtZc&feature=emb_logo


DNA
Fingerprinting

What you will learn…

- Essential Question:
  - How can DNA (collected from a crime scene) be helpful in solving a crime?
  - How is DNA extracted from evidence/suspect samples?
  - How is DNA linked back to a particular suspect?
- Standard:
  - SFS3 f & g

DNA in Forensics

Video Link:
https://www.youtube.com/watch?v=_POdWsii7AI

DNA in Forensics

- Except for identical twins, no two people have the same DNA
- Advances in DNA technology have allowed criminal cases to be solved (re-examined)
- DNA is considered individual evidence because it can be linked to a specific person.

DNA in Forensics

- DNA can be collected from the following:

✓ Skin

✓ Blood

✓ Saliva

✓ Urine

✓ Semen

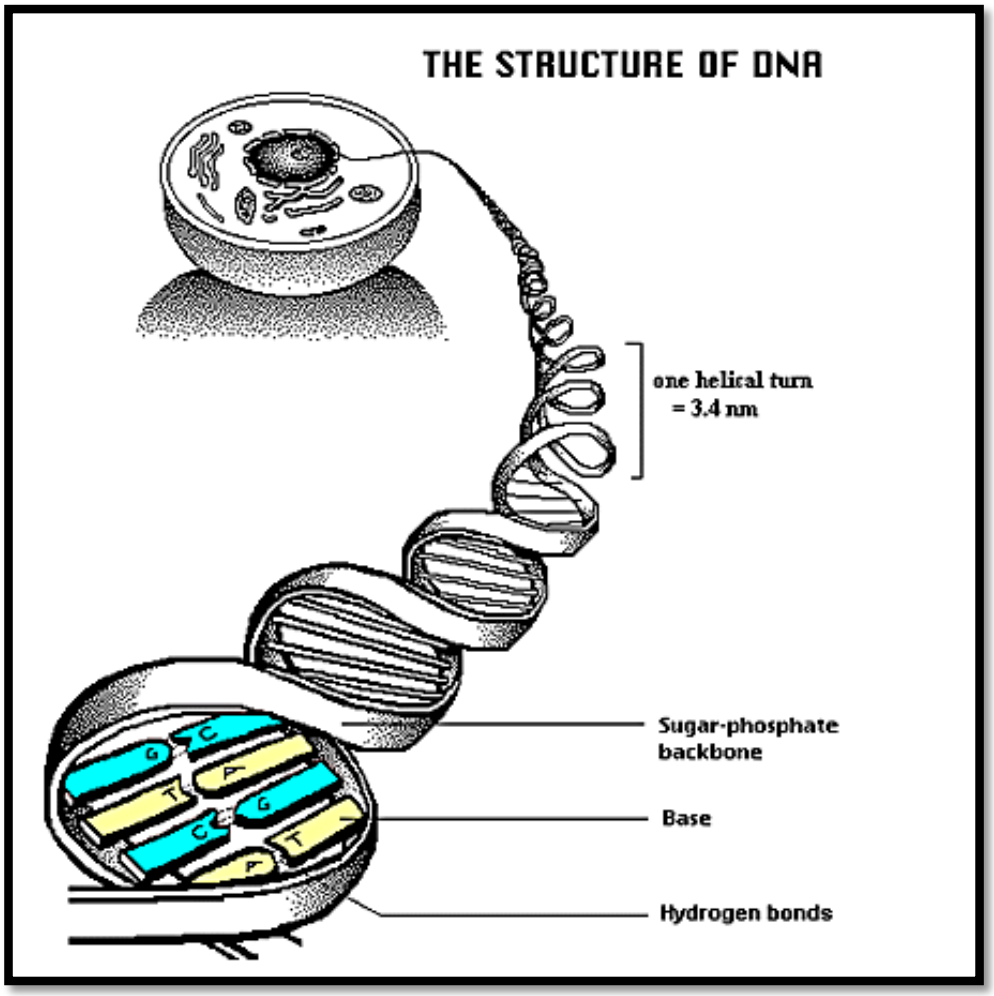
✓ Hair

DNA in Forensics

- DNA fingerprinting, aka DNA profiling is used in criminal and legal cases to determine identity or parentage.

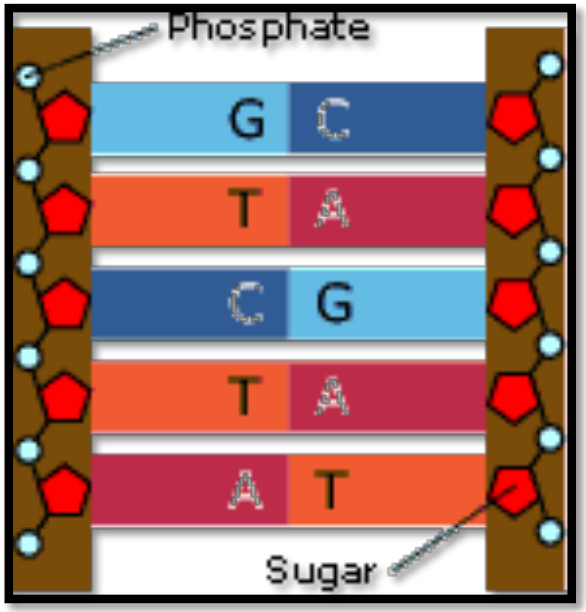
DNA in Forensics

- Deoxyribonucleic acid
- Located in the nucleus of the cell
- Carries an organism's genetic information



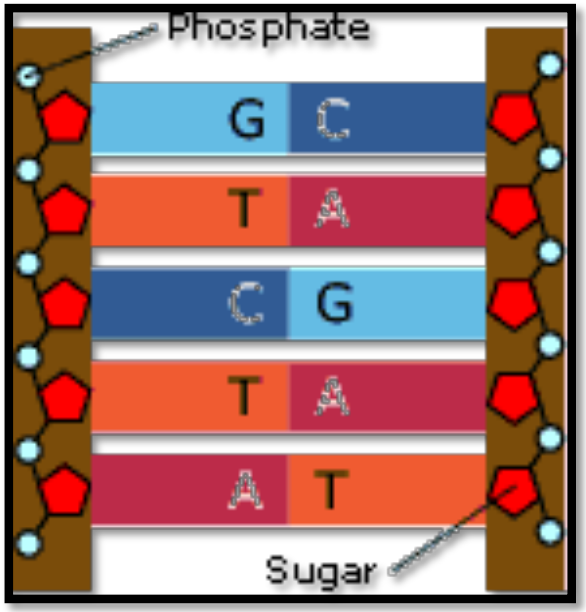
DNA in Forensics

- DNA is a polymer that consists of many monomers called nucleotides.
- Each nucleotide has 3 parts:
  - A phosphate group
  - A sugar called deoxyribose
  - A nitrogen-containing base



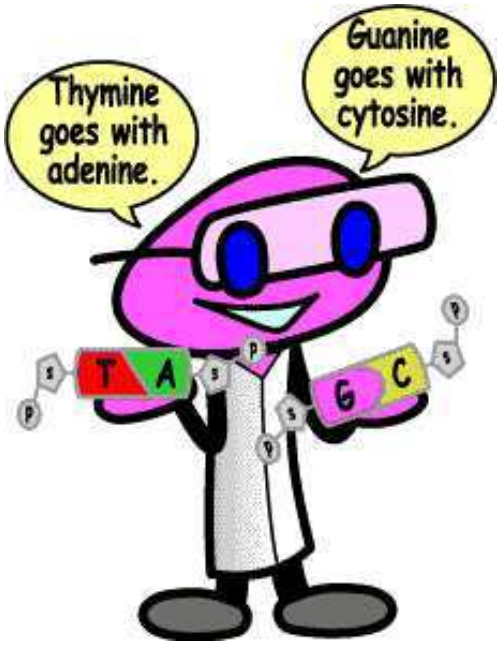
DNA in Forensics

- One molecule of human DNA contains billions of nucleotides, but there are only 4 types in DNA
  - Thymine (T)
  - Cytosine (C)
  - Adenine (A)
  - Guanine (G)



DNA in Forensics

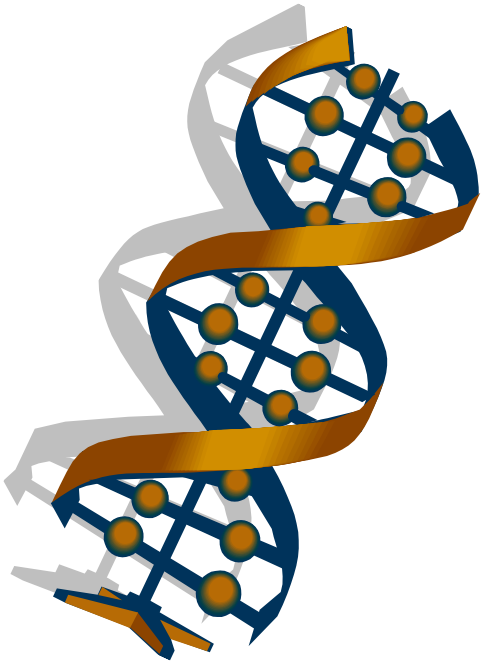
- The same four bases are found in the DNA of all organisms, but the proportions are different
- In the DNA of each organism, the amount of adenine equals the amount of thymine and the amount of cytosine equals the amount of guanine.
- A=T and C=G



DNA in Forensics

How will the following *nucleotides pair?*

- ATCGGCTACGT
- TAAGCCGATAT
- GCATGCATTAC



DNA in Forensics

- If DNA is found at a crime scene, it belongs to someone and a match can be found by removing the DNA from the crime scene and matching it to a suspect or victim
- DNA is a fairly new technology
- DNA is considered the most useful form of evidence in obtaining convictions

DNA in Forensics

- When DNA is found, it is compared to DNA entered in the national database- this database is known as CODIS
- If the DNA is not registered in the CODIS database, a suspect sample is needed for comparison
- Suspect DNA is collected
  - Hair
  - Blood
  - Saliva (buccal swab)

How to Collect a Buccal Swab Video: https://youtu.be/azpmJ4cXilM

DNA CASE STUDY *project*

Introduction:

DNA, as evidence, has been an influential part of many real life cases. Most forensic investigators agree that DNA is the most helpful evidence in solving crimes. Many older cases have been re-evaluated via The Innocence Project and convictions have been overturned due to the advancements of DNA technology. Many of these cases are extremely interesting. In this project, you will research a case of interest and showcase your findings via a Google Slide presentation.

Learning Target:

Through research, you will be able to recognize the importance of DNA evidence in solving crimes and exonerating innocent persons.

Task:

Research and find an actual case where DNA profiling was instrumental in sovling the case (or exonerating the wrongfully accused) and create a Google Slide presentation that showcases your findings.

Due Date: Your project is due on _____.

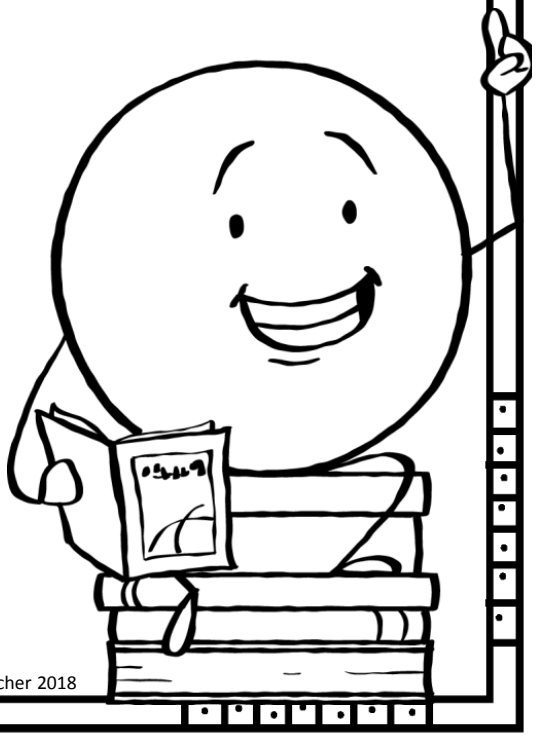
Project Guidelines:

- ❑ Your project must be posted to Google Classroom by the due date (-20 for each day that it is late)
- ❑ Your case MUST involve DNA as evidence in the case
- ❑ Be sure to refer to the rubric as you work to ensure that you have all the required components
- ❑ You MUST have at least 9 slides; however, you may have more slides

Slide Quick Reference:

*Use the following checklist as you create your slideshow

- ❑ Slide 1: Title Slide
- ❑ Slide 2: Question Slides (see next page)
- ❑ Slide 3: The Science Behind DNA
- ❑ Slide 4: Summary of Case
- ❑ Slide 5: Main Suspects
- ❑ Slide 6: Evidence From Case
- ❑ Slide 7: DNA's Influence
- ❑ Slide 8: Case Outcome
- ❑ Slide 9: Reference Slide



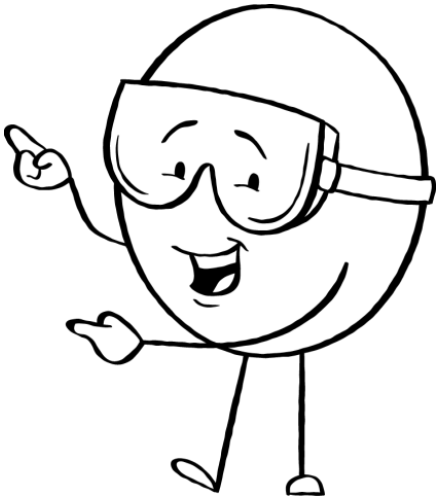
DNA CASE STUDY *project*

Slide 1: Title Slide

Your title slide must include your name, the date, the name of your case and a picture

Slide 2: Questions to Answer:

Directions: After your title slide, you will include evidence of your research by answering the following questions. In order to receive FULL credit for this portion of the project, you must type each question and answer each question. Be sure to highlight your answers (or change the color of the font so that it stands out from the questions.)



1. When was this crime committed?
2. Where was the crime committed?
3. Who (or what agency) investigated the case?
4. Where did the trial take place?
5. Who was/were the main suspect/suspects in this criminal investigation?
6. What evidence was presented in this case that proved vital in solving/not solving the case?
7. How was DNA profiling used in this case?
8. Did the DNA help to solve the case? Explain.
9. What was the outcome of your case?
10. What do you think the outcome would have been without the DNA evidence?

Slide 3: The Science Behind DNA

To receive credit for this portion of the project, you must include a brief summary of DNA. What is it? How does it relate to the cell? What function does it serve in the human body? How does it relate to Forensics?

Slide 4: Summary of Case

Include a summary of your case on this slide. Please put in bullet format

- XXXXX
- XXXXX
- XXXXX

Slide 5: Main Suspects

List any main suspects on this slide. Be sure to include pictures.

Slide 6: Evidence From Case

Using bullets, list all evidence that was used in your case. Pictures and video clips embedded in this slide will give you creativity points.

Slide 7: DNA's Influence

How did DNA impact your case? Write a short 2-3 sentence explanation. Add a graphic or image.

Slide 8: Case Outcome

In this slide, explain what happened in your case. You can choose to place a short video clip on this slide (or embed the hyperlink to a video clip)

Slide 9: Reference Slide

It is vital that you give credit to your sources. As you conduct research, copy and past the url into this slide.

DNA CASE STUDY RUBRIC

Name:_____

Case Name:

Content Assessed	No Evidence (0 Points)	Little Evidence (5 Points)	Complete Evidence (10 Points)
Slide 1: Title			
Slide 2: Research Questions & Answers			
Slide 3: The Science Behind DNA			
Slide 4: Summary of Case			
Slide 5: Main Suspects			
Slide 6: Evidence from Case			
Slide 7: DNA's Influence			
Slide 8: Case Outcome			
Slide 9: Reference Slide			
Aesthetics: Grammar, Creativity, Color, Graphics/Pictures/Images/Video			
Total Points for Each Category			
FINAL GRADE & Comments			

DNA FINGERPRINTING IN FORENSICS

DNA FACTS

- ☐
- ☐
- ☐

How is DNA fingerprinting used?

_____

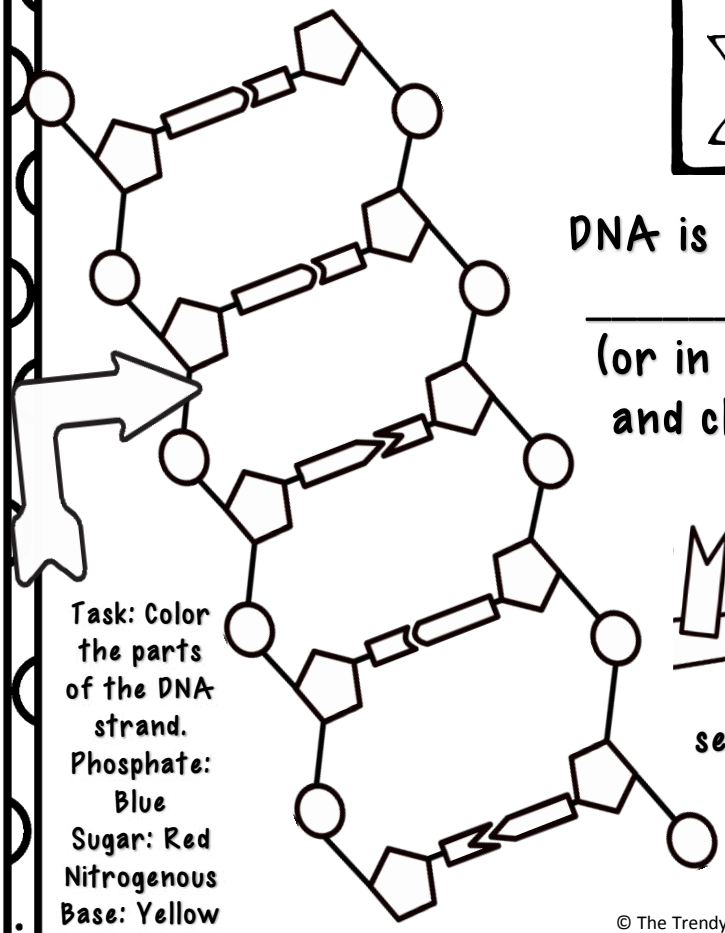
DNA

AKA: _____

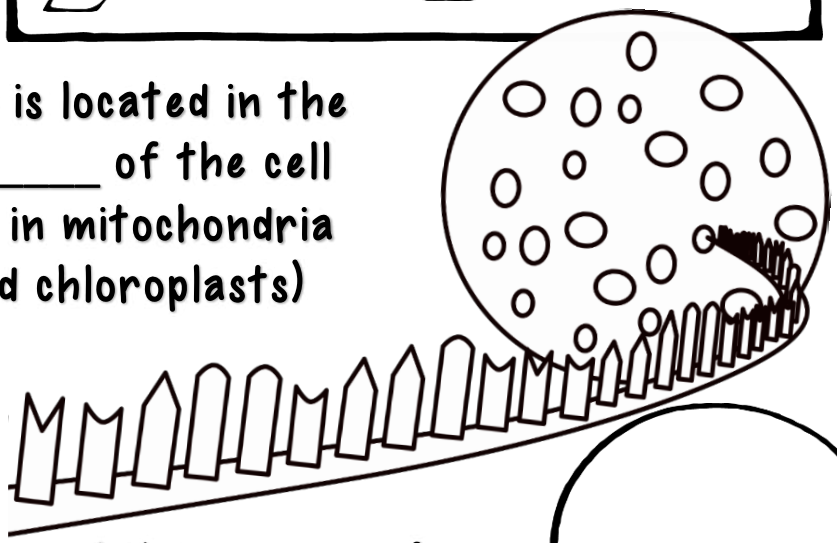
DNA can be collected from:

-
-
-
-
-
-

DNA is located in the _____ of the cell (or in mitochondria and chloroplasts)



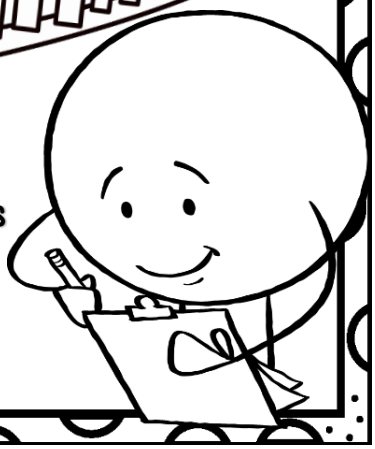
Task: Color the parts of the DNA strand.
Phosphate: Blue
Sugar: Red
Nitrogenous Base: Yellow



DNA is comprised of a sequence of four nitrogenous bases:

_____ _____

_____ _____



How will the following nucleotides pair?

ATCGGCTACGT

_ _ _ _ _ _ _ _ _ _ _ _ _

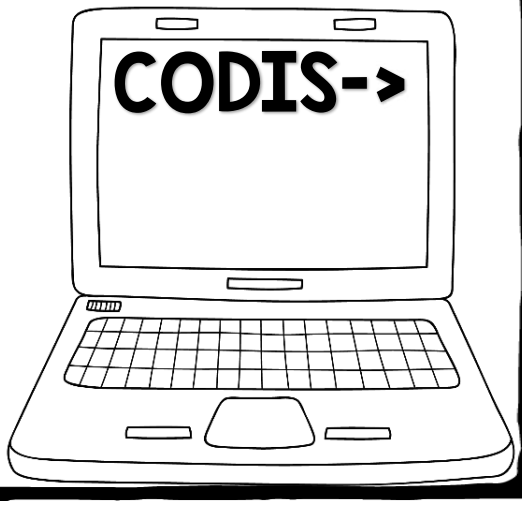
TAAGCCGATAT

_ _ _ _ _ _ _ _ _ _ _ _ _

GCATGCATTAC

_ _ _ _ _ _ _ _ _ _ _ _ _

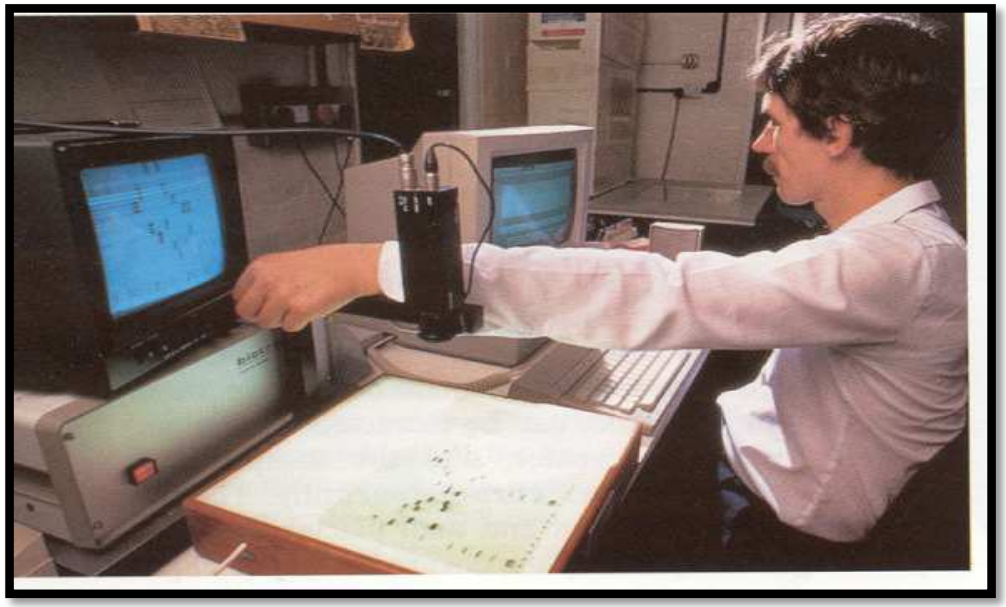
DNA in Forensics



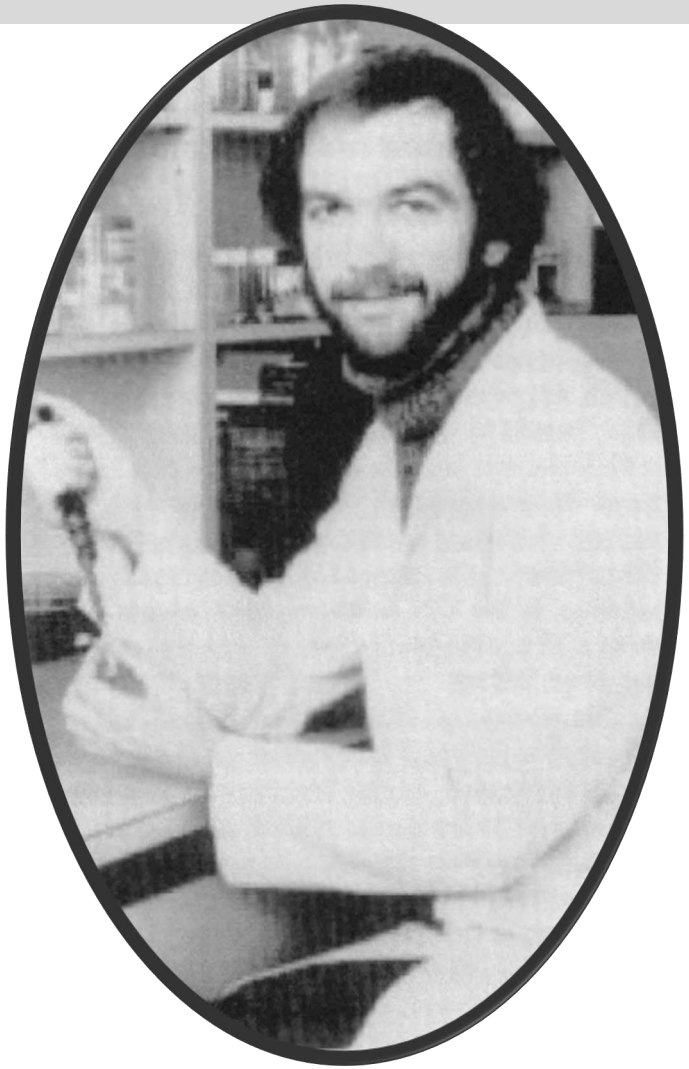

DNA PROFILING

DNA PROFILING

- A process or technique of analysis that reveals unique patterns of an individual's DNA.
- The most important discovery in Forensics to date!



DNA PROFILING



1980 - American researchers discovered non-coding regions of DNA

1984 - Professor Alec Jeffreys developed the process of DNA profiling

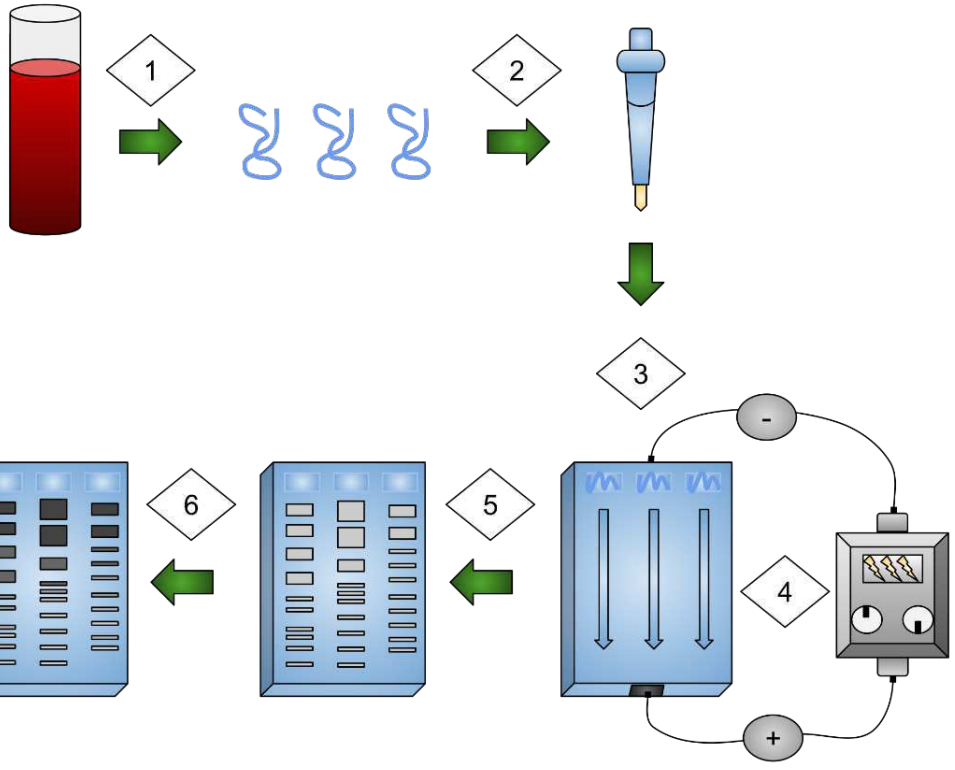
1987 - First conviction based on DNA evidence

DNA PROFILING

- Chromosomes are large entwined strands of DNA.
- They can be divided into smaller sections called alleles.
- When common alleles are identified between two samples of DNA a positive match can be made.
- Ex. Sample of DNA from crime scene finds several alleles in common with a sample of DNA taken from suspect.

DNA PROFILING

1. Cells broken down to release DNA (DNA extractio



2. DNA strands cut into fragments

3. Fragments separated

4. Pattern of fragments analysed- This entire process is known as **electrophoresis**

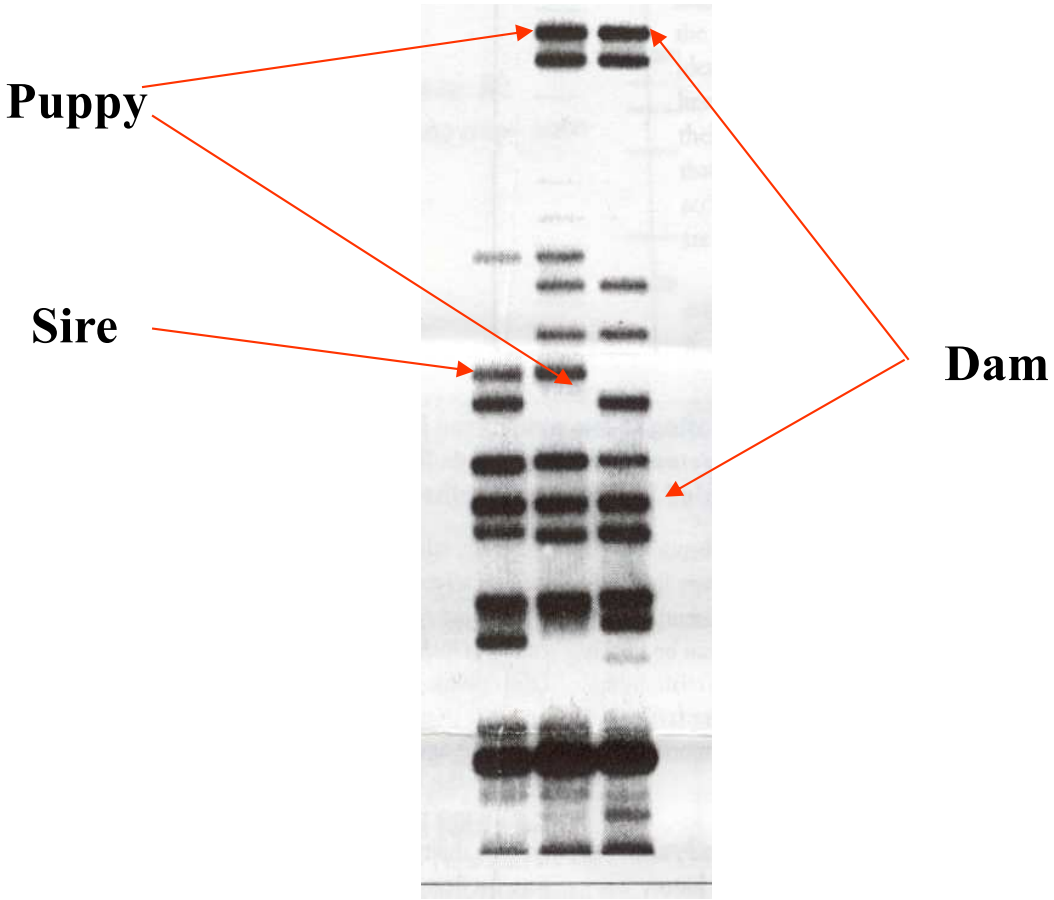
DNA PROFILING

- Forensic Science
- Family Relationships
- Health Care

ancestry.com™

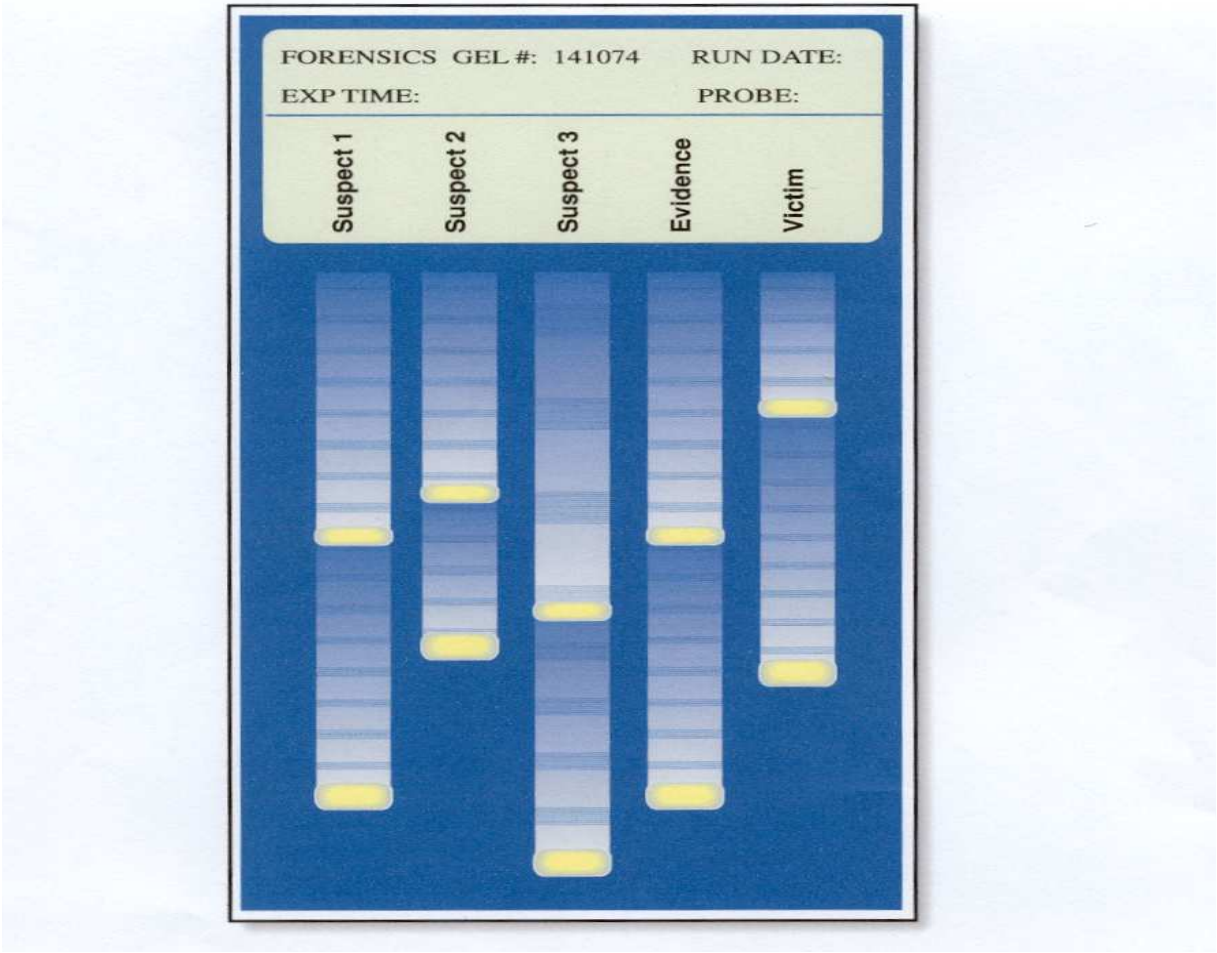
DNA PROFILING

Pedigree

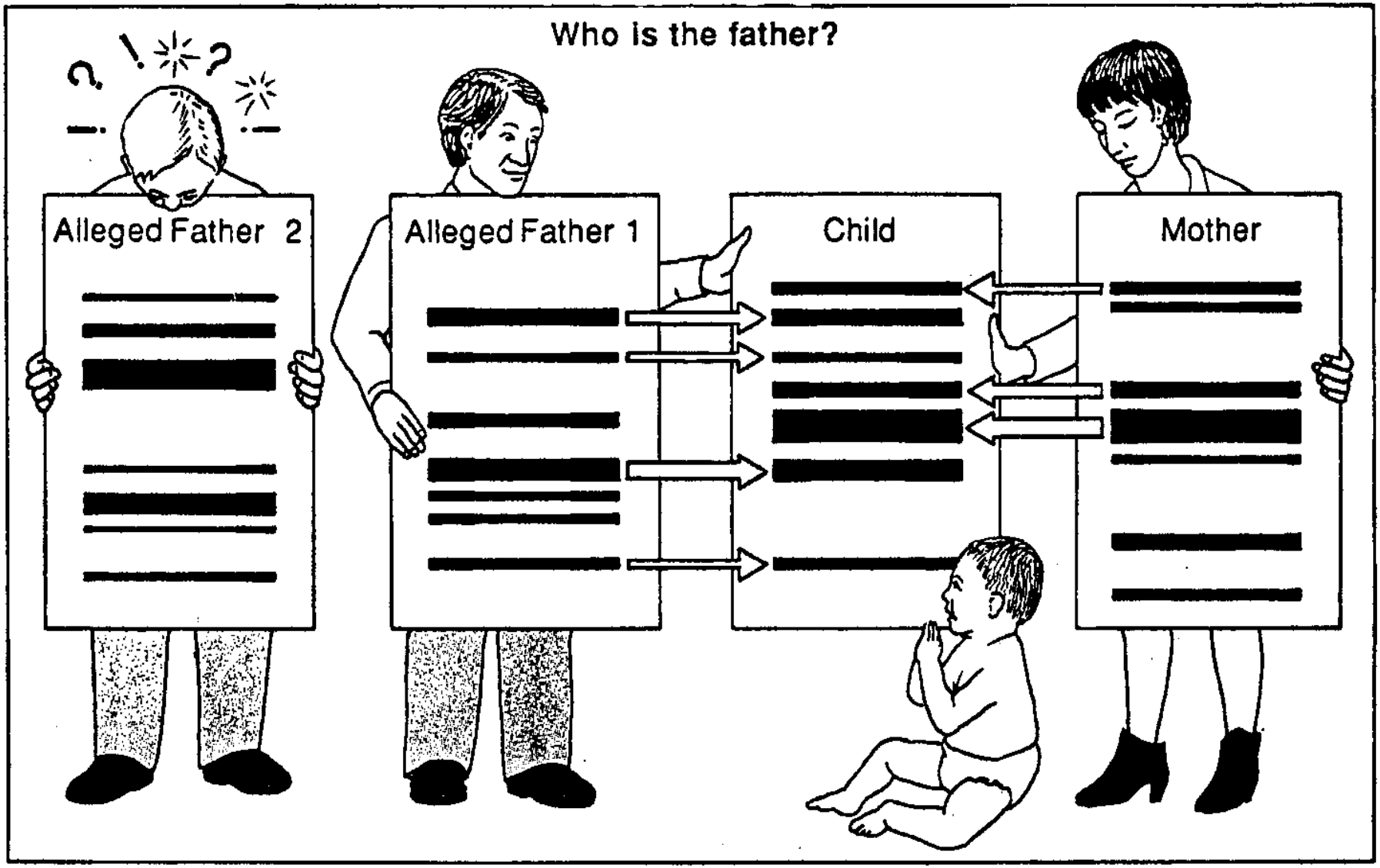


DNA PROFILING

What can be gathered from the DNA profile to the right?



FAMILY RELATIONSHIPS



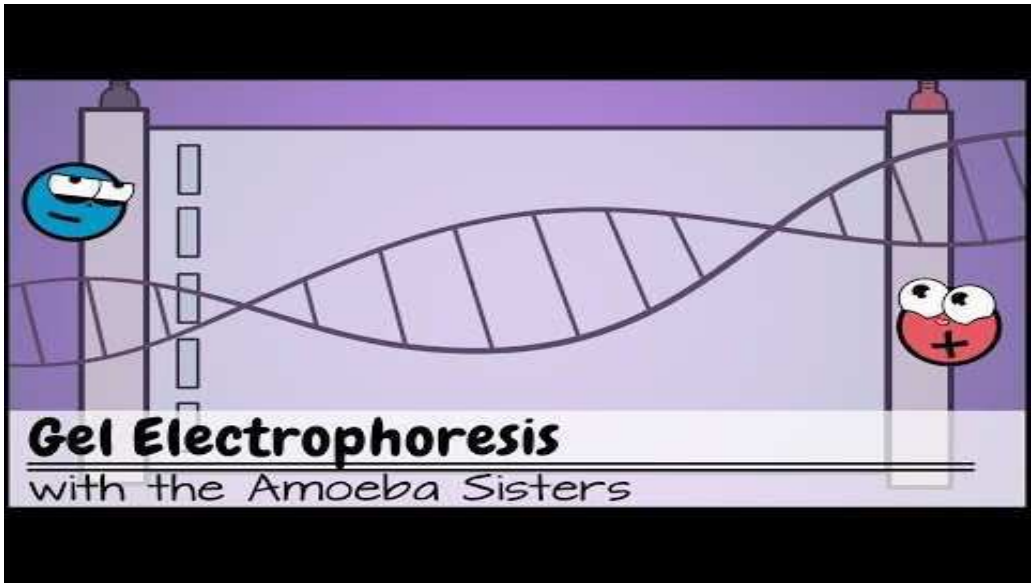
DNA PROFILING

COMMON CONCERNS IN FORENSICS

- Quality of sample
- Mistakes and inaccuracy
- Interpretation
- Evidence from criminal investigations
- Cost effective

DNA PROFILING

Gel Electrophoresis Explained



Link:
https://www.youtube.com/watch?v=ZDZUAleWX78

DNA PROFILING

Gel electrophoresis is a complicated and expensive lab. Today, you will complete a virtual electrophoresis lab experiment. Visit the link below:

Link: http://learn.genetics.utah.edu/content/labs/gel/

Once you learn how to perform electrophoresis, now you can learn how to read the results.

When you finish the virtual lab, pick up a **DNA profiling worksheet** and complete it with a partner.

Gel Electrophoresis

Virtual Lab Activity

Name:_____

Step 1:

Visit the following website: http://bit.ly/2WpvNwN

Step 2:

Read through the instructions, pressing FORWARD after each page. Answer the following questions as you maneuver through the pages.

1. Can we see DNA strands?

2. How can DNA strands be measured?

3. What is the gel made of?

4. How does the DNA get "pushed" through the gel filter?

5. How do short strands of DNA move as compared to long strands?

6. How are the DNA strands made visible to the naked eye?

Step 3:

Next, follow the prompts to run your own gel. Answer the following questions as you maneuver through the lab.

7. What supplies are needed to make a gel?

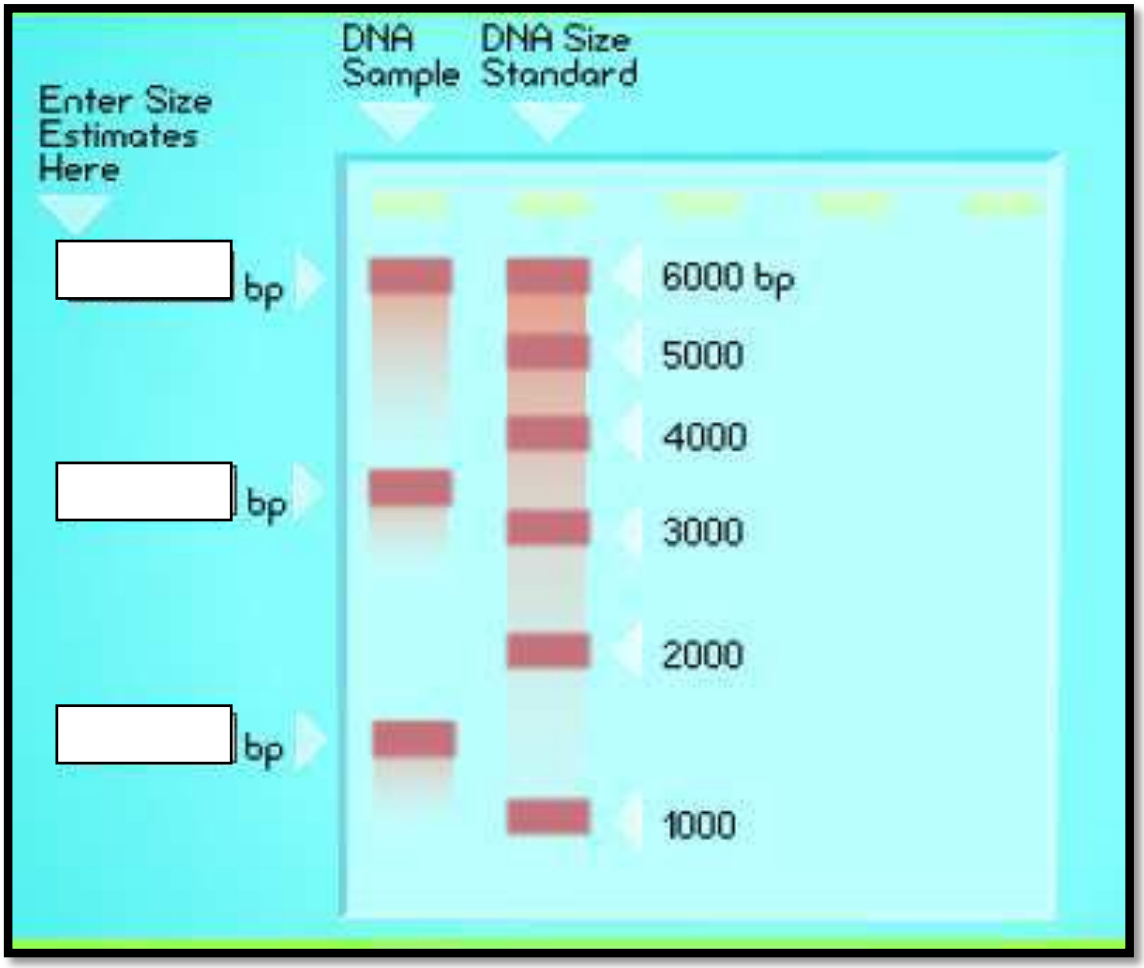
8. How long will it take the heated gel to cool and solidify?

9. A buffer is added to the electrophoresis box. Why is the buffer needed?

10. What electrical charge does DNA have?

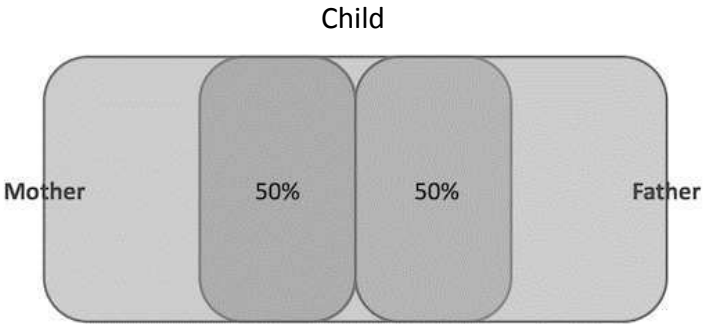
11. How long does it take the stain to make the DNA bands visible?

12. At the end of electrophoresis, you will measure the lengths of the DNA strands in your sample and enter the measurements. Write your estimated measurements below:

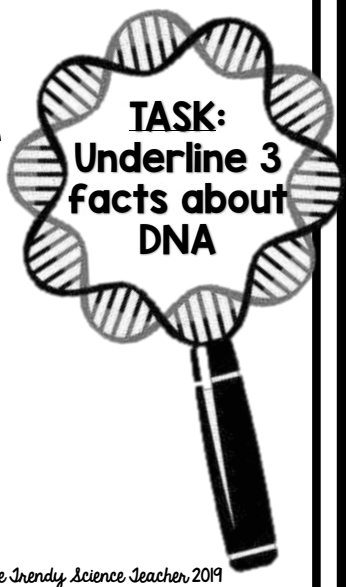


DNA Fingerprinting in Forensics

DNA is short for deoxyribonucleic acid. DNA is a large molecule found in the nucleus of every cell and in every organism. DNA is often referred to as a double-rung ladder, because its shape is similar to a ladder. Each DNA strand is comprised of over 3 billion "rungs" or nucleotides and is the chemical of which chromosomes are made. Chromosomes are large entwined strands of DNA. They can be divided into smaller sections called alleles, which encode instructions for cell operation. These instructions are genes, and they are passed down from parent to child through alleles in DNA. The DNA from related people is always more similar than DNA from unrelated people. In the same way, the DNA of closely related animals and plants is also more alike than the DNA of organisms that are distantly related. This makes DNA extremely unique to each person. In fact, the only people who share exactly the same DNA are identical twins.

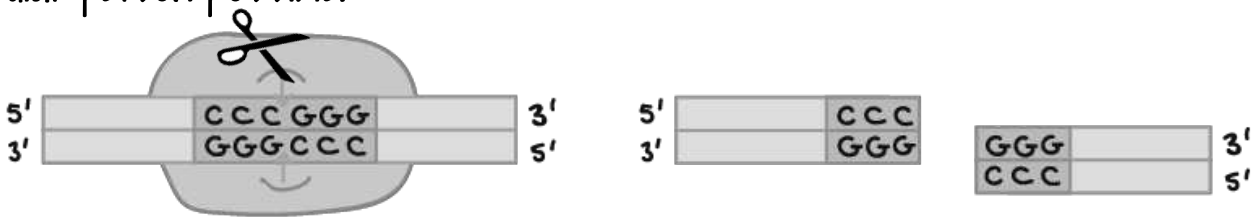


This genetic code is a combination of alleles which are inherited from an organism's father and mother. In fact, exactly 50% of the alleles that a child has comes from the child's father, while the other 50% are inherited from the child's mother. This fact is extremely helpful to forensic investigators, as they often use alleles to identify matches in DNA profiles. DNA profiling (aka DNA fingerprinting) is a technique that has been used since the 1980's to identify suspects involved in serious crimes, such as murder or kidnapping. DNA profiling is probably the most important discovery for use in forensics since the development of fingerprinting over a hundred years ago. DNA is considered to be individual evidence and can be left behind at a crime scene in the form of saliva, blood, semen, urine, hair (with the follicle), or other biological material that includes cells.



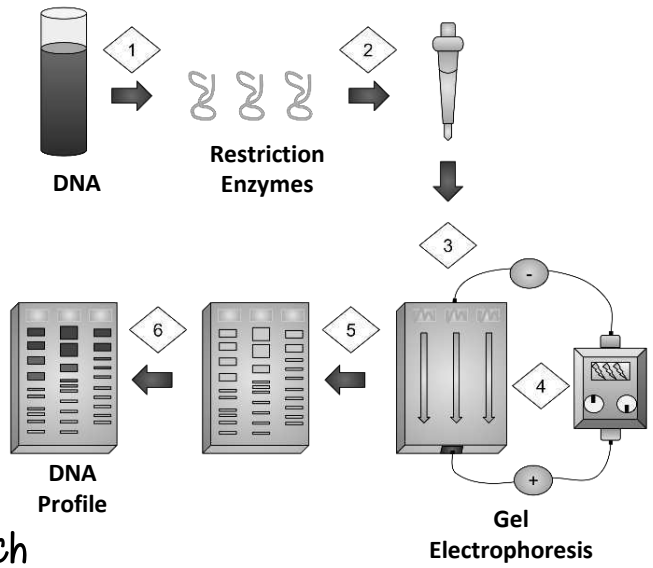
When investigators search a crime scene, they are careful to look for DNA evidence. If they collect DNA evidence, a DNA profile can be generated and compared to suspect DNA.

One of the most common DNA fingerprinting procedures uses restriction enzymes to cut a sample of DNA into segments. The enzymes locate a particular base sequence and cut the DNA apart any time that sequence is identified. This results in DNA fragments being produced in varying lengths. The assortment of fragment sizes varies greatly from one individual to another and makes identification of a particular person possible.

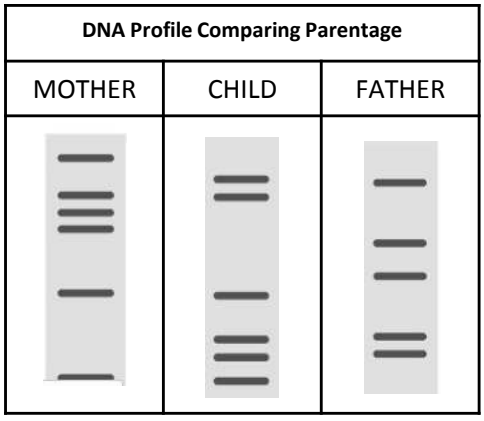


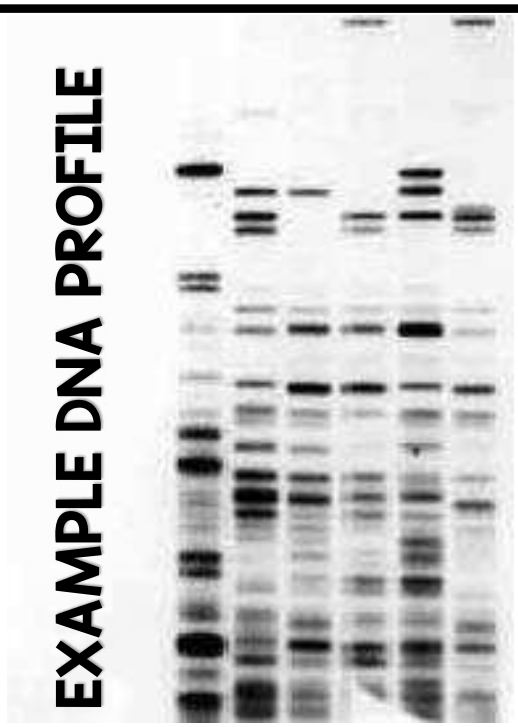
The DNA segments are then injected into wells that are filled with agarose gel (very similar to clear jello). Then, an electric charge is applied to the gel using a power source and the DNA fragments separate by size.

Smaller DNA fragments move faster and farther than larger DNA segments, thus creating a unique pattern in the gel. Then, the gel is stained and a unique pattern of alleles is made visible (very similar to a barcode). This process of using an electric current to produce a visual representation of alleles is known as gel electrophoresis.



DNA profiling, in addition to being used to catch criminals, is also used routinely to establish paternity or parentage. DNA profiles are obtained from the mother, the child and the father and are compared to show evidence of kinship. In the diagram to the right, the DNA profiles of a father, mother and child can be compared to see that half of the alleles match the father, while the other half match the mother.





In the early days of DNA analysis, it could take up six weeks for a profile to be produced and the odds of a random match were one in several billion! Additionally, there had to be a sufficient quantity of DNA collected in order for electrophoresis to work. Modern advances in technology now allow scientists to collect a DNA profile from even the tiniest bit of DNA evidence and run electrophoresis in a matter of minutes.

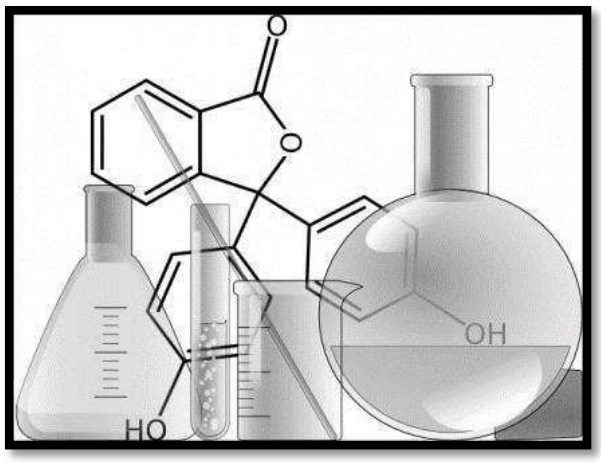
Think About It!
In the early days of DNA analysis, what were the odds of a random match?

Once a DNA profile is created, detectives/lab technicians compare the DNA samples between evidence and suspects to confirm a match. If there are no suspects, the DNA profile from evidence can be compared to a digital database that belongs to the FBI and houses millions of fingerprints. This database is known as the Combined DNA Index System or CODIS. Sometimes, a match is not immediately available and the DNA profile is stored and compared against the CODIS database annually to see if a match is confirmed. At the present time, CODIS has been used to confirm over 500,000 DNA matches.

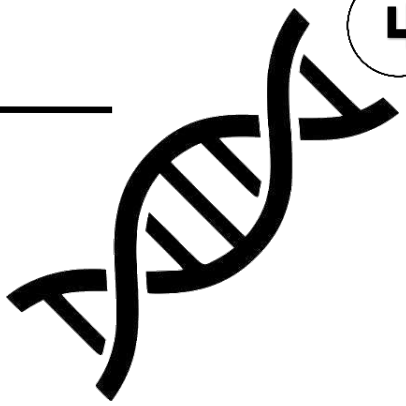
While no method in analyzing evidence at a crime scene is fool-proof, advances in DNA technology have proven to be influential in many cases. Today, DNA profiling has many applications. It can be used to determine whether a family relationship exists between two people, to identify organisms causing a disease, to solve crimes and even to provide hints about evolutionary relationships of two different species. As DNA technology continues to evolve, its uses will become more prevalent and established.

Understanding Key Terms

Skim through the passage again. This time, underline the key terms



Reading Analysis Questions:



1. Where is DNA located?

2. How many nucleotides comprise a single strand of DNA?

3. What is the function of an allele?

4. What is the relationship between a child's alleles and the alleles of that child's mother and father?

5. Why are alleles helpful to Forensic Science?

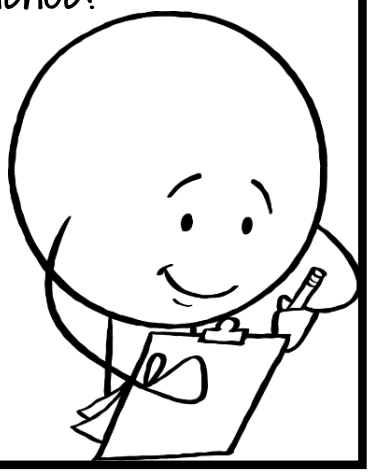
6. In DNA fingerprinting, what do restriction enzymes do?

7. The process of using an electric current to create a DNA profile is called _____ _____.

8. What are some applications (uses) of DNA profiling?

9. How have advances in DNA technologies benefited Forensic Science?

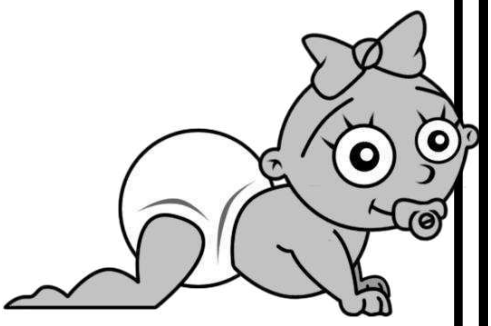
10. What is the purpose of CODIS?

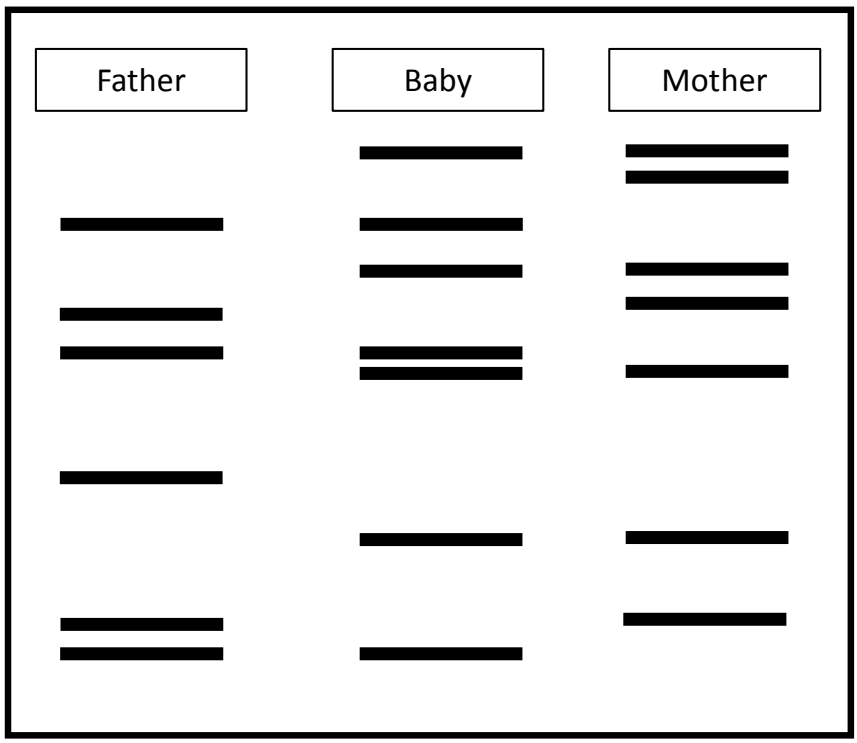


DNA Profiling Practice

5

A Mr. and Mrs. Lexington have just brought a new bundle of joy home from the hospital. However, when they arrived home, they noticed that the foot bracelet on the baby's ankle read a different last name. To be sure that they had the right baby, they requested a DNA profile. Below are the results from the test.



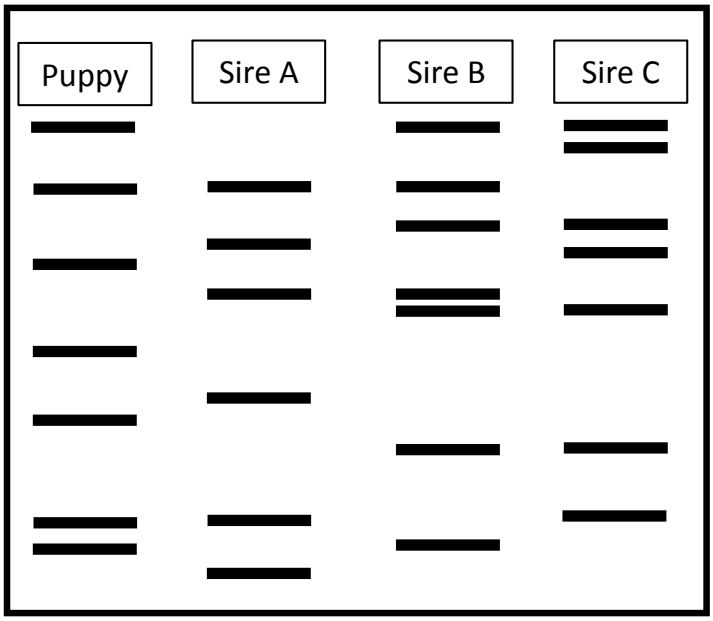


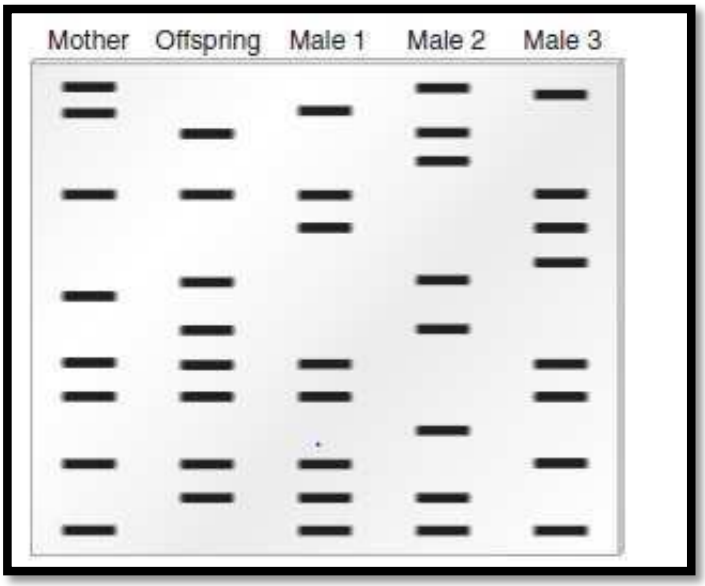
Task: Highlight the alleles that are shared between the baby and father. In a different color, highlight the alleles shared between the baby and mother.

Did a mix-up occur at this hospital? Explain your answer.

B The DNA fingerprints were made from the blood samples taken from a puppy and three possible sires in an attempt to determine the puppy's pedigree. According to the profile below, which sire is most likely the father of this puppy?

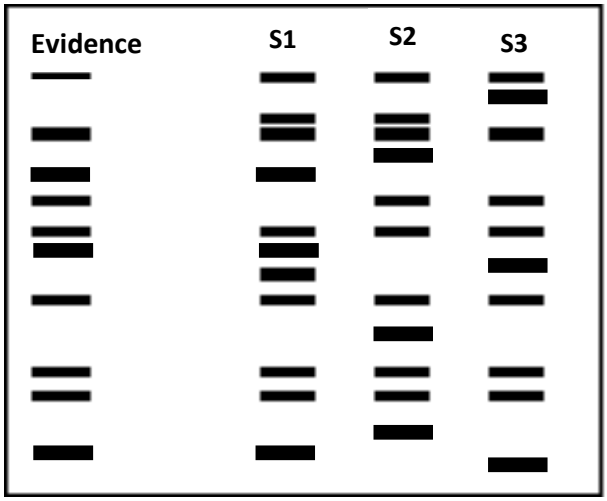
How do you know?





C Three men are claiming to be the father of the child of a rich heiress who died suddenly without leaving a will. They are all suing for custody of the child. A DNA sample was collected from a toothbrush that was used by the heiress. Blood samples were collected from each man and the baby. Which man is the father of the child?

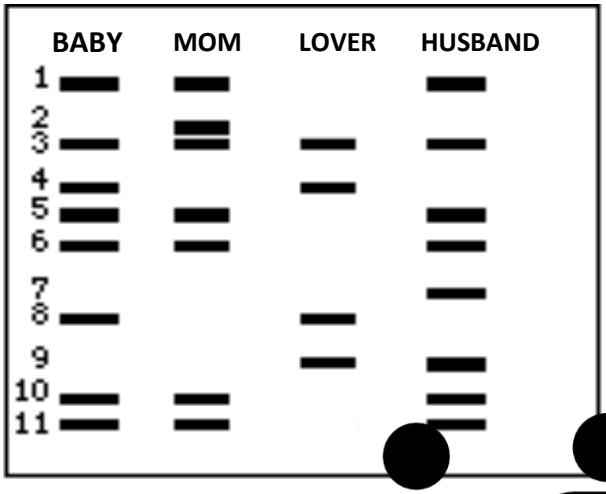
_____



D Jane was assaulted in an alley and is the victim of rape. A lab collected a sample of sperm that was found in the rape test conducted by the investigators. The police now have 3 suspects in custody. Which of the suspects most likely rapped Jane?

_____

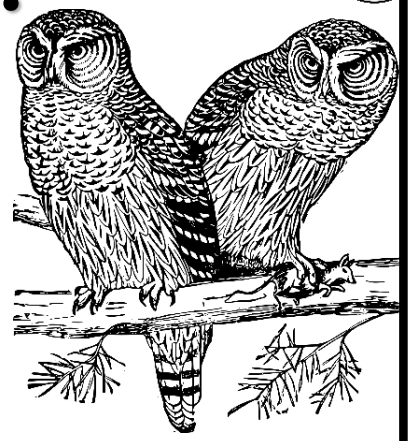
E Once again, two men were involved in a paternity suit brought by a woman against her estranged husband. The woman was seeking child support for her infant from her husband, but the husband accused the woman's lover of being the biological father. Unfortunately, blood typing was inconclusive: both men had the same blood type. So the judge ordered DNA analysis. A sample of blood was taken from the mother, the baby, and both men. The results are shown below.



Which of the men are most likely the father?

_____

O-WL BET WE'RE RELATED!



The sequence below represents the same portions of a DNA molecule from the same gene used by a researcher to study the relationship between two species of owl.

A biological catalyst that recognized the AATT site is used to cut the DNA molecules into pieces. The catalyst cuts the DNA between the A and T of the site.

1. Use a pencil and draw a line in the sequences below for species A and species B to show where the catalyst would cut the DNA.

Species A: A A T T G G C C T A A T T A A T T C G G C C T A G

Species B: A A T T C C T A C G G C C T A G C C T T T A A T T

2. Use a highlighter to highlight the sections of the cut DNA strand. Be sure to use a different color highlighter for each section.

3. Complete the data table below to represent the results of the action of the catalyst.

	Number of Cuts Made	Number of DNA Segments
Species A		
Species B		

4. Based on the data above, do you believe Species A is closely related to Species B? Explain.

DNA Profiling Quiz

1. What is the name of the database that houses DNA profiles?

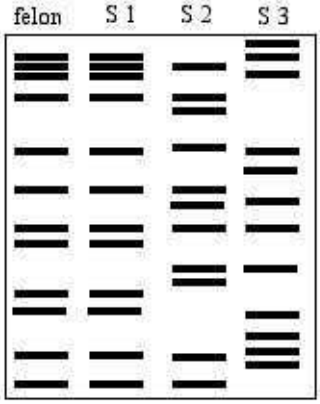
    a. CODIS
    b. AFIS
    c. LANTUS
    d. F.B.I.

2. Which of the following is a piece of evidence that does **NOT** contain nuclear DNA?

    a. Hair with the follicle
    b. Saliva
    c. Hair without the follicle
    d. Blood

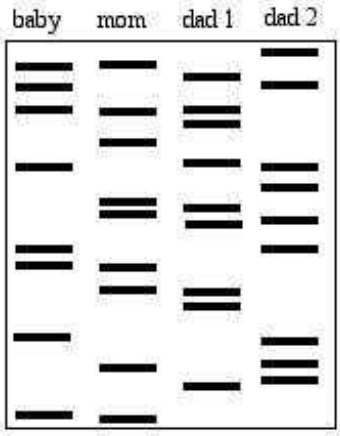
3. Based on the DNA profile below, which suspect matches the "felon" DNA?

    a. Suspect 1
    b. Suspect 2
    c. Suspect 3
    d. None of the above



4. Who's the daddy? This mother is trying to decide between two men who desperately want to support her and her newborn baby. Both want to be a part of the baby's life, because they love the mother so much. Who gets the honor and privilege?

    a. dad #1
    b. dad #2
    c. neither dad is a match

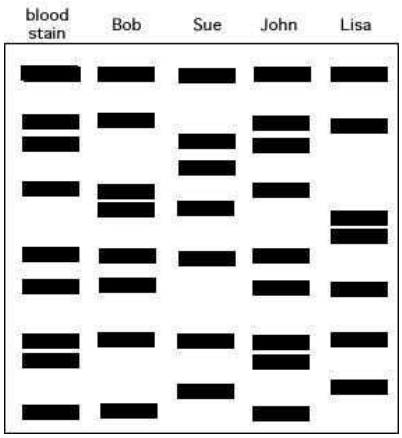


5. Which of the following is the process of extracting and analyzing DNA?

    a. CODIS
    b. DNA tracking
    c. Gel Electrophoresis
    d. Criminalistics

6. In the following DNA profile, whose blood stain was left at the crime scene?

    a. Bob
    b. Sue
    c. John
    d. Lisa



7. Before electrophoresis can be conducted on a sample of DNA, which of the following must take place first?

    a. The DNA must be treated with acid.
    b. The DNA profile must be printed.
    c. The DNA must be treated with benzene.
    d. The DNA must be extracted from the source and the DNA segments must be cut.

8. Which of the following is true regarding DNA collection?
    a. DNA can only be collected from blood evidence
    b. DNA has a relatively short life and will degrade quickly
    c. DNA can be extracted from substances as small as a nanogram
    d. DNA profiling is only conducted in rape and murder cases

9. Who was the scientist responsible for creating DNA profiles as a means of identification in criminal cases?

    a. Colin Pitchfork
    b. Alec Jeffreys
    c. Albert Einstein
    d. Edmond Locard

10. *True or False*: The complementary base strand to the DNA sequence ATGGCTA is TACCGAT.

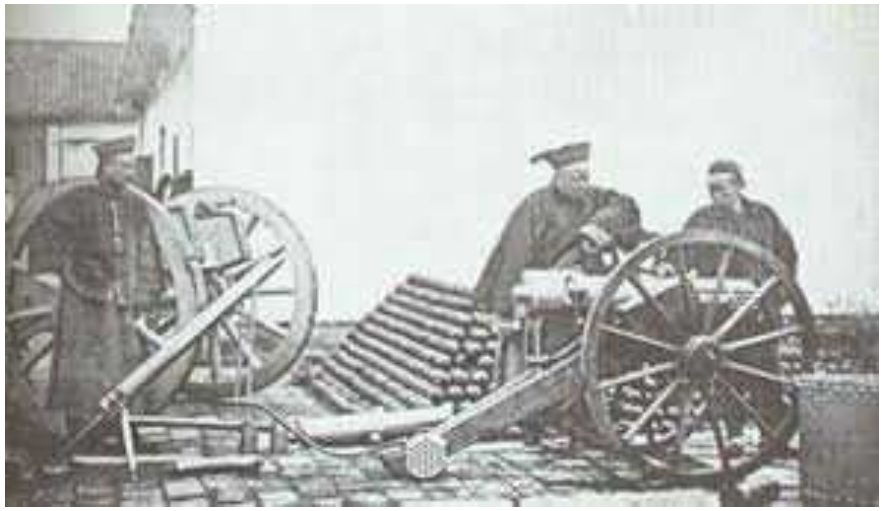
BALLISTICS NOTES

BALLISTICS

a. Ballistics refers to the scientific analysis of **firearms**, **bullets**, and the travel of **projectiles** in flight.
b. Ballistic experts help to interpret evidence and establish facts during shooting-related crimes.
c. Ballistic experts determine what **type** of firearm was used during the crime, what **caliber** of bullet was used, how **many** bullets were fired, **where** the shooter was positioned during the crime, and whether the weapon been used in **previous** criminal cases.

History of Firearms

a. A firearm is a weapon, such as a **gun**, capable of firing a projectile using a **confined** explosive.

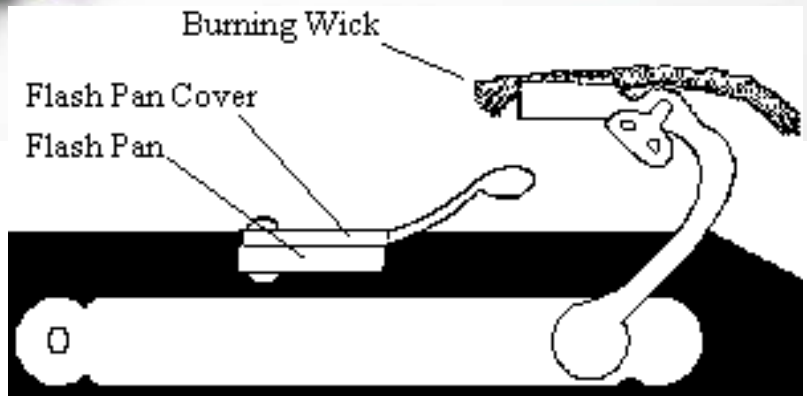


b. The **Chinese** invented gunpowder over a thousand years ago to make **fireworks** and weapons.

   i. Gunpowder is potassium nitrate, charcoal, and **sulfur**.

   ii. When ignited, gunpowder **expands** and causes a violent explosion.

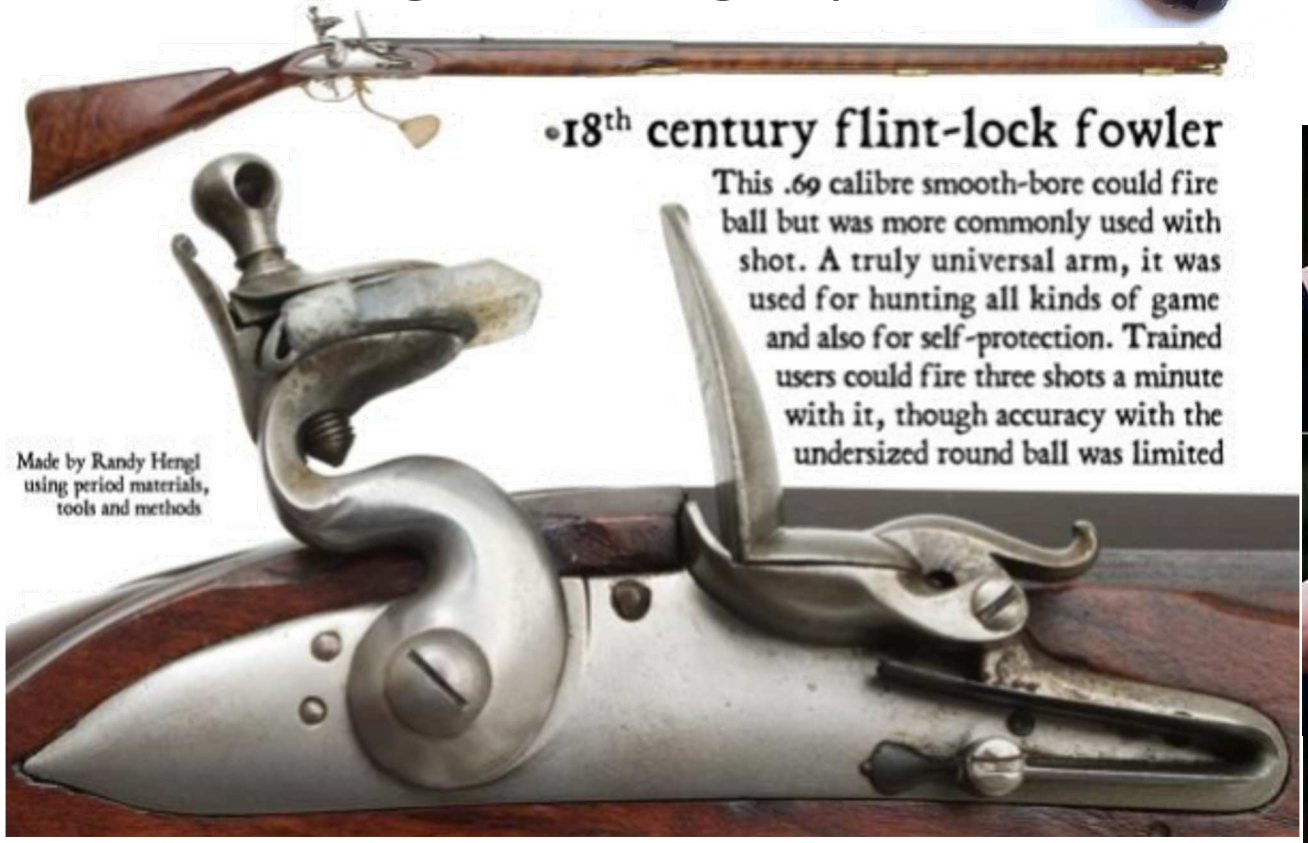
The first firearms, called **matchlock** weapons, used **wicks** to ignite the gunpowder.



The Matchlock secured a lighted wick in a moveable arm which, when the trigger was depressed, was brought down against the flash pan to ignite the powder. This allowed the musketeer to keep both hands on the gun, improving his aim drastically.

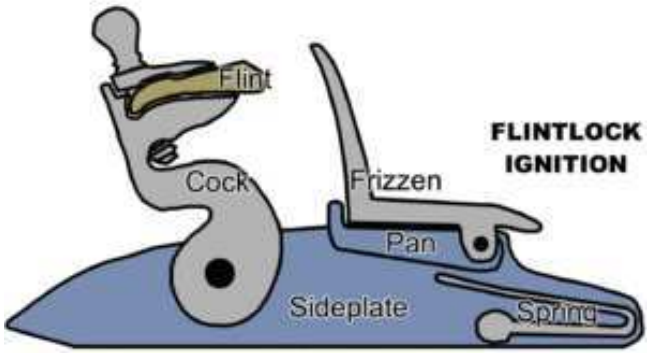
Video Clip

Flintlock weapons used **sparks** from flint to ignite the gunpowder.



Video Clip

The flintlock improved upon the matchlock, an open flame was no longer needed as it was replaced with a simple spark.



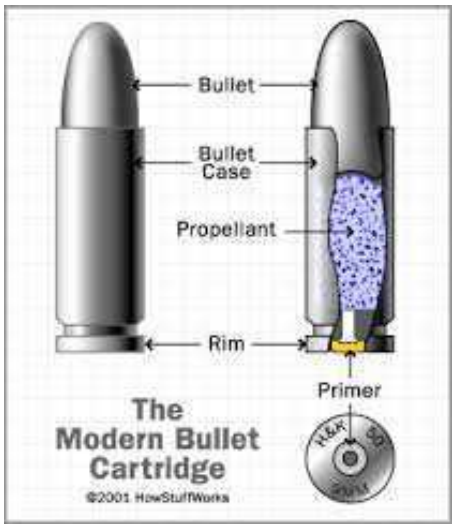
These early weapons were called **muzzle**-loaders, which meant the shooter had to manually pack the gunpowder and bullet down into the barrel.

A muzzleloader is any firearm into which the projectile and usually the propellant charge is loaded from the muzzle of the gun (from the open end of the gun's barrel). This is distinct from the more popular modern designs of breech-loading firearms.

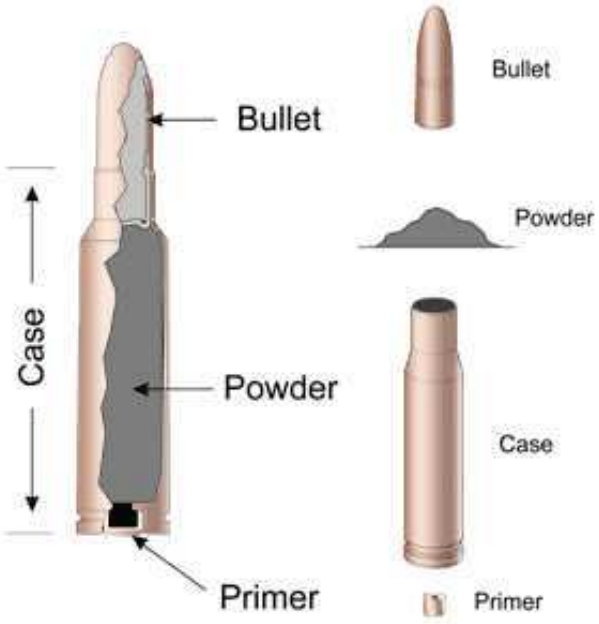
Muzzle-loaders were replaced by **breech**-loading firearms with the advent of the cartridge.

i. A cartridge, also called a **round**, is a case that holds a bullet, a small amount of exploding **primer** powder, and the gunpowder.

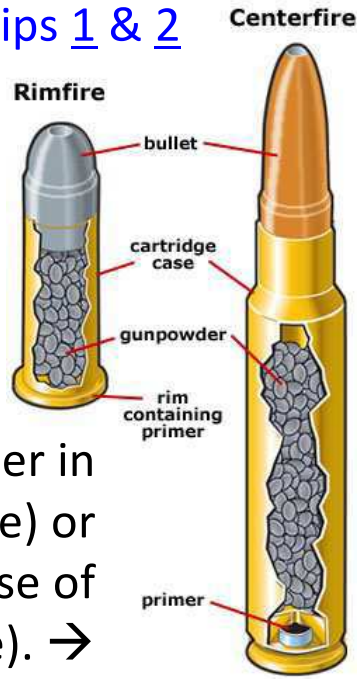
1. A primer is a volatile compound that ignites when struck by the firing **pin** of a gun. It detonates the propellant in the cartridge.
2. The gunpowder is the **propellant**. It forms **gases** which push the bullet out of the cartridge and the gun barrel.
3. The casing is left behind and does **not** propel with the bullet.



Video Clips 1 & 2



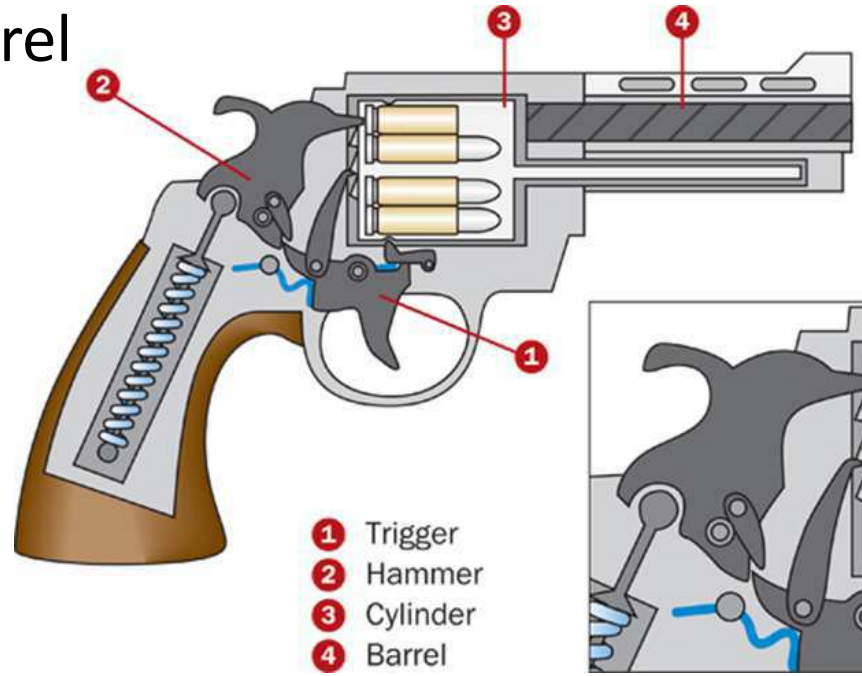
Round or Cartridge is the correct and accurate name for the "entire package". It is not accurate to use the word bullet, as the bullet is one of multiple components.

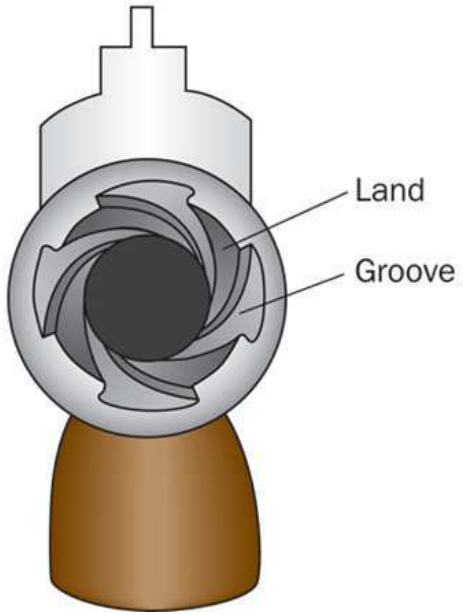


Primer may be placed either in the rim of the case (rimfire) or in the center of the base of the case (centerfire). →

How a Firearm Works

1. The firing pin hits the base of the cartridge, igniting the primer powder.
2. The primer powder sparks through the flash hole to the main propellant supply
3. The pressure of the explosion pushes the bullet from the casing into the barrel
4. The bullet follows lands and grooves to spiral out of the barrel



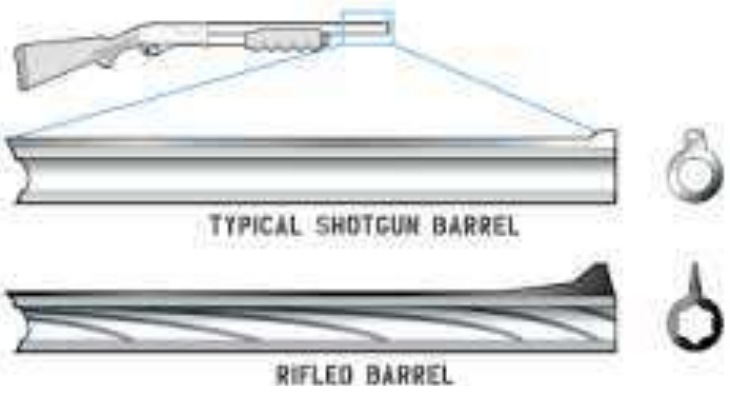


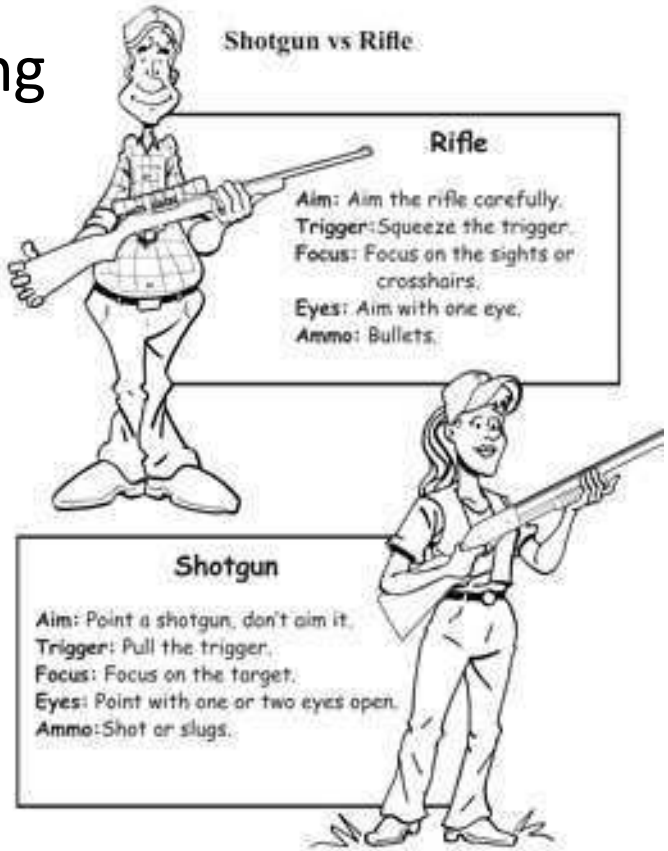
Modern Firearms

Two categories: Handguns and **Long** guns

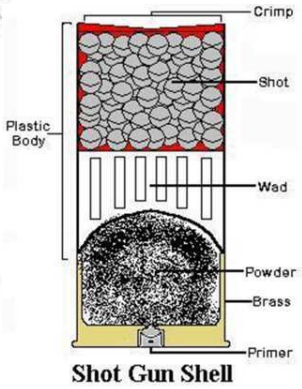
Long guns

1. Includes **rifles** and **shotguns** which require two **hands** for accurate shooting
   a. Rifles fire **bullets**.
   b. Shotguns fire small round pellets called **shots**, or single projectiles called **slugs**.





Shotgun shells are different from rifle and pistol cartridges.



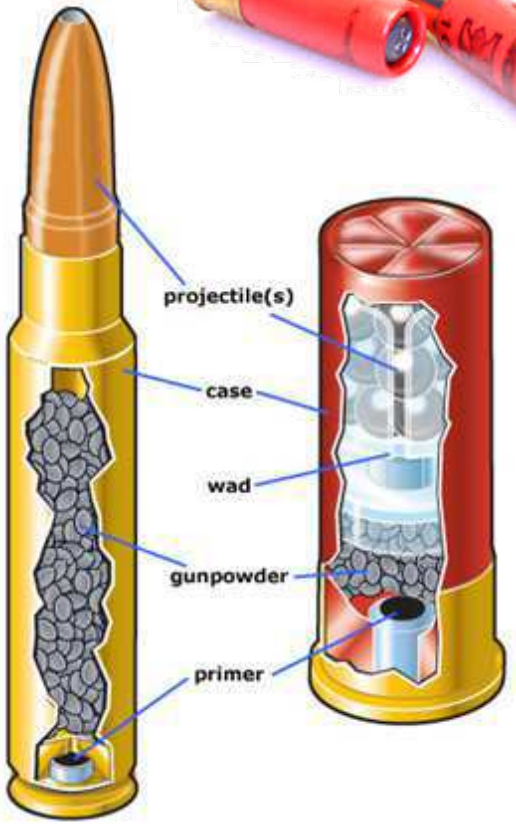
Shot Gun Shell

In addition to a case, primer, and powder, there is also a **wad** of plastic or fiber separating the shot from the powder.

- The wad forms a seal to allow the gases from the burning powder to push the shot down the barrel in a uniform manner.

Instead of a bullet, shells are filled with "shot" – small, round pellets usually made of lead or steel. A shotgun shell can contain anywhere from a half-dozen ball-bearing-type pieces of metal to 1,300 pellets. It can also contain a slug, which is a solid piece of metal.

← Police usually carry a shotgun in their cruisers



Handguns

1. Handguns that can be fired with one hand are called **pistols**.
   a. A pistol that holds several cartridges that can be fired one after another is called a **revolver**.

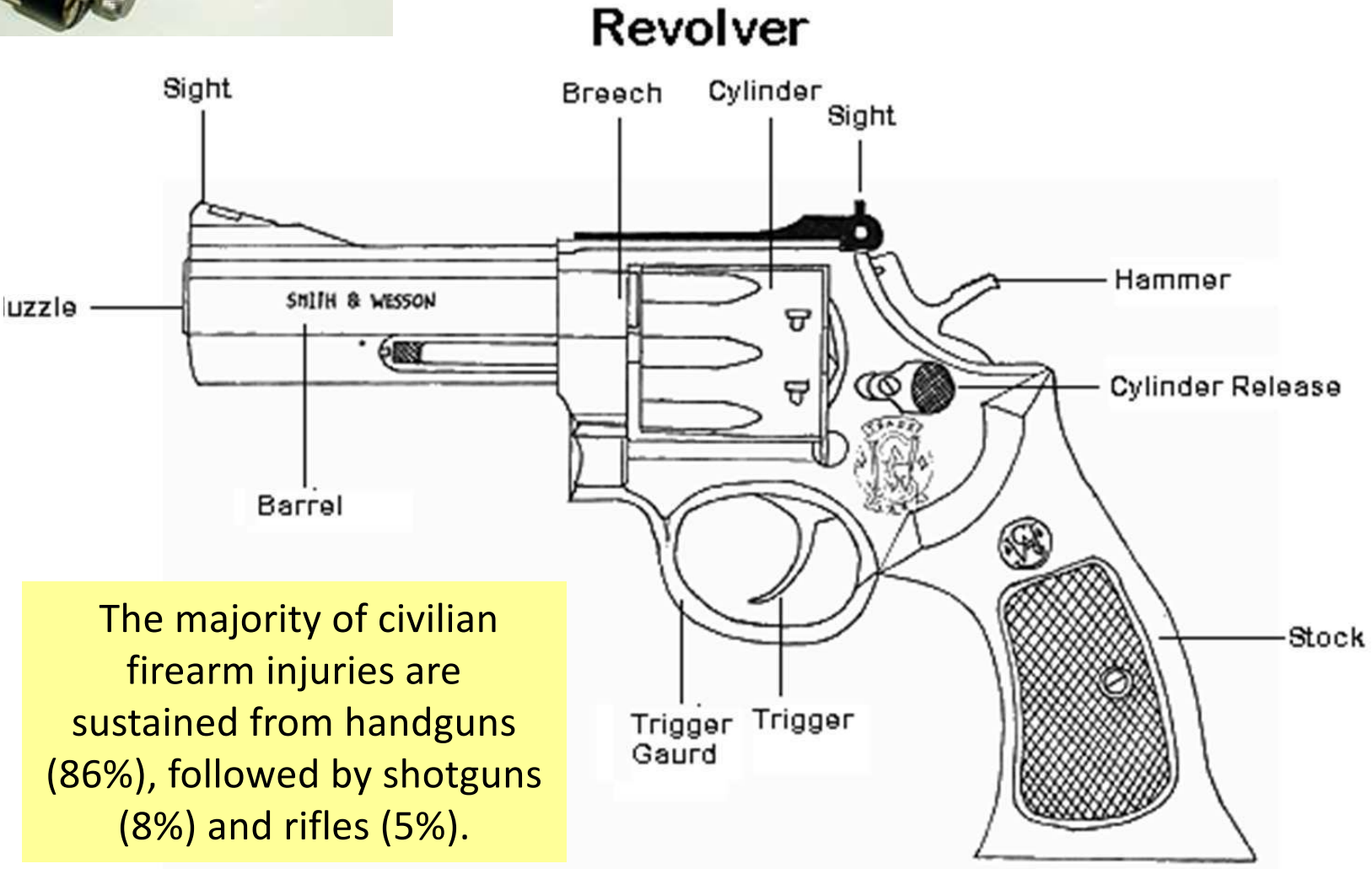
Semiautomatic Pistol vs. Revolver

2. Today handguns are grouped as a ***revolver*** or ***semiautomatic***.
    a. Revolvers hold **6** cartridges; semiautomatic weapons load up to **10** cartridges in a magazine clip
    b. Semiautomatic weapons fire **one** bullet per trigger pull; automatic weapons **continuously** fire as long as the trigger remains pulled.

Revolvers are usually easier for first time shooters to learn how to shoot safely. The recoil seems to be less and lighter loads can be used.

- The revolver utilizes a rotating cylinder to store rounds.
- In a semiautomatic pistol the rounds are loaded into a magazine or clip. After a round is fired, most semiautomatic pistols will use the spent gasses of the fired round to move the whole or part of the slide rearward to extract and eject the empty case. Forward motion of the slide will chamber a new round and make it ready to fire.

Revolvers have been around since the 1830s and semiautomatic pistols have been with us since the 1890s.

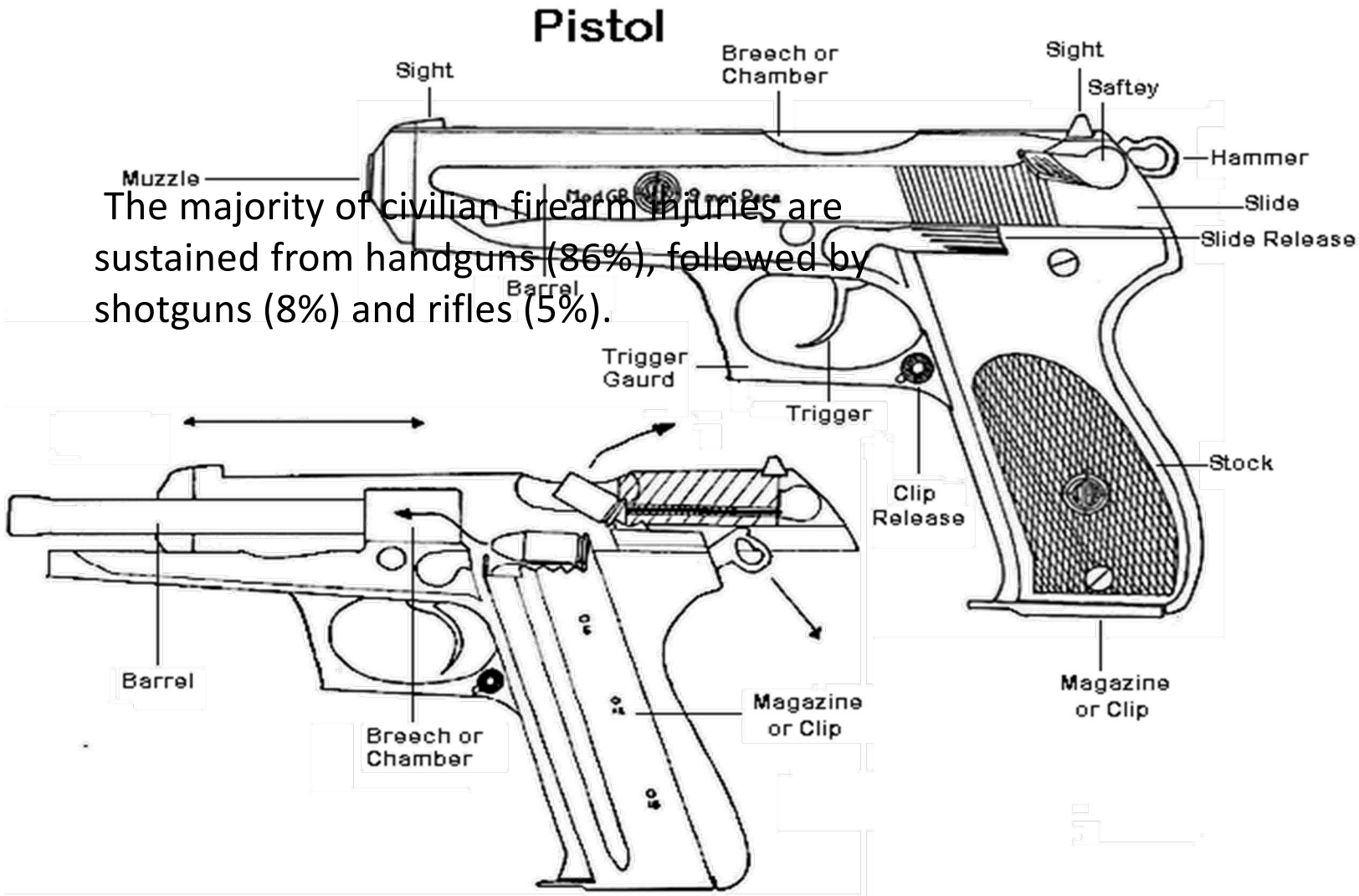


The majority of civilian firearm injuries are sustained from handguns (86%), followed by shotguns (8%) and rifles (5%).

← The Glock debuted in the 1980s.

Rather than six rounds, the Glock has 17. Instead of a 12-pound trigger pull, like the traditional revolver, it has a trigger pull of around 5 pounds so it is more accurate. The gun is much lighter, so that if you're wearing it on your hip for 8 or 10 hours, it will be more comfortable. It is also more durable and will function if it's not cleaned properly or regularly.

The majority of civilian firearm injuries are sustained from handguns (86%), followed by shotguns (8%) and rifles (5%).



BULLETS

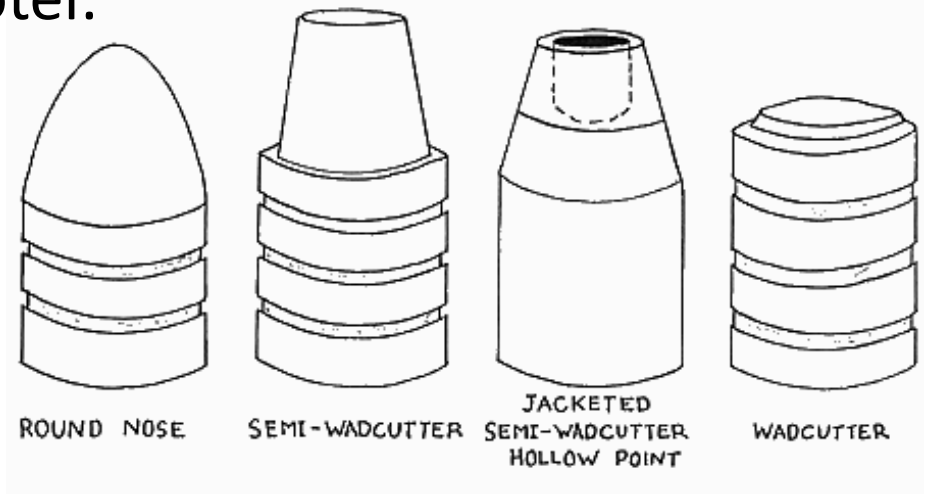
a. A bullet is a projectile propelled from a firearm.
b. Bullets are made of **metals**, such as copper, lead, brass, bronze, steel, aluminum, etc.

Three Basic Compositions of Bullets:

Lead	½ Jacketed	Jacketed (full metal jacket)
• Cheap • Dense • Soft • Easy to mold	A lead bullet coated with copper half way up the exposed portion of the bullet • Copper improves exit velocity • Lead promotes mushrooming	• Copper improves exit velocity • Used to hold the shape of the bullet in an effort to maximize penetration

Bullets are shaped or composed differently for a variety of purposes.

- "round-nose" - The end of the bullet is blunted for maximum penetration.
- "hollow-point" - There is a hole in the bullet that creates more damage, inhibits penetration, and spreads or mushrooms on impact.
- "jacketed" - The soft lead is surrounded by another metal, usually copper, that allows the bullet to penetrate a target more easily.
- "wadcutter" - The front of the bullet is flattened; Used exclusively as a practice load; Rips a hole in target paper which is visible by the shooter.

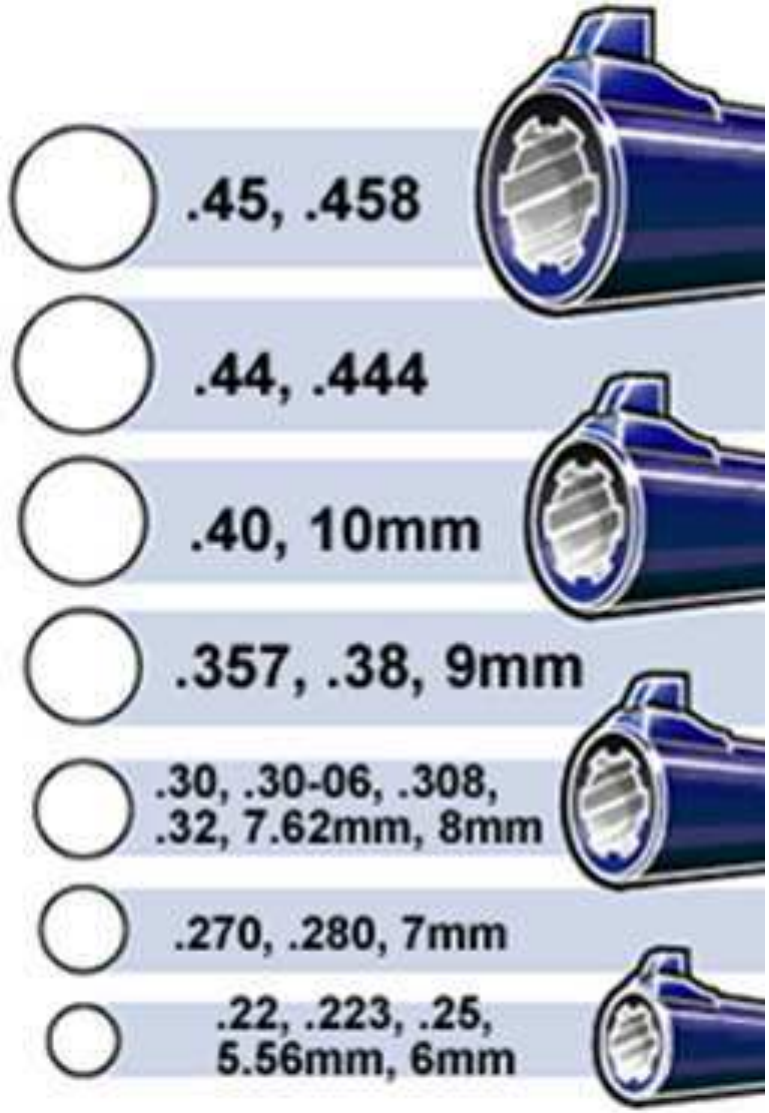


c. Bullets are named by **caliber** and **length**.

i. Caliber refers to the **diameter** of the bullet, usually expressed in hundredths of an **inch** (0.22 cal) or in millimeters (9 **mm**).

ii. Caliber also matches the diameter of the inside of a firearm's **barrel**.

Common handgun cartridges (left to right): 3-inch 12-gauge magnum shotgun shell (for comparison), size "AA" battery (for comparison), .454 Casull, .45 Winchester Magnum, .44 Remington Magnum, .357 Magnum, .38 Special, .45 ACP, .38 Super, 9 mm Luger, .32 ACP, .22 LR

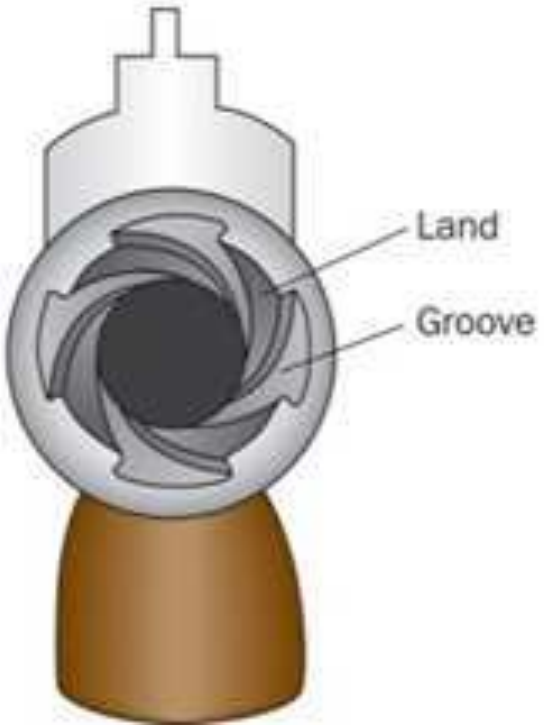


Bullet and Casing Marks

a. A bullet or casing at a crime scene can be linked back to the weapon that was used to fire it based on several **unique** markings:

i. Rifling Patterns

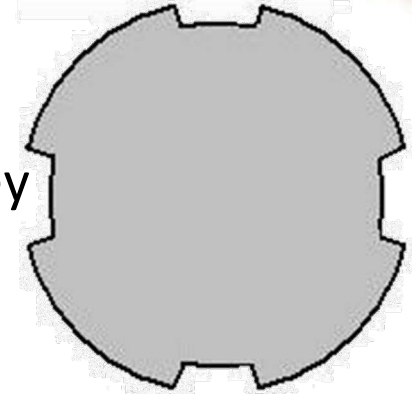
1. Rifling refers to **grooves** cut in a spiral down the barrel of a firearm to help increase range and accuracy. Video Clip



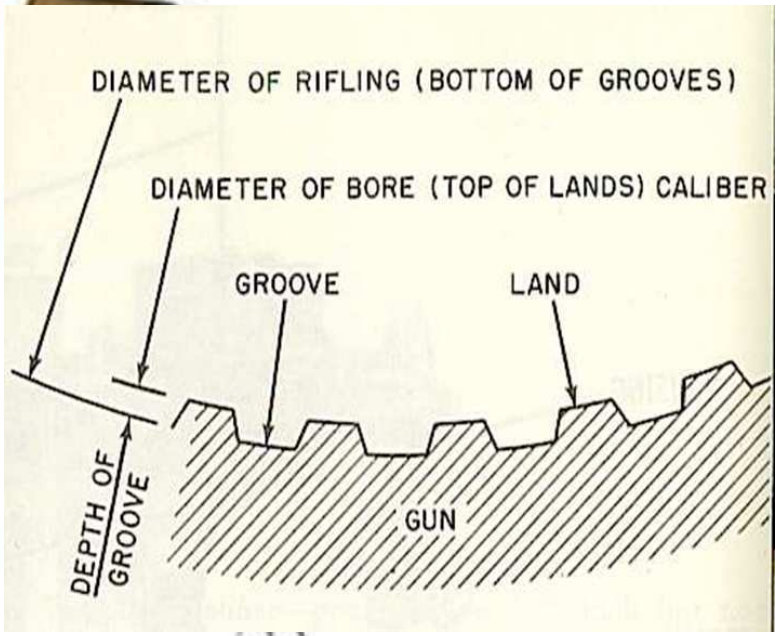
   a. Even though two guns may be the same model, the rifling inside the barrels will **differ**.

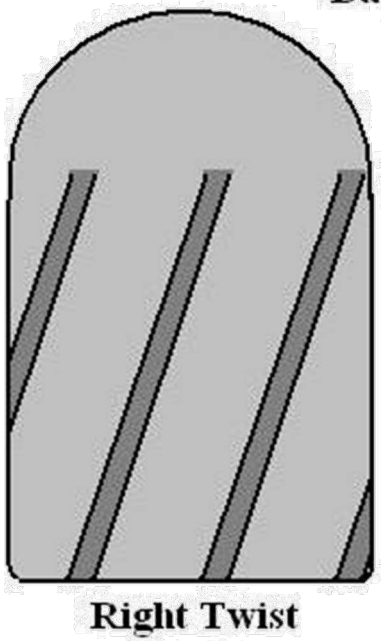
As a gun is fired, the barrel marks each bullet with a pattern unique to that gun. Therefore, bullets can be matched to the **exact** gun from which they were fired.

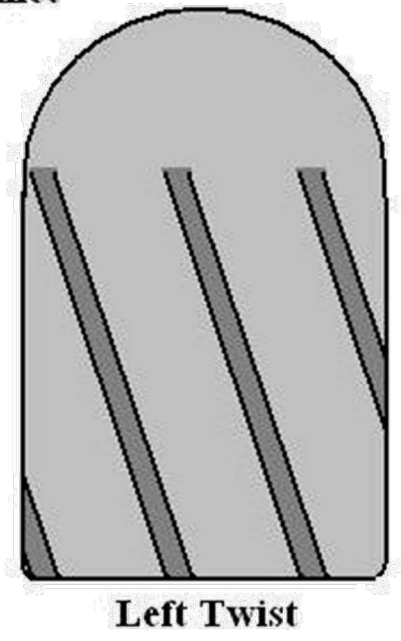
Bullets become scared by rifling as they travel down the barrel of a gun



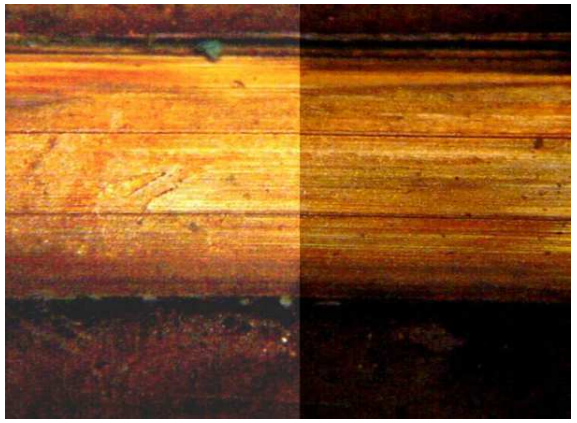
holding the nose of the bullet pointing away from you, the direction the impressions run away from you (either to your left or right) determines the direction of twist.

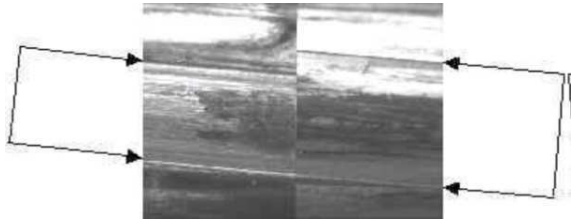


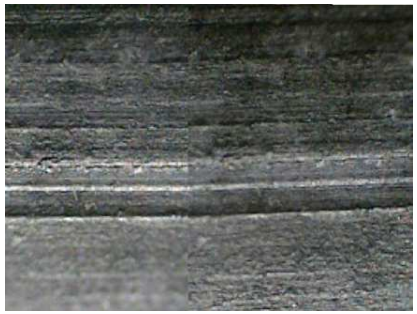




- It is extremely difficult to convict some one of a murder without possession of the murder weapon.
- In the case of a shooting, matching a bullet with a gun is essential in most cases.





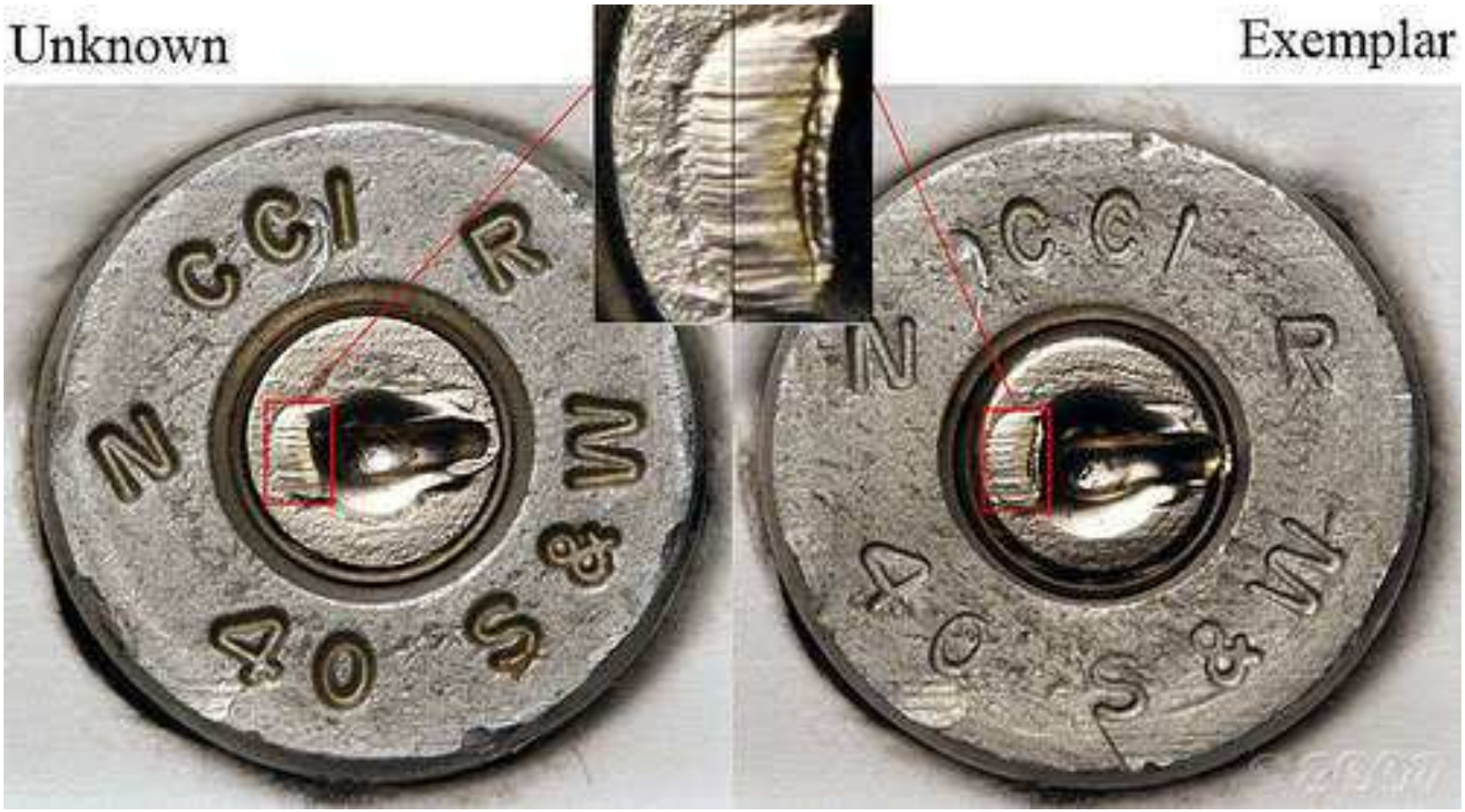


Matching Procedure:

- Fire bullets from a suspected weapon
- With the aid of a **comparison microscope**, compare these “test fires” to the suspected bullets
- Striations must be identical for a positive match

ii. Breech Marks

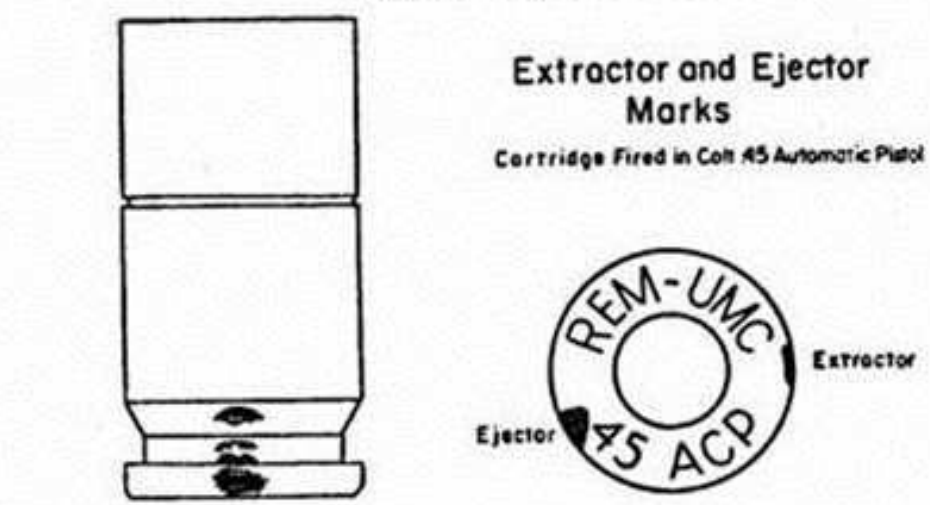
1. A **breechblock** prevents a cartridge from shooting backwards towards a user as it **recoils**
2. Unique marks are produced on the **casing** as it moves backward and hits the breechblock.

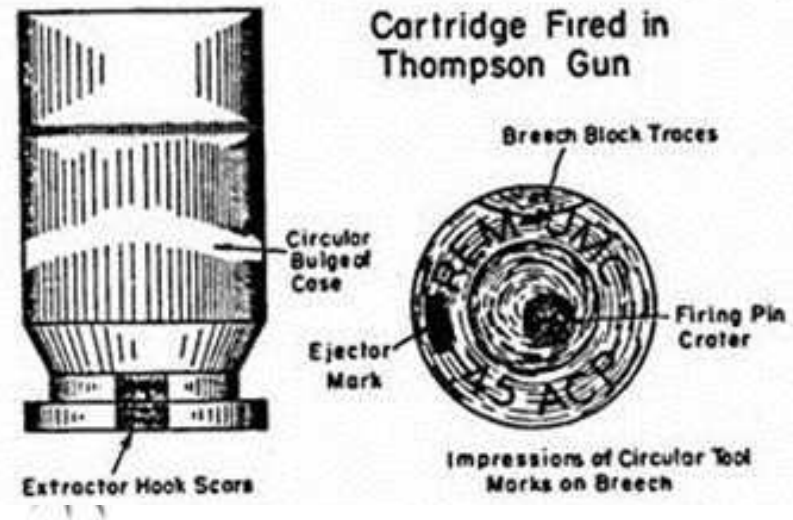


iii. Firing Pin Impressions

1. Impressions are made on the bottom of the cartridge by the firing pin as it strikes to fire.
2. Depending on the firearm and type of cartridge used, these marks can appear on the **rim** or the **center** of the used cartridge.

iv. Semiautomatic and automatic weapons also have **extractor** marks and **ejector** marks which are tiny scratches formed from the insertion and removal from the firing **chamber**.





Ballistic Databases

i. A firearm databases can be searched to match ballistic evidence from a crime-scene to **registered** weapons.
ii. Created in 1999, National Integrated Ballistics Information Network, or **NIBIN**, is composed of two combined databases:

1. National Integrated Bullet Identification System (N**IBIS**)- has records of ballistic markings of firearms used in **previous** crimes
2. Drugfire- FBI multimedia database imaging system that holds data on cartridge **casings**

IBIS
INTEGRATED BALLISTICS IDENTIFICATION SYSTEM

FBI
DRUGFIRE

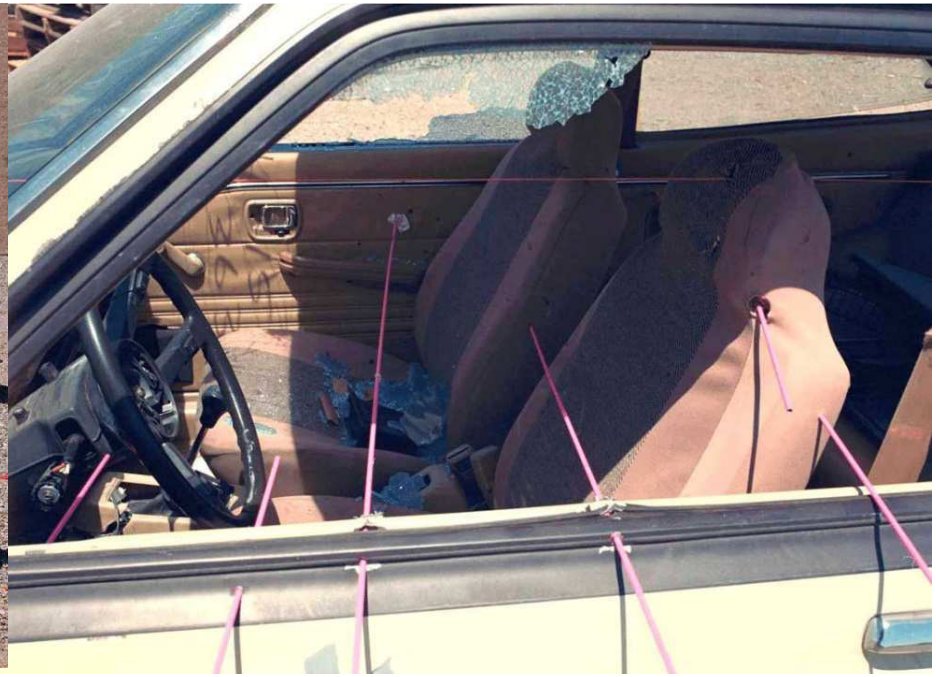
Gun Shot Residue (GSR)

a. Because of the explosion of gunpowder in a firearm, guns leave **residue** when fired.
b. GSR is trace evidence made of **smoke** and unused powder particles that can land on the **hand**, arm, face, hair, and clothing of the shooter and victim.
    i. Even if washed, chemical tests can **detect** residue.
c. The amount of GSR decreases as the **distance** between the firearm and shooter increase
    i. Therefore GSR patterns can be examined to help determine the distance from victim to shooter.

Trajectory

a. Trajectory is the **path** of a propelled bullet.

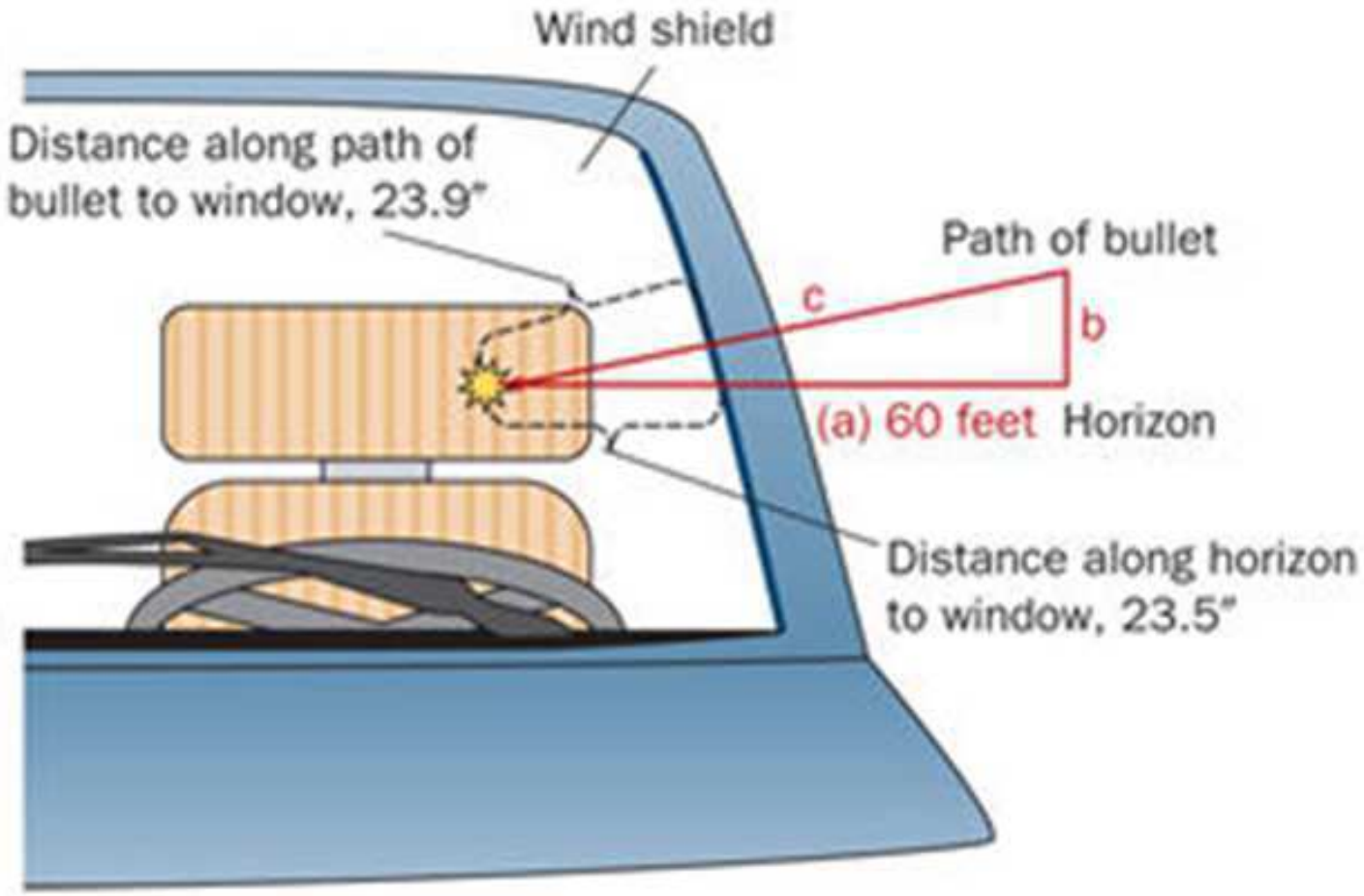
b. Ballistic evidence can help experts determine trajectory, and therefore figure out where a shooter was **located** during a crime.



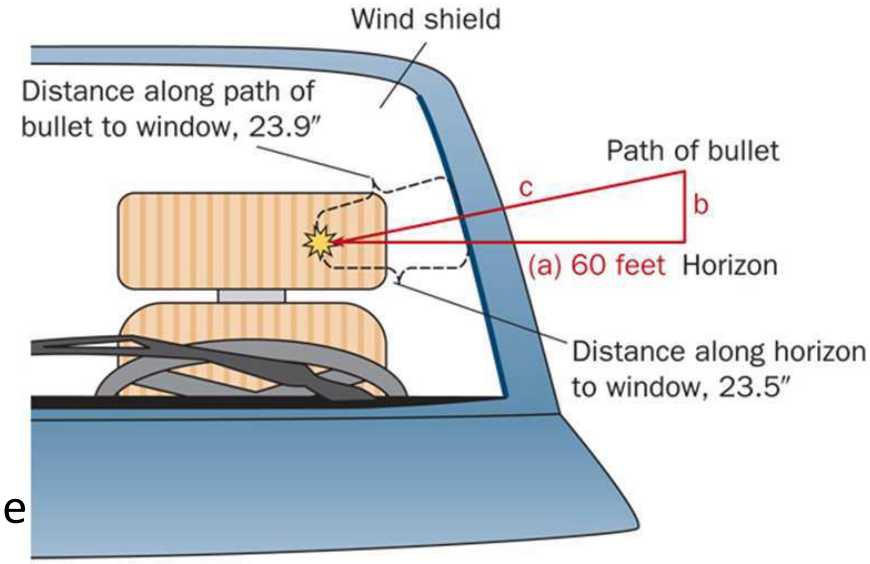
c. **Two** reference **points** are needed to calculate the trajectory.

i. Reference points can be bullet **holes**, gunshot **residue**, **empty** cartridges, and entry/exit points on a **victim**.

ii. Pythagorean's theorem can be used for **triangulation** with reference points.



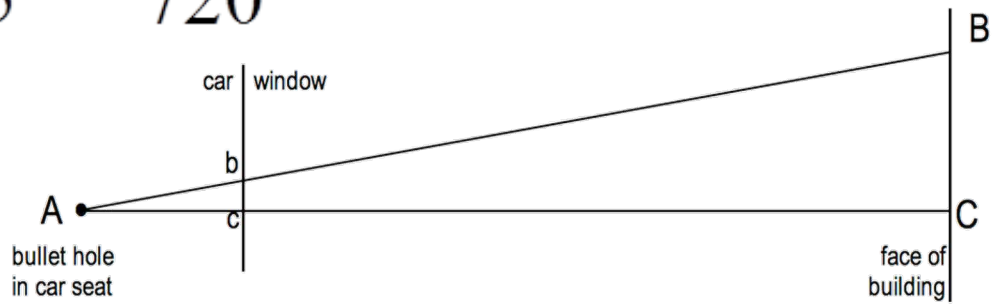
Building is 60 feet away along the horizon line; Bullet hole is 4 feet above the ground. Where is the shooter located?



B is where the shooter is located; find the length of BC. The Abc triangle has the same proportions as the ABC triangle

So $\frac{Ab}{Ac} = \frac{AB}{AC}$ or $\frac{23.9''}{23.5''} = \frac{AB}{720''}$

AB = 732.3”



Using Pythagorean’s theorem

$AB^2 = AC^2 + BC^2$

$732.32 = 7202 + BC^2$

$BC^2 = 732.3^2 – 720^2$

$BC^2 = 536117 – 518400$

BC = √17717 (square root)

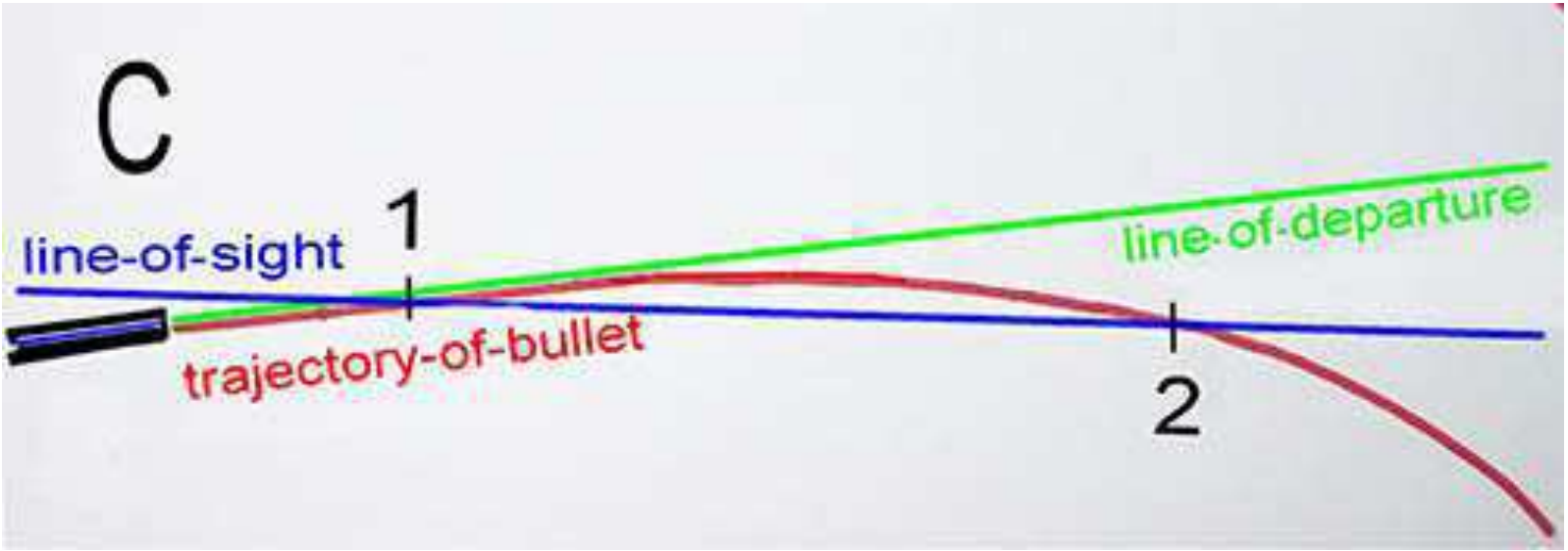
BC = 133.1 inches

BC = 11.1 feet

We know that the bullet hole in the seat is four feet above the ground, so the shooter is 15.1 feet above the ground

d. **Lasers** can also trace a straight-line path to determine the position of the shooter. Investigators can figure the shooter discharged the firearm somewhere along that line.

e. Keep in mind, a bullet's path may be slightly curved due to **gravity** pulling downward on the bullet as it propels forward, especially when shot from **long** distances.
   i. **Wind** speed and direction may also affect trajectory.



We can't change the laws of science, but by placing a sight on top of a rifle, we compensate for the differences between straight-line optics and curved trajectory by combining the two. This angle (exaggerated in the illustration) is what accounts for the idea of the rising bullet. Although the bullet does pass through the line-of sight from below, it never rises above the line-of departure. In a sense, a bullet is both rising and falling at the same time! It may be rising in relation to the ground, but it is still falling from the line-of-departure, even when the rifle is aimed and the bullet is fired in an upward angle.

Bullet Wounds

a. Eyewitness accounts are not always **accurate**, so it is important for forensic detectives to examine evidence to either confirm or **dispute** witness accounts.

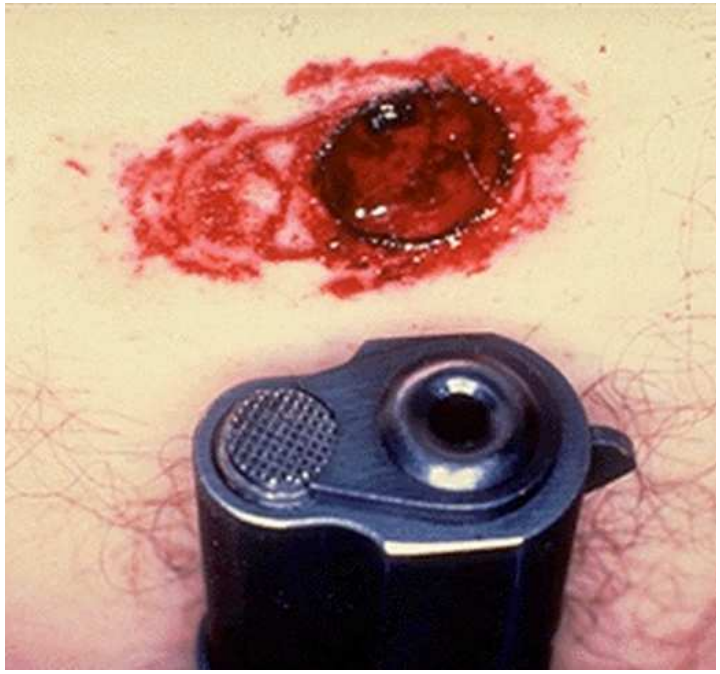
b. Bullet wounds can be helpful in re-creating a scene of a crime.

Expert in gunshot wounds: Dr Vincent di Maio holds up a picture of the closeup of Trayvon Martin's gunshot wound and explains the markings surrounding it and what it means

c. First step is to figure out if a bullet would is from entrance or **exit** of a bullet:
   i. Entrance wounds tend to be **smaller** because the skin **stretches** as a bullet enters.
      1. **Clothing** fibers may also embed in the entrance wound.
      2. Gunshot **residue** may also be found around an entrance wound.
      3. If the bullet is from a close contact muzzle, there will also be **burn** marks caused by the gun's hot **gases** as they release.

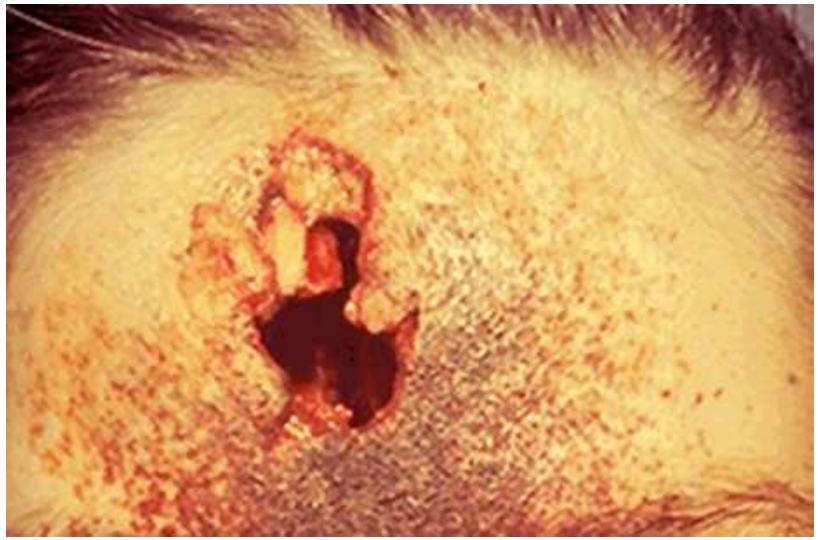
The abrasion ring, and a very clear muzzle imprint, are seen in this contact range gunshot wound. →

An abrasion ring, forms when the force of the gases entering below the skin blow the skin surface back against the muzzle of the gun.



Since the barrel contacts the skin, the gases released by the fired round go into the subcutaneous tissue and cause the star-shaped laceration. Note also the grey-black discoloration from the soot, as well as the faint abrasion ring.

Powder tattooing is seen in this intermediate range gunshot wound. The actual entrance site is somewhat irregular, because the bullet can tumble in flight.

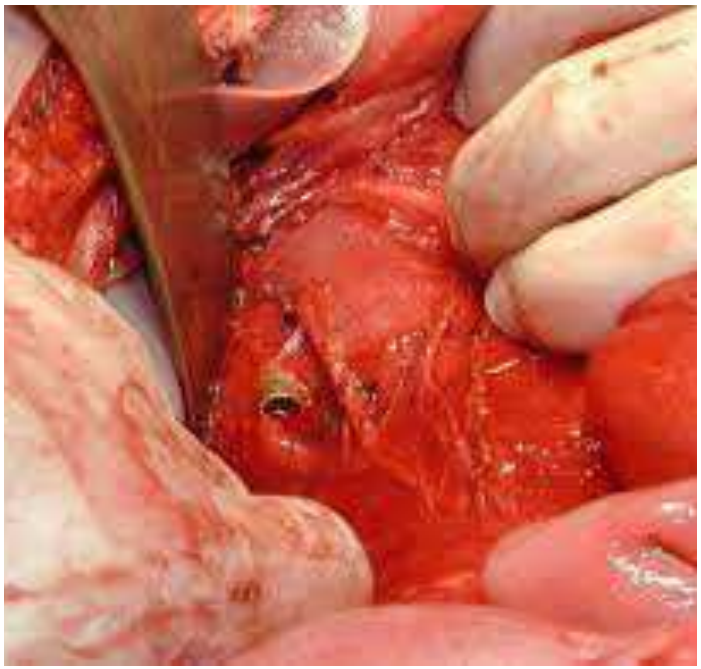


ii. Exit wounds tend to be **larger** because the bullet **carries** tissue and bone that it picked up as it moved through the body.

1. Bullets usually do not travel **smoothly** through a victim, and in many cases will ricochet off bones before exiting, or may not **exit** at all.
    a. Fast-moving **high** caliber bullets tend to pass through a victim.
    b. Small caliber and **low**-velocity bullets tend to stay lodged in the body.

Here is a slit-like exit wound. Note that there is no powder or soot visible

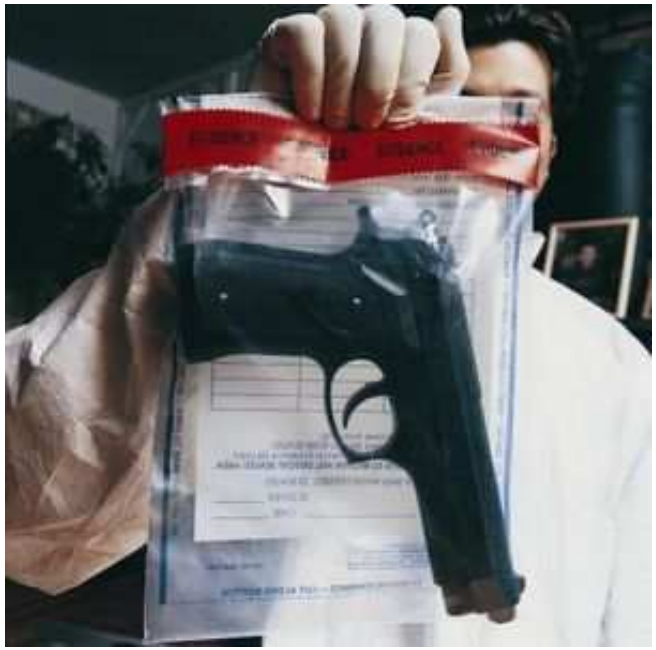
There may be no exit wound at all if the bullet's energy is absorbed by the tissues. Some bullets (such as a hollowpoint) are designed to deform so that all their energy will be converted to tissue damage and not exit.



Ballistic Evidence

Firearms

i. Never submit a **loaded** gun to the laboratory!
ii. Never pick up a weapon by placing a **pencil** or other object in the end of the barrel.
iii. **Record** serial number, make, model, and caliber of the weapon.
iv. Place weapons in well packed, strong cardboard or wooden **boxes** to prevent shifting of guns in transit.
v. If blood or any other material is present on the gun, place a clean **paper** around the gun and seal it with tape to prevent movement of the gun and loss of the sample during shipment.
vi. Remember the gun will likely be examined for **latent** fingerprints, so avoid excess handling.



Bullets and Cartridge Cases

i. Wrap recovered bullets and casings in paper and seal in separate labeled pill boxes or envelopes.

ii. Bullets recovered from a body should be **air** dried and wrapped in paper. Washing may destroy trace evidence.

iii. Always attempt to recover **unused** ammunition for comparison purposes.

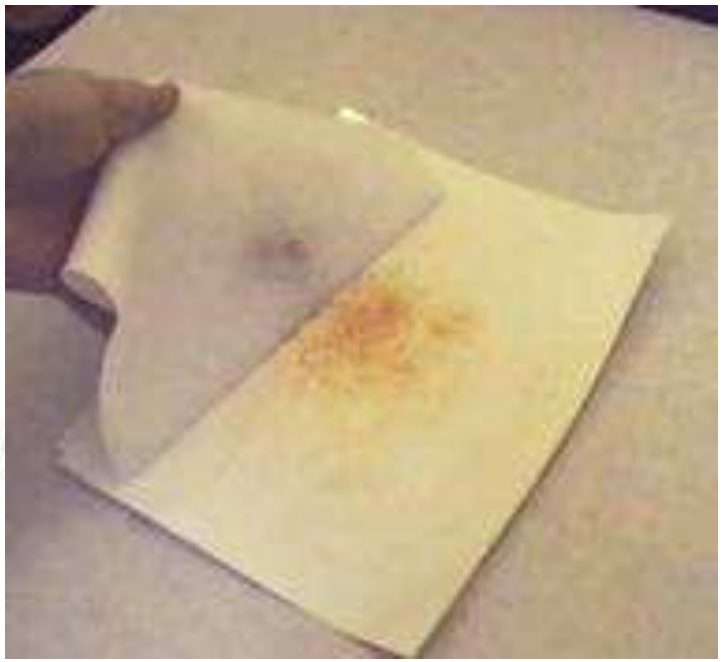
Gunshot Residue

i. Gunshot residue is extremely fragile evidence and should be collected as soon as possible (preferably within **three** hours of the discharge of firearm).

Hand Protection Bags are used to "bag" the hand of a decedent when suicide is suspected or to preserve valuable evidence on the hands of suspects or assault/sexual battery victims. The bagging of the hands prevents the loss of GSR from hands while the body is being transported to the medical examiner's office.

ii. Submit **clothing** or other material showing evidence of gun powder residue or shot holes to the laboratory. The clothing should be carefully wrapped in clean paper and folded as little as possible to prevent dislodging powder particles. Package each item separately.

How to detect gunshot residue



The first step is to visually and microscopically examine the evidence. The presence of any gunshot residues found around the bullet hole as well as the shape and appearance of the hole will be documented.

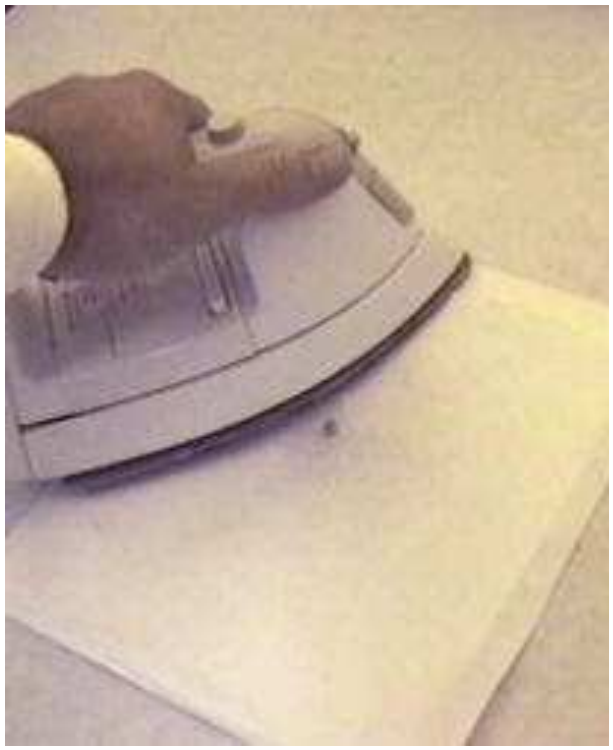
Video Clip

The next step involves chemically processing the exhibit for gunshot residues.

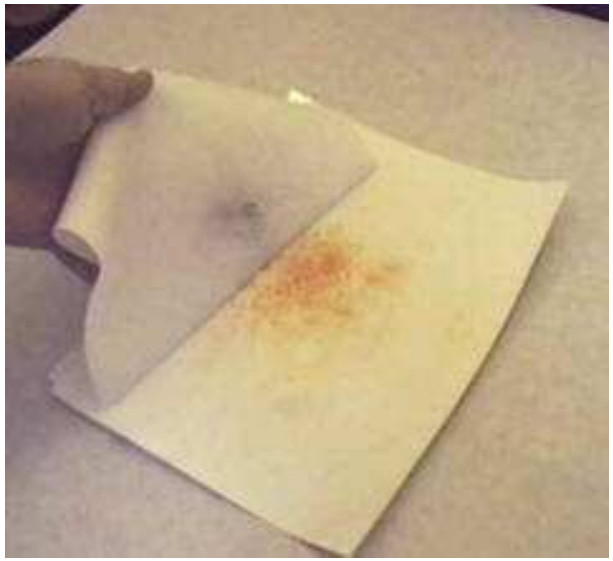
A common chemical test conducted on GSR is called the Modified Griess Test. The Modified Griess Test is performed first on the exhibit because it will not interfere with later tests for lead residues. The Modified Griess Test is a test to detect the presence of nitrite residues, which are a by-product of the combustion of smokeless gunpowder. This is the primary test used by firearms examiners to determine a muzzle-to-garment distance.

The Modified Griess Test

The Modified Griess Test is performed by first treating a piece of desensitized photographic paper with a chemical mixture of sulfanilic acid in distilled water and alpha-naphthol in methanol. The photographic paper will no longer be light-sensitive but will be reactive to the presence of nitrite residues.



The exhibit being processed is placed face down against a piece of treated photo paper, with the bullet hole centered on the paper.
The back of the exhibit being examined is then steam ironed with a dilute acetic acid solution in the iron instead of water.



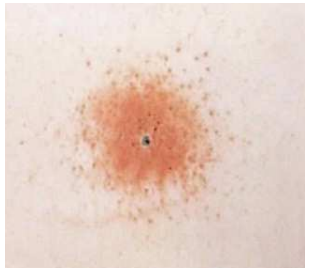
The acetic acid vapors will penetrate the exhibit and a reaction takes place between any nitrite residues on the exhibit and the chemicals contained in the photographic paper. The resulting reaction will appear as orange specks on the piece photographic paper.

Video Clip

Typical Patterns of Residue from Various Weapon Distances

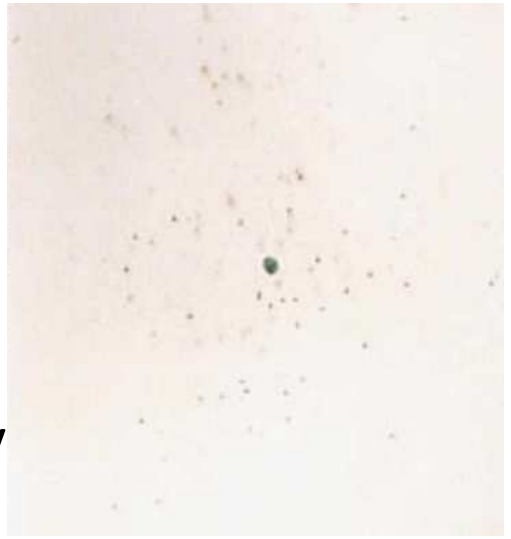
1 inch

- Heavy concentration of smoke-like vaporous lead surrounds bullet hole. Clothing/skin will show scorch marks from flame discharge of weapon.



12-18 inches

- Halo of vaporous lead (smoke) deposited around bullet hole



25-36 inches

- Scattered specks of unburned and partially burned powder grains can be found

More than 3 feet

- Will not deposit any residue on target's surface.
- Only visual indicator is a dark ring around the bullet hole called bullet wipe →