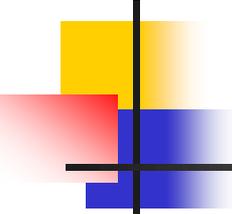


What is Forensic Ballistics?

Ballistics = the study of projectiles (bullets) and firearms.



Forensic ballistics is the scientific analysis or interpretation of all ballistic related evidence with the purpose of interpreting and establishing the facts in a shooting related crime



First, a little history lesson. Wham! Bam! Thank you, Ming.

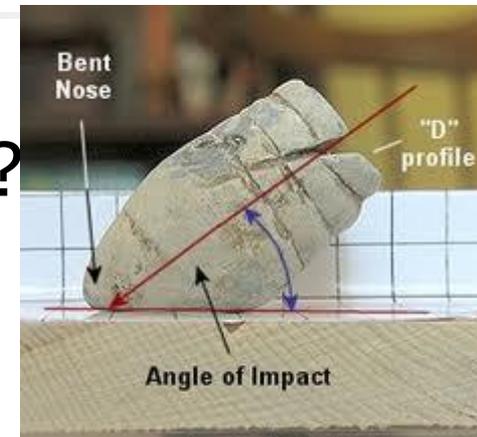
- The invention of gunpowder led to the development of firearms.
- Gunpowder first appeared in use in China over a thousand years ago, but was used primarily in firecrackers and only sparingly in weapons for military use (canons and such).
- The knowledge of gunpowder manufacture spread to Europe in the 14th century did not at first lead to military usage.
- Once they realized how much damage a projectile can do to a knight's armor or a fortification, the use of firearms proliferated rapidly.

How does Gunpowder (Black Powder) work?

- Gunpowder, made of a mixture of
 - sulfur,
 - charcoal, and
 - saltpeter (potassium nitrate)
- Its explosive force is due to the fact that 1 mole of solid powder will, when ignited, produce 6 moles of gas.
- This rapid expansion in the enclosed space of a metal tube could be used to drive a projectile at high speed in a specified direction.
- Modern gunpowder is a more refined version of the primitive gun powder
- In modern gun powder, the chemical composition has been altered to provide the *greatest expansion* with the smallest quantity of gun powder and the least amount of residue.

Ballistic evidence helps police answer the following questions pertaining to a crime scene.

- 1. What type of firearm was used?
- 2. what was the caliber of the bullet?
- 3. How many bullets were fired?
- 4. Where was the shooter standing?
- 5. What was the angle of impact?
- 6. Has this firearm been used in a previous crime?
- Caliber = a measure of the inside diameter of a firearm barrel.





Related evidence includes

- (a) firearms or guns
- (b) bullets
- (c) cartridge cases



- **Firearm = A weapon capable of firing a projectile using a confined explosive as a propellant.**
- **Bullet = the projectile that is released when the firearm is discharged.**
- **Bullet primer = a device for igniting the powder charge**
- **Cartridge = a case that holds a bullet, primer powder and gun powder.**



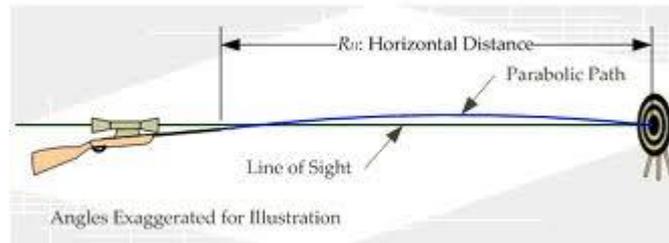
Ballistics Quiz

- `"http://investigation.discovery.com/investigation/quiz-central/dna-forensics/ballistics.html"`



**The most common types of crime scene evidence
Includes:**

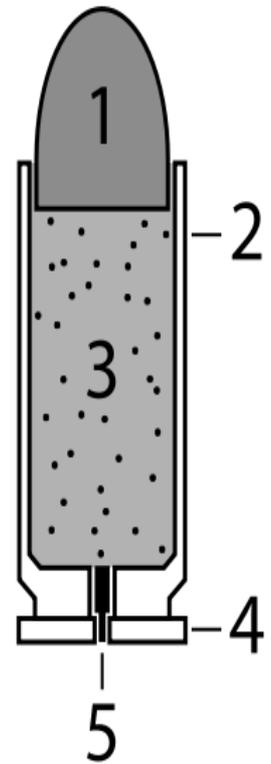
- (a) bullet holes**
- (b) bullet damage on various mediums**
- (c) bullet trajectories**
- (d) gunshot wounds**
- (e) Trajectory = the path of flight of the trajectory**
- (f) Bullet casings**



The anatomy of a cartridge

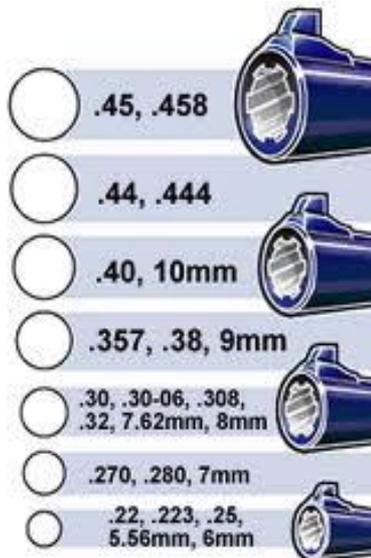
The typical cartridge is composed of

- The **bullet**. It's the actual projectile that comes out the loud end of the gun.
- The **casing**, or **shell**. It encloses everything.
- The **powder**. This is the stuff that combusts and propels the bullet out of the loud end of the gun.
- The **rim**. This is what the extractor grabs to eject spent casings.
- The **primer**. This is what the firing pin hits, which then ignites the gunpowder, which then propels the bullet out of the loud end of the gun.



Caliber of the Cartridge

- In guns including firearms, **caliber** or **calibre** is the approximate internal diameter of the barrel in relation to the diameter of the projectile used in it.
- Bullets are named by caliber and length.
- Some common calibers include: .22, .25, .357, .38, .44, .45.
- They are usually measured in hundreds of an inch.
- Ex.: A .45-caliber cartridge measures 45/100 of an inch in diameter.

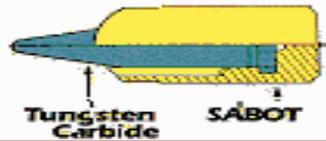


What are the basic types of bullets?

Ogive = the curve of the bullet's forward section



TIP SHAPES



Tungsten Carbide
SABOT

Full Metal Jacket



Soft Point



Hollow Point



OGIVE SHAPES

Spitzer



Round Nose



Flat Nose



Semi-wadcutter



Wadcutter



HEEL SHAPES

Flat Base



Boat Tail



How does a firearm work?

- This is a revolver

- 1. Barrel. The barrel is the part the bullet moves through after it is fired. The muzzle is the open end of the barrel that the bullet exits the gun through
- 2. Action. The action is the part that has the mechanism that fires the bullet.
- 3. Grip or Stock. Is the handle. It's a grip on a handgun and a stock on a long gun.
- 4. Trigger Guard. The piece around the trigger that protects it from getting bumped.
- 5. Trigger. The part your finger pulls to make the gun fire.
- 6. Sights. Sights come in various styles. Most firearms have a front sight at the muzzle end of the barrel, and a rear sight at the back end of the barrel.



Forensic officer labeling crime scene evidence

1. Make a list of all the evidence that you see in this crime scene the forensic specialist who will analyze this evidence in order to solve this crime.
2. Now assume the role of one forensic specialist and report your analysis.

Example: Ballistics Expert

Weapon is fully functional and in good operating condition.

The barrel of the weapon is clean with faint traces of carbon observed, consistent with a single shot being fired following the last cleaning.

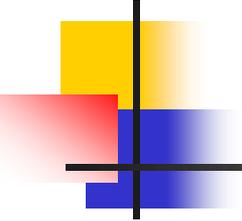
Bullet recovered from east wall of crime scene (Evidence # 001023-03) is a ballistic match to this weapon.

Bullet recovered during autopsy (Evidence # 001023-013) is not a ballistic match to this weapon.



h200177 [RM] © www.visualphotos.com

Comparison of Rifling Marks



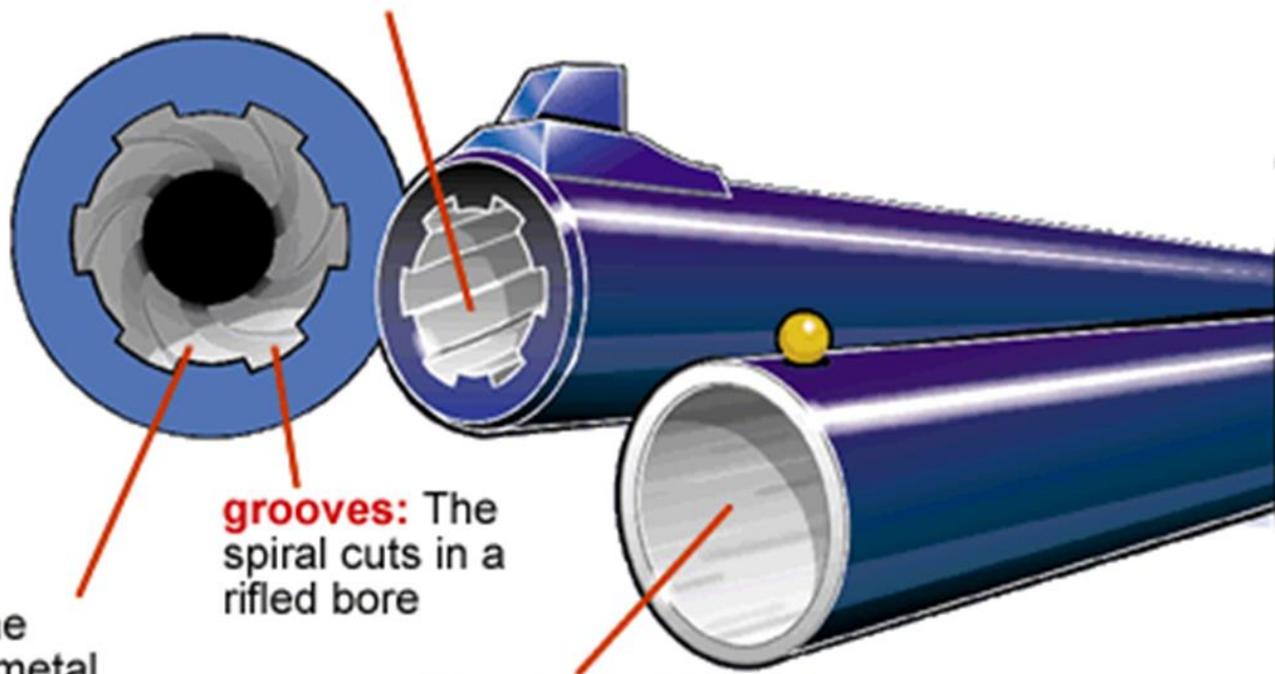
- No two rifled barrels are alike.
- Even made one after another, by the same manufacturer, the rifling process can never be identical.
- As the bullet is expelled through a barrel, the rifling causes it to spin.
- The rifling also leaves impressions on the surface of the bullet.
- These indentations on the bullet can help identify the firearm used.

- Rifling = The process or operation of cutting spiral grooves in a rifle barrel

Rifle, Handgun, and Shotgun Bores

Rifle or Handgun Barrel

The bore of a rifle or handgun is **grooved**, which puts a spiral spin on the bullet for greater accuracy.



lands: The ridges of metal between the grooves in a rifled bore

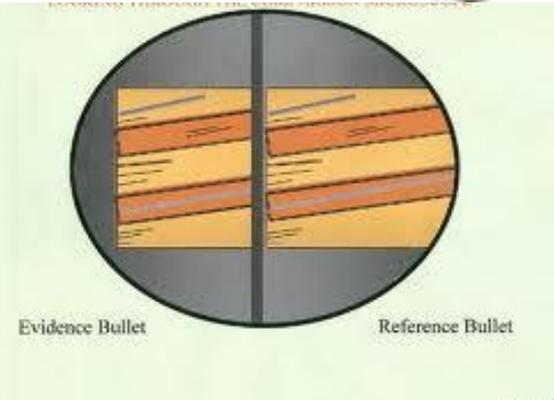
grooves: The spiral cuts in a rifled bore

Shotgun Barrel

The bore of the shotgun barrel is **smooth** because rifling would spread the shot pattern too soon.

Comparison Microscope

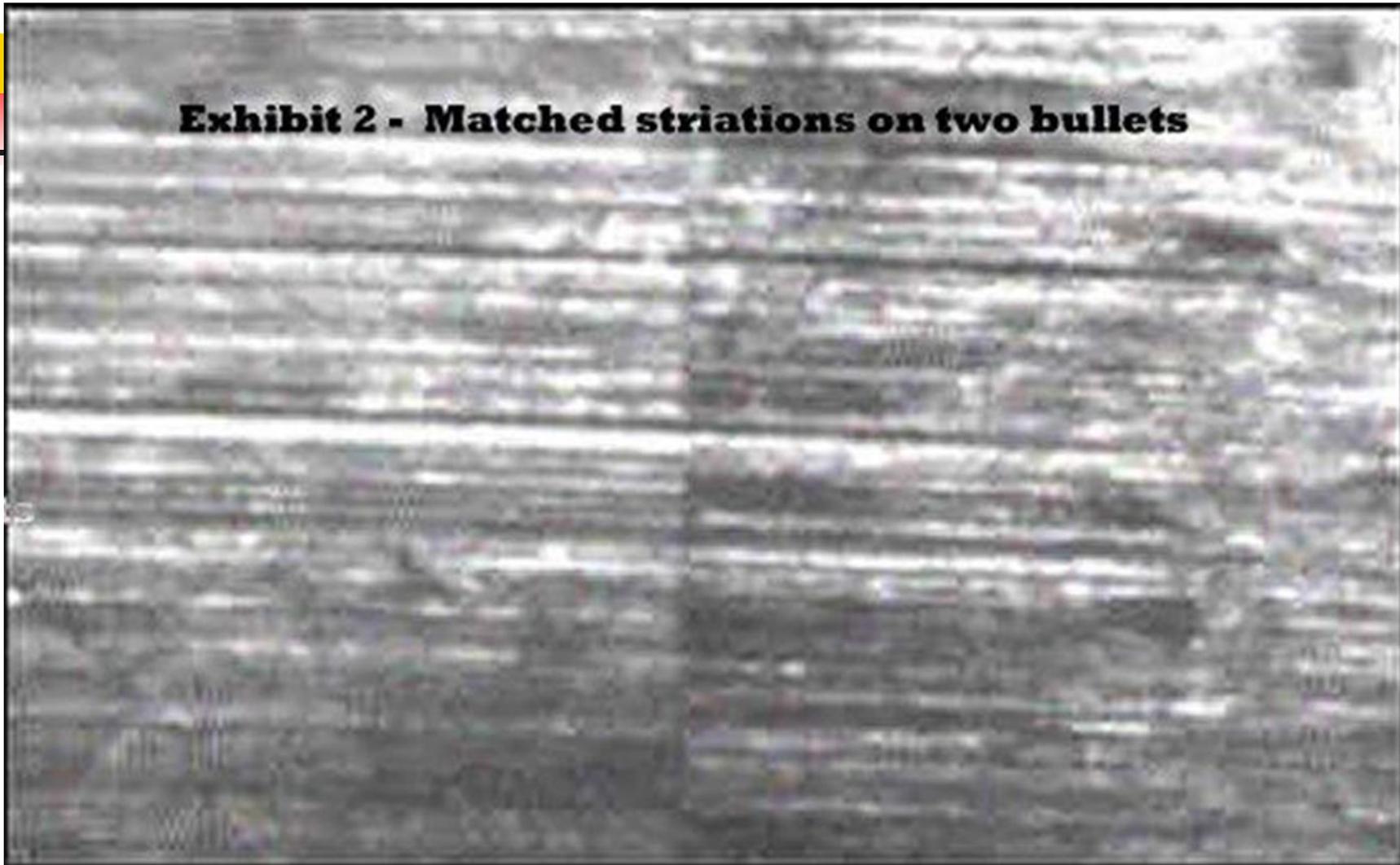
- **B**ullets collected for comparison to a specific firearm are examined first to see if they are of a **caliber** that could have been fired from the submitted firearm. They are then examined to determine if the pattern of **rifling impressions** found on the bullet match the pattern of **rifling** contained in the barrel of the questioned firearm. If these class characteristics agree the next step is to try to make a positive match between the individual characteristics that may have transferred to the bullet from the barrel.
- The comparison microscope consists of two microscopes mounted side by side and connected by an optical bridge. There are two stages on the lower part of the macroscope that the bullets to be compared are mounted on.
- *Magnifications typically used in firearms identification are 5X, 10X, 20X, 30X, and 40X.



The bullet on the left was fired from an automatic pistol, and the rifling grooves are the same distance apart from top to bottom. The bullet on the right was fired from a revolver, and the grooves are wider at the top than at the bottom, due to slippage.



Exhibit 2 - Matched striations on two bullets

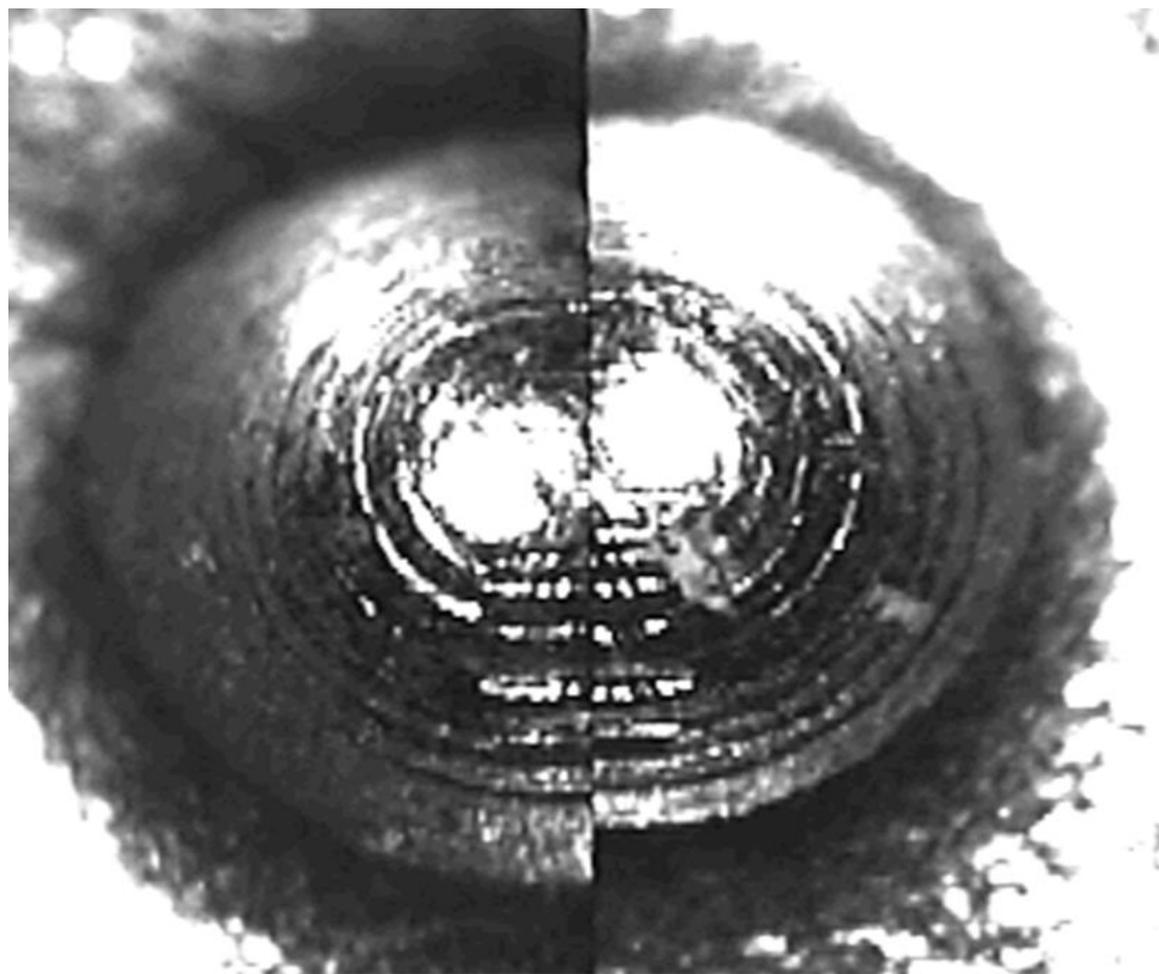


Comparison of Firing Pin Indentations

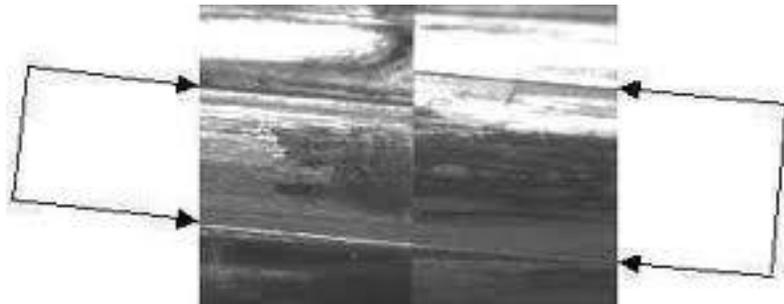
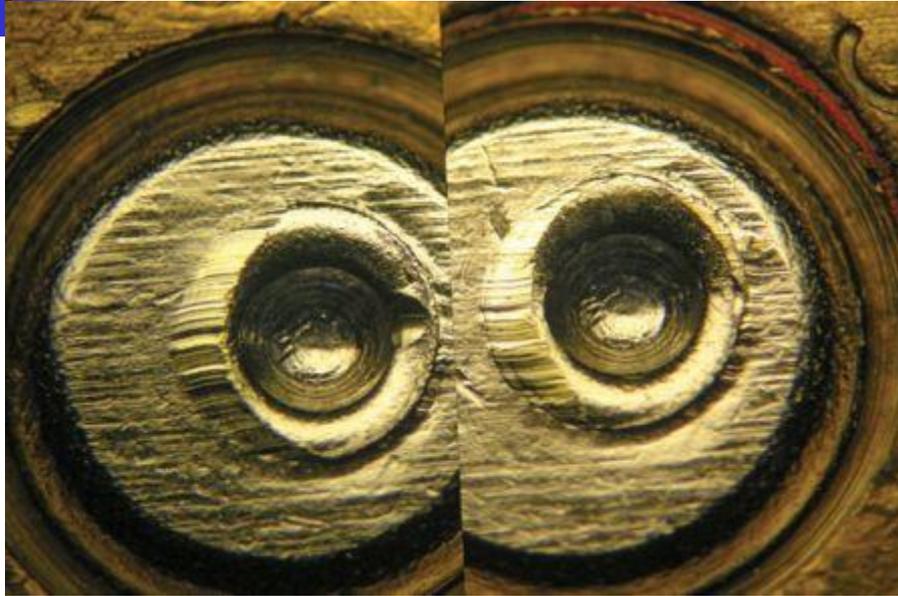
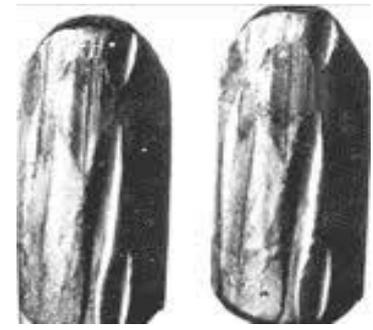
- Examination of some ballistic characteristics can be done with the naked eye. Cartridge on the left was fired from a "Glock" automatic pistol, as for the one on the right, it could have been fired from many different guns, and closer examination is required.



Two cartridges with the same firing pin imprint – positive I.D.



Bullet Comparisons



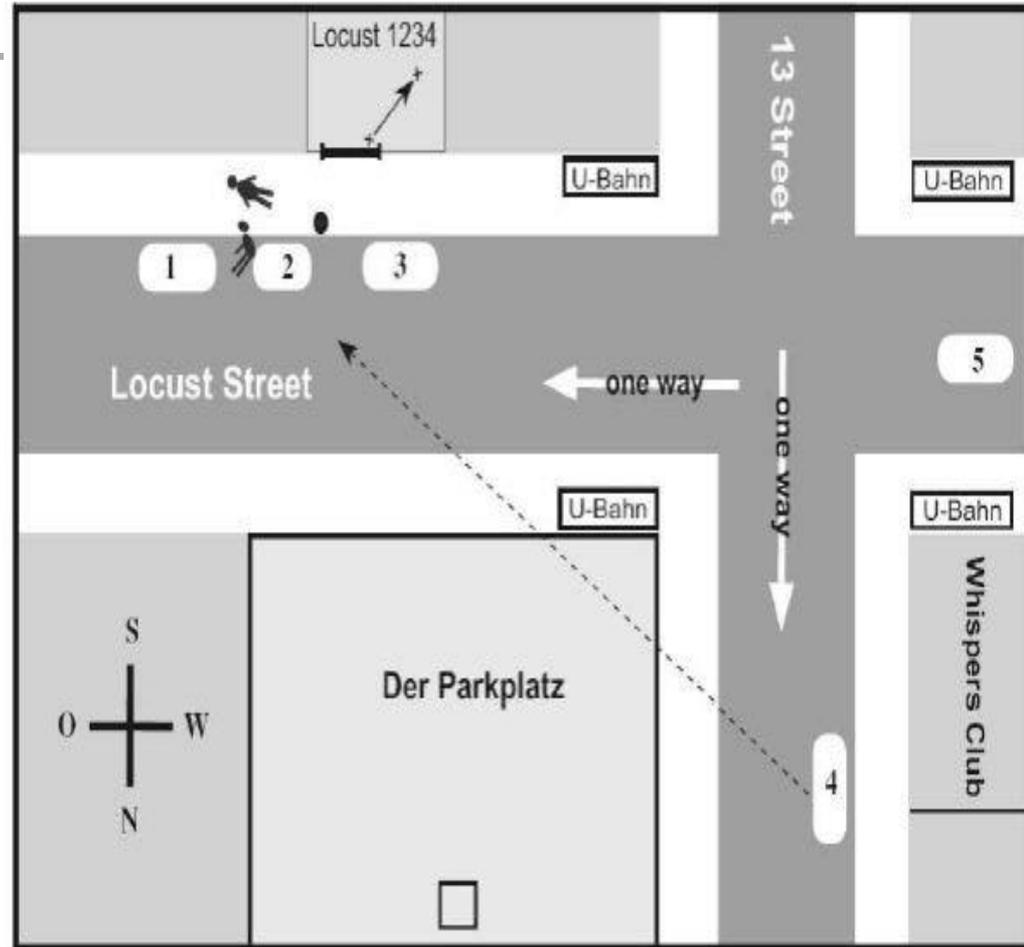
Use the information below to write two lines of evidence based on ballistics: One for the prosecution and one for the defense.

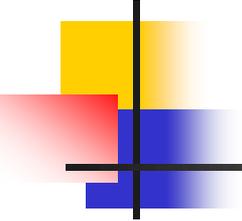
Mumia Abu-Jamal is an American convict, serving a life sentence for the 1981 murder of Philadelphia police officer Daniel Faulkner. He was sentenced to death in July 1982. He was removed from death row in January 2012.

(4) Mumia's car (5) Scanlan's car (Short Arrow at 1234 Locust) The trajectory of the bullet inside the vestibule (Long Arrow From 4) Mumia's direction approaching the scene. Mumia's direction is in contradiction to the bullet trajectory and the fragments found in the wall.

A .38 caliber revolver, belonging to Abu-Jamal, with five spent cartridges was retrieved beside him at the scene. He was wearing a shoulder holster, and Anthony Paul, the Supervisor of the Philadelphia Police Department's firearms identification unit, testified at trial that the shell casings and rifling characteristics of the weapon were consistent with bullet fragments taken from Faulkner's body.

Tests to confirm that Abu-Jamal had handled and fired the weapon were not performed, as contact with arresting police and other surfaces at the scene could have compromised the forensic value of such tests.





**Forensics Ballistics is divided into 3 sub-
categories**

(a) internal

(b) external

(c) terminal ballistics



Internal Ballistics

The study of the processes occurring inside a firearm when a shot is fired. The most common types of internal ballistics are:

- (a) examining mechanism to determine the causes of accidental discharge**
- (b) examining home-made devices to determine if they are capable of discharging ammunition effectively**
- (c) microscopic examination and comparison of fired bullets and cartridge cases to determine whether a particular firearm was used**

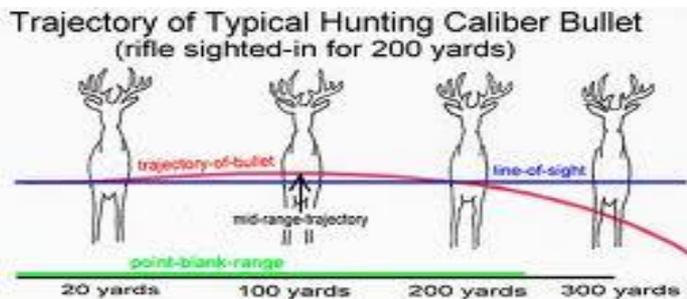
A comparison microscope is a device used to analyze side-by-side specimens

External Ballistics

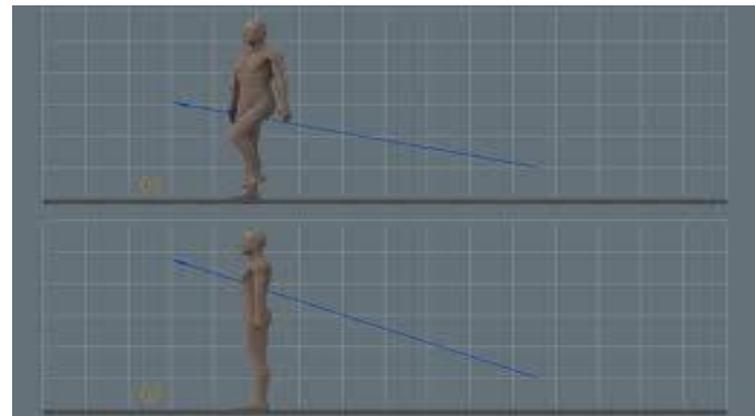
The study of the projectile's flight from the moment it leaves the muzzle of the barrel until it strikes the target.

The 2 most common types of external ballistics examinations are:

- (a) the calculation and reconstruction of bullet trajectories
- (b) establishing the maximum range of a given bullet



* Items and distances between given yards are not drawn to scale.





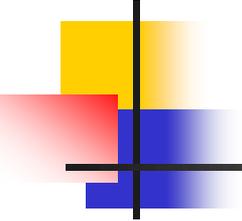
Terminal Ballistics

The study of the projectile's effect on the target or the counter-effect of the target on the projectile.

The 'target' can be any solid or liquid object, but when the target is a human or animal it is common to use the term "wound ballistics".

Common types of terminal ballistics examinations are:

- (a) determination of the distance between firing point and target.**
- (b) establishing whether or not a particular wound was caused by a fired bullet.**
- (c) determining the caliber and type of projectile that caused bullet damage or gunshot wound.**
- (d) examination of bullet exit/entrance by examining the holes in targets, or the wounds in biological tissue.**
- (e) examination of ricochet possibilities and fired projectiles.**



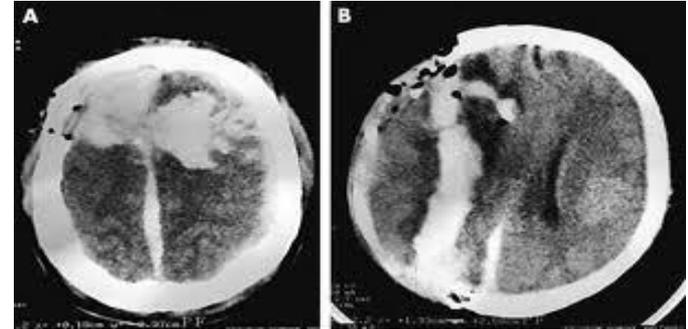
Gunshot Injuries

The seriousness of gunshot wounds depends on 5 factors

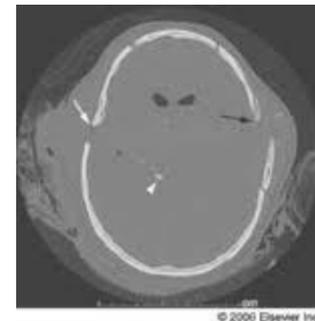
- (a) kinetic energy of the bullet**
- (b) distance to the target**
- (c) type of tissue**
- (d) tumbling (flipping around or going straight through)**
- (e) bullet design ex. hollowpoint, vs. round nose etc.**

Gunshot Wounds (GSW)

- Two types of gunshot wounds:
- Penetrating--the bullet enters, but does not leave the body
This means there is only an entrance wound, and the bullet is somewhere in the body.
- Perforating--The bullet enters and exits the body.
This means that there is an entrance and exit wound, and the bullet has left the body



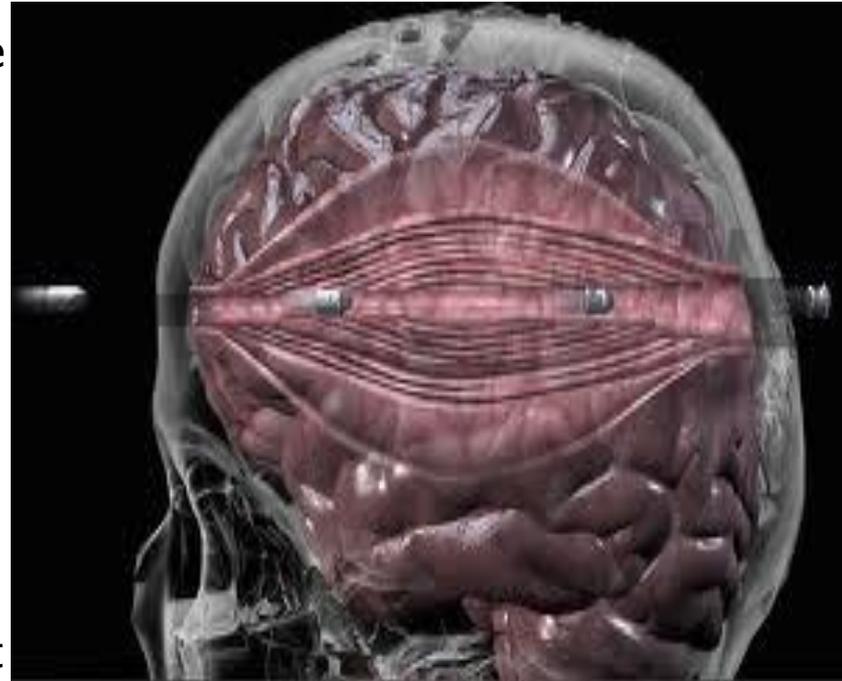
Axial CT scan of patients with **penetrating gunshot wounds**



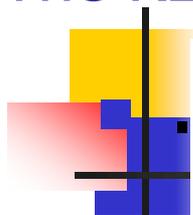
Perforating bullet

What happens when a bullet enters the body?

- The bullet hits the skin first, yet it does not penetrate immediately. The bullet pushes on the skin until the skin breaks.
- This can result in the skin being pushed back into the body a considerable distance (very similar to hitting someone with a blunt object).
- Finally the skin breaks and the bullet can enter the body.
- Once the bullet is in the body it creates one or two cavities (hollow spaces). The cavity is created because the tissue is pushed out of the way of the bullet.
- Low power bullets only create a small permanent cavity
- High power bullets create a very large temporary cavity (like a splash in water) and a permanent cavity. It is this temporary cavity that can cause massive wounds.



The KE of the bullet is key to the amount of damage it can cause



$$KE = 1/2 MV^2$$

Full Metal Jacket (High Speed)



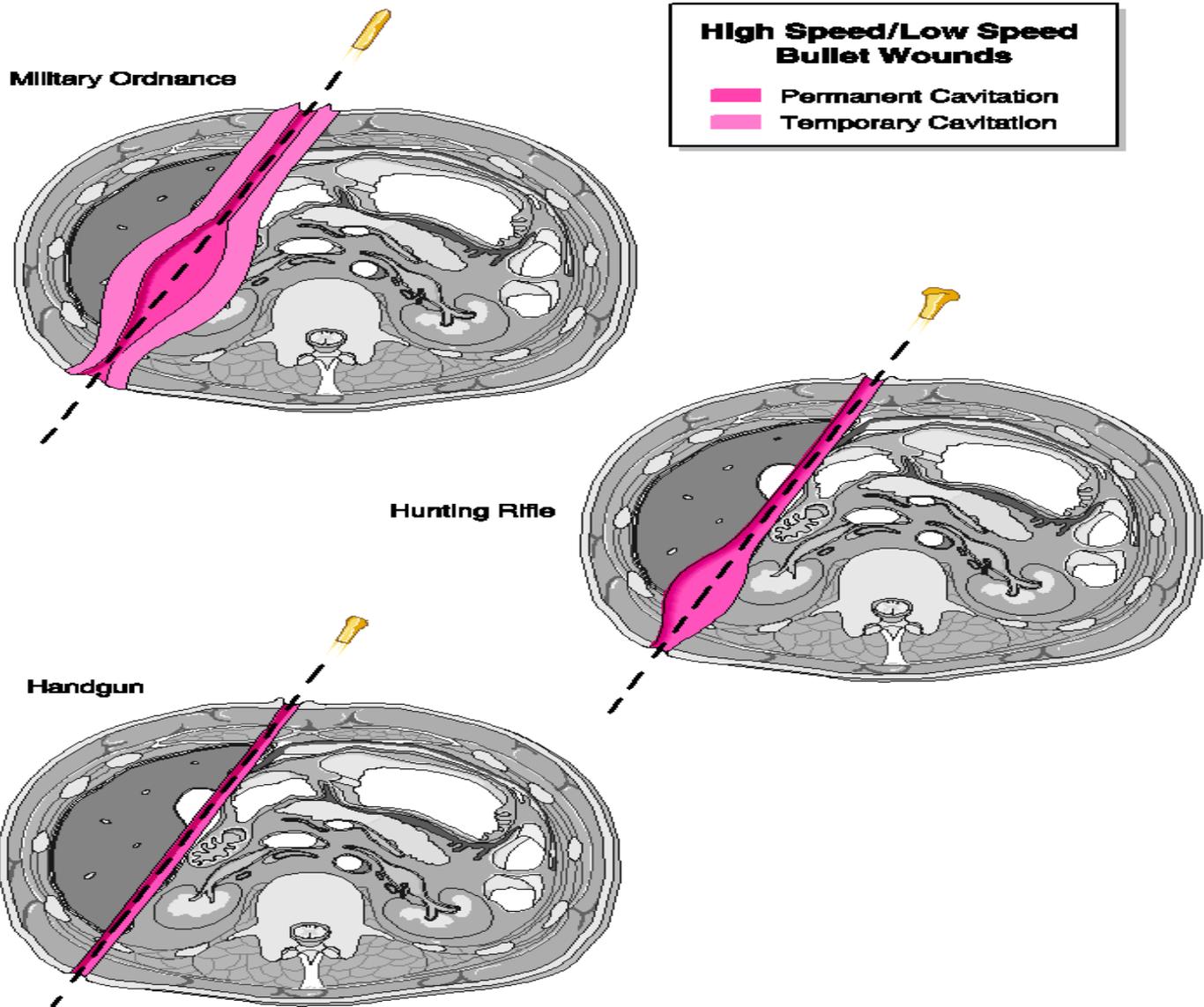
Hunting Rifle (High Speed)



HandGun (Low Speed)



In the diagram below, the difference between temporary and permanent cavitation is shown in terms of color, with the paler color indicating the temporary cavitation.



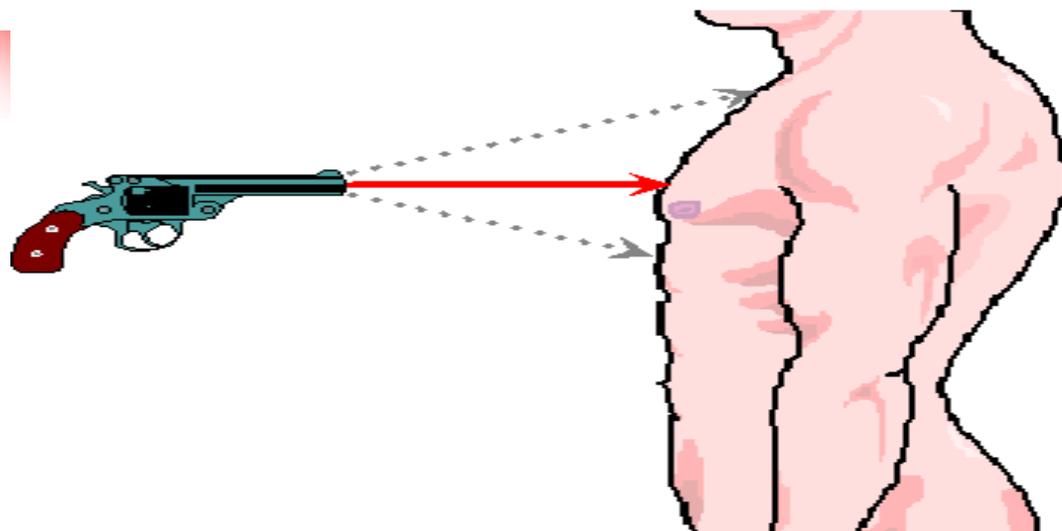


Distance Determination

- There are four categories of distance for a forensic pathologist/investigator--distant, intermediate range, near contact, contact
- Distant shot-- no powder burns on the skin, no pieces of unburnt powder (called stippling), a slight grey smudge around the entrance wound called bullet wipe (lubricant, lead, powder, and other materials)
- Intermediate shot--no powder burns, stippling is present (the larger the surface that has stippling, the further the shot was taken from), bullet wipe present on the wound
- Near Contact shot--powder burns on skin, clothing and hair, stippling is present in a very narrow area, bullet wipe hard to see because of other materials present
- Contact shot--Powder burns present, clothing and skin may be torn from the introduction of gases, stippling inside the wound

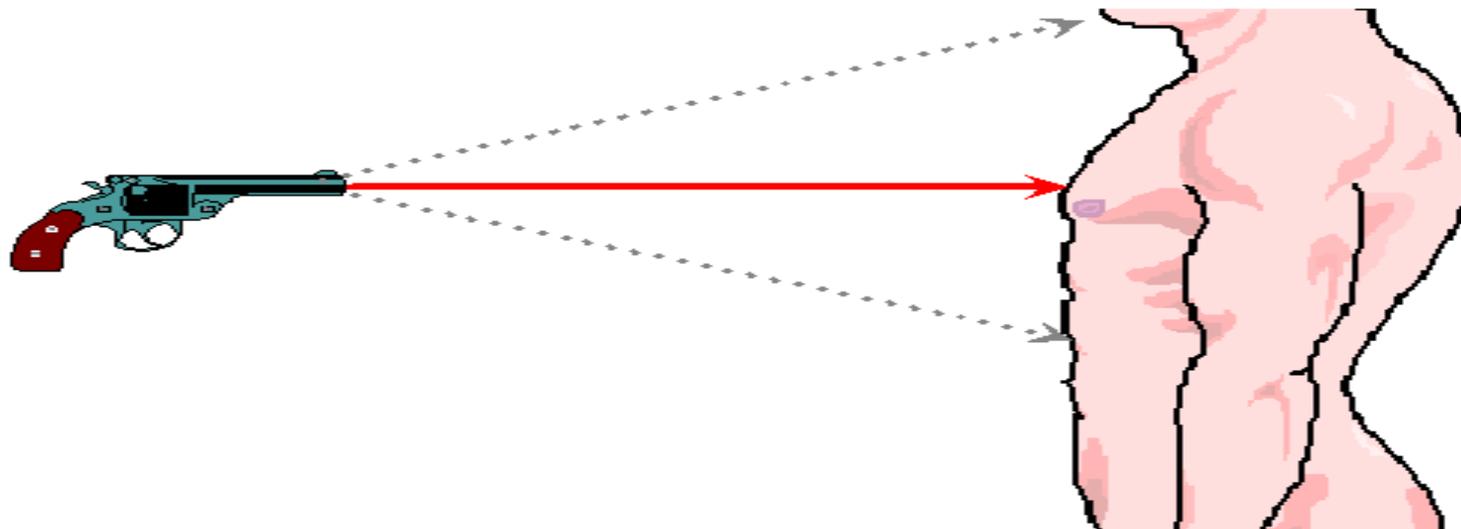
**= Pathway of the powder
(creating powder burns)**

= Pathway of the bullet



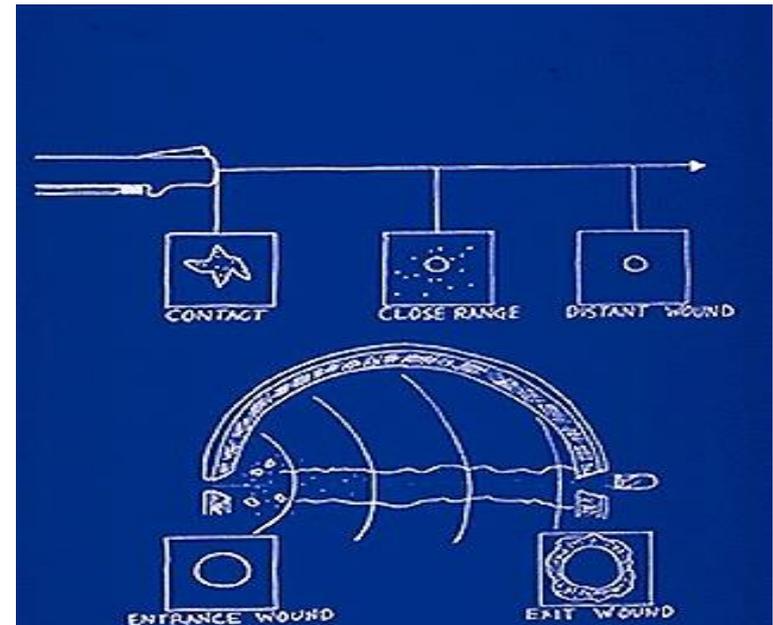
NOTE:

- 1. The greater the distance, the larger the dispersal of the powder burns.**
- 2. The larger the dispersal, the less densely packed the powder burns**



Range of Fire

- One of the commonest determinations of the forensic pathologist is the range of fire. Gunshot wounds are typically classified as
- Contact -characteristically have soot on the outside of the skin, and muzzle imprint, or laceration of the skin from effects of gases.
- Close range or Intermediate range- Intermediate, or close-range, wounds may show a wide zone of powder stippling, but lack a muzzle imprint and laceration.
- Distant range-are lacking powder stippling and usually exhibit a hole roughly the caliber of the projectile fired.



Contact Wounds



In a hard-contact wound, the muzzle is held tightly against the skin. The cherry-red color of the blood is probably due to carbon monoxide from the incomplete Combustion of gunpowder.



Note barrel-shaped bruise and soot around Bullet wound



The contact wound may exhibit triangular shaped tears of the skin. These tears are the result of injection of hot gases beneath the skin. These gases will cause the skin to rip and tear in this characteristic fashion.

Stippling or Tattooing



Stippling or powder tattooing is the term used to describe the circular pattern of dots created around a *gunshot wound* when a firearm is discharged in very close proximity to the Skin.

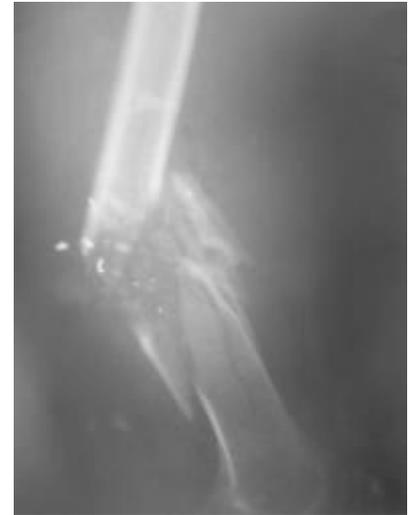
Radiographs of Bullet Damage



Gunshot injury in a young man who presented to the emergency department with a single bullet hole in the thorax. Arrow and arrowheads show at least three separate clumps of lead which could not possibly have come from a single bullet. An old radiograph from the files shows that two of the clumps of lead predated the current injury.



Fractures involving the femur with multiple bone fragments and gun pellets.



Radiographs of Bullets



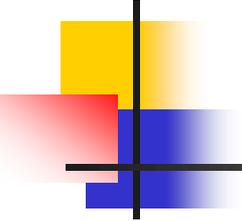
Bullet lodged in
foot of soldier



Multiple gunshot
pellets in left foot



.22 caliber bullet
Lodged in the skull



Tissue

- the more dense the tissue the greater the damage (will create permanent cavity)

ex. muscle is more dense than lung

tissue

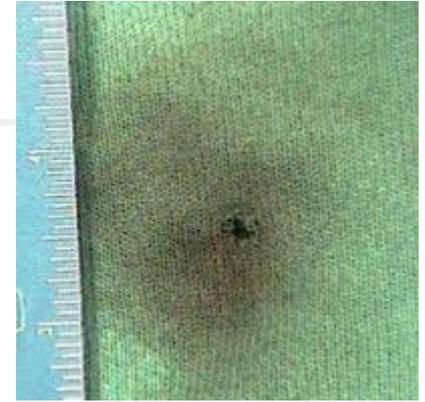
- the more elastic the tissue the less damage because will NOT create a permanent cavity

ex. muscle tissue is more elastic than organ tissue

What is Gunshot Residue (GSR)?

Gunshot residue is composed of 2 substances

- (a) propellant (Gun Powder)**
- (b) primer**



Time-lapsed image showing a bullet exiting from the barrel. Streaks of burning gunpowder, smoke, and unburned particulate can be seen exiting the barrel as well.



Difference between a Revolver and a Pistol



Colt M1917 Cal. .45 Revolver with 5-1/2 inch barrel