

**U3: IT'S IMPRESSIVE**

# Q: What is impression evidence?

- Impression evidence can be defined as **objects** or **materials** that have retained the characteristics of other objects through **direct contact**.
- Impressions are created when **one object** is pressed against another material with enough **force** to leave an impression of the object.
  - Examples:
    - Shoeprints, tool marks, tire tracks, bite marks, marks on a fired bullet



# Q: What is impression evidence?

- The **quality** of the impression depends on:
  - The object making the impression
  - The surface conditions
    - i.e., how hard or soft it is and what type of material it is (soil, mud, dust, concrete, grass, skin, etc.)

# Q: What is impression evidence?

Impressions fall into three basic categories

- **Patent Impressions**
  - Visible 2D impressions produced as an object moves through soil, dust, paint, blood or other fine particles and leaves a trace

# Q: What is impression evidence?

Impressions fall into three basic categories

- **Latent Impressions**
  - Hidden to the eye but can be visualized through the use of special dusting and electrostatic techniques or chemical developers
  - Oils, fine soil and other minute debris can be carried onto clean floors and be transferred as a latent impressions

# Q: What is impression evidence?

Impressions fall into three basic categories

- **Plastic Impressions**

- 3D Imprints
- Can be left in soft materials (snow, mud, oil, soap)
- Easily lost
  - A strong wind or a sudden change in the weather can mean the loss of important evidence



## **Q: How do we analyze impression evidence?**

Investigators analyze impression evidence to find unique characteristics to link shoes, tires, tools, and other objects found in a suspects possession to evidence at a crime scene.

# Q: How do we analyze impression evidence?

- Collection of impression evidence can be accomplished using several methods:
  - **2-D:** This type of impression is documented using **photography**.
    - Some impressions may be **dusted with fingerprint powder to be photographed or lifted with tape**.
    - They may also be collected using an **electrostatic** dust lifting process



# Q: How do we analyze impression evidence?

- Collection of impression evidence can be accomplished using several methods:

- 3-D:** This type of impression can be **documented using photography as well as by casting**

- Casting involves using **dental stone** or a similar substance to **preserve the dimensional characteristics** of the print.



“If you say that this bite fits this person and nobody else in the world, and if you use the bite mark as the only piece of physical evidence linking an attacker to his victim, that’s not science — that’s junk.”

Dr. Richard Souviron  
Chief Forensic Odontologist  
Miami-Dade Medical Examiner’s Office.

Guided notes!

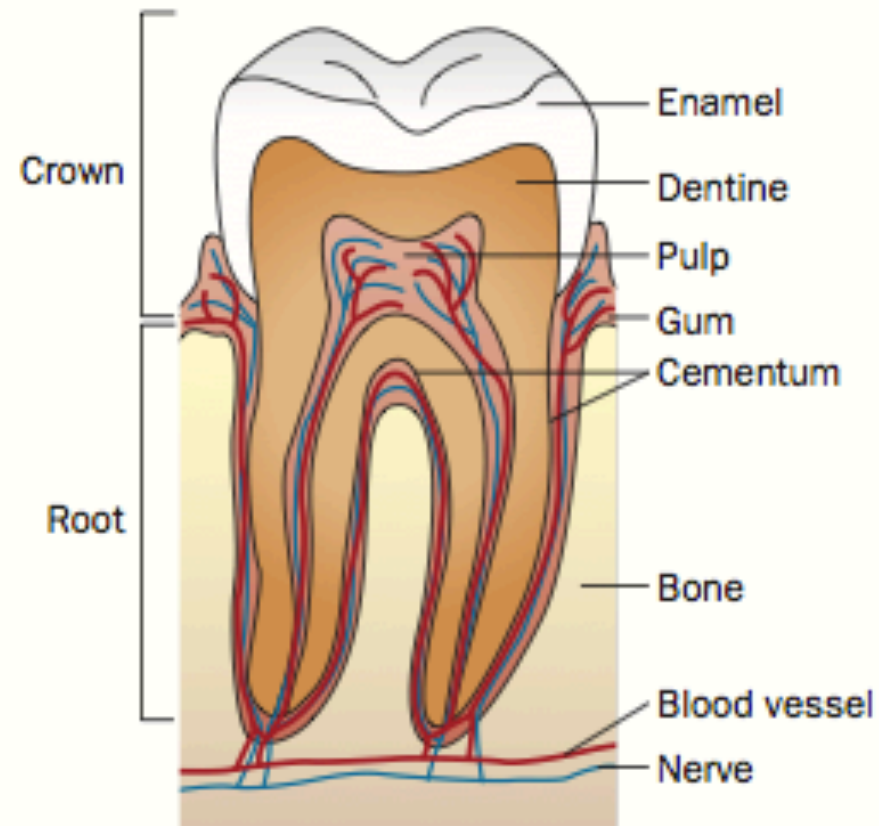
# **BITE MARKS & DENTAL IMPRESSIONS**

# Q: What are Teeth?

- Digestion begins in the mouth
- Enzymes in the saliva chemically break down complex carbohydrates into simpler molecules
- **Teeth mechanically grind and crush food**
- Tooth is divided into three regions
  - **Crown**—above the gum line
  - **Neck**—where crown and root meet
  - **Root**—embedded in in bony socket

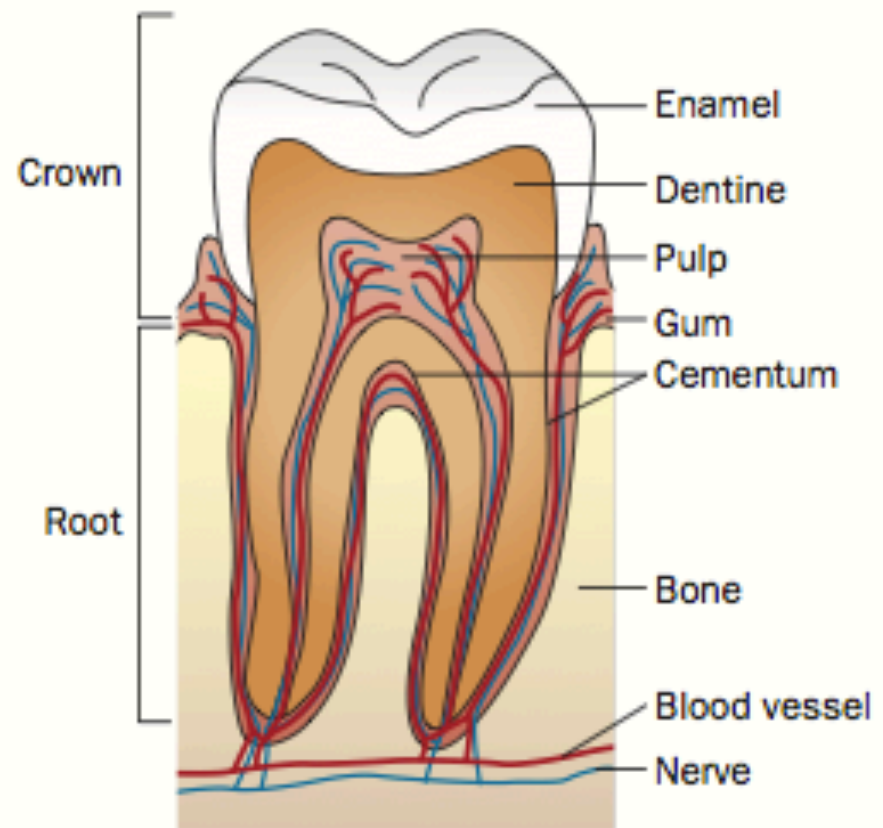
# Q: What are Teeth?

- **Enamel**
  - a tough covering that protects the living tissue underneath
  - composed of **calcium** and **phosphorus**
  - hardest substance in the human body
- **Dentin**
  - a connective tissue that has *calcified* and **gives teeth their basic shape.**



# Q: What are Teeth?

- **Pulp**
  - a softer connective tissue inside the tooth; **contains nerves and blood vessels**
- **Cementum**
  - a **bonelike substance** that covers the dentin in the root
- **Periodontal ligament**
  - **anchors the tooth to the bone**
  - keeps teeth in alignment
  - acts as shock absorber



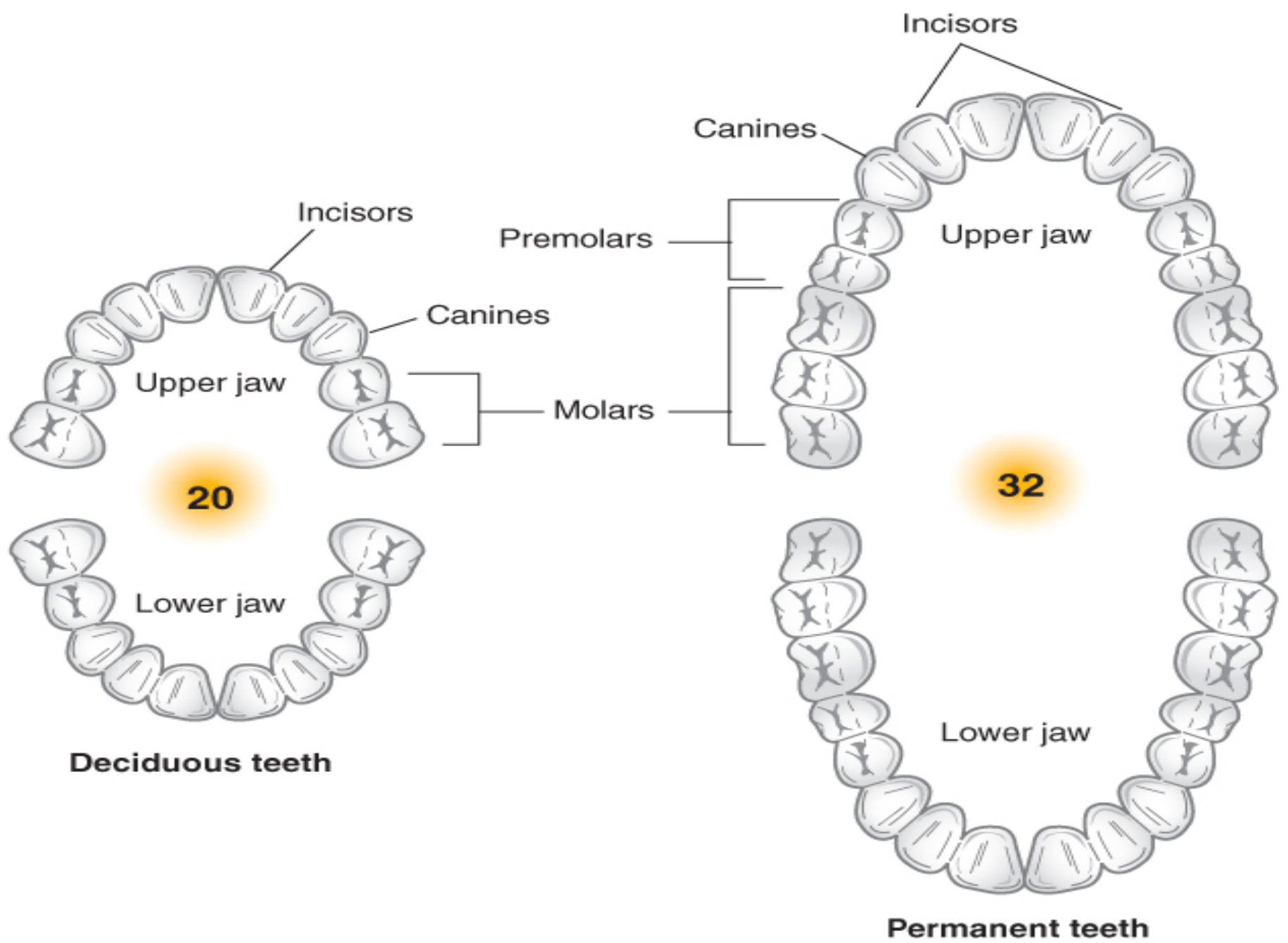
# Q: What are Teeth?



- The appearance of **20 primary, baby teeth** follows a predictable pattern beginning in the first 7 to 12 months of life.
  - Replaced by **32** permanent teeth.
  - **Wisdom teeth = last to develop** (emerge between 17 and 21)

# Q: What are Teeth?

- The complete, adult set of teeth encompasses 32 teeth, including wisdom teeth.
  - **8 incisors:** very front, four on the upper jaw and four on the lower jaw
    - These are straight teeth that work well in **cutting food**.
  - **4 canines:** one on each side of the incisors
    - Good for cutting and tearing food
  - **8 premolars:** two on each side
    - Flatter than canines with ridges
  - **12 molars:** flatter and wider; involved with **chewing and grinding**



**Figure 11-5.** Full sets of deciduous and permanent teeth.



# Q: What are Teeth?

- The shape of a set of teeth (the **dentition pattern**) varies from person to person.
- Differences in the **size of teeth and jaws**, position, and **crowding** make the inside of each person's mouth unique

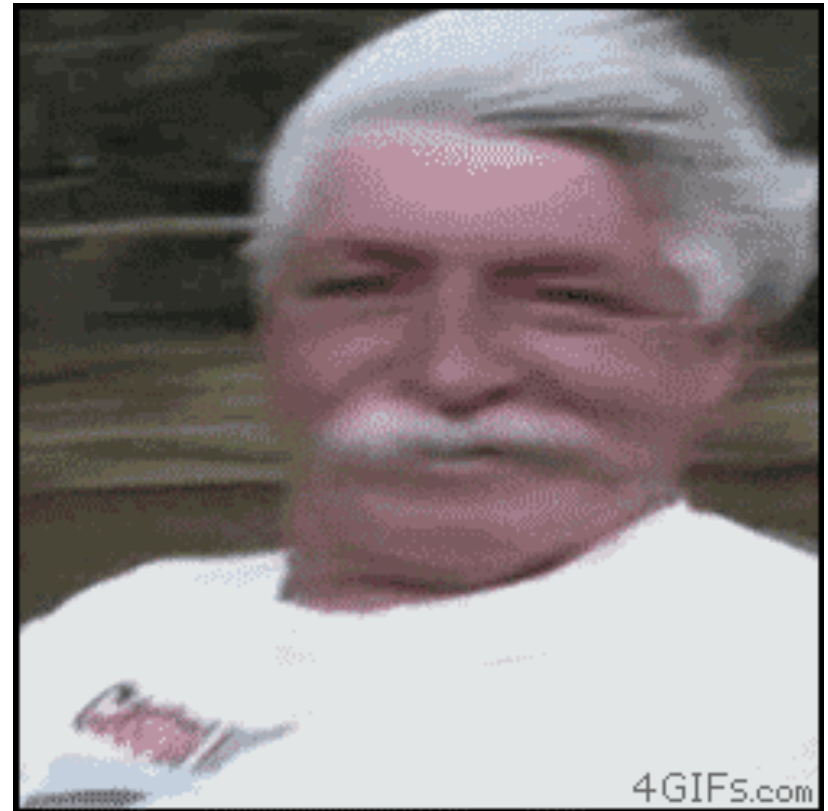


# Q: What is Forensic Odontology?

- Forensic odontology is a unique field that **combines the skills of a specially trained dentist with those of law enforcement.**
  - The forensic dentist's **primary duty is human identification.**
- They examine evidence from cases involving **violent crime, abuse, missing persons, and disaster scenarios** to identify victims or suspects.
- Forensic dentists examine bite marks and compare with replicas of the suspect's teeth

# Q: What is Forensic Odontology?

- The majority of a forensic dentist's case load are two types of case:
  1. Missing and unidentified persons
  2. Recognition, documentation, and preservation of bite mark evidence



# Q: What is Forensic Odontology?

- Forensic Odontologist compares
  - The antemortem records (taken during life)
  - The postmortem records (recorded after death)
- Especially helpful
  - Fillings
  - Bridgework
  - Dental implants

# Q: What is Forensic Odontology?

- In addition, a forensic Odontologist examines
  - **Teeth:** size, shape, gaps, cracks, alignment, missing or extra one, wears, stains
  - **Dental alterations:** fillings, caps, bridgework, and dentures
  - **Dentition:** the pattern made by a particular set of teeth

# Q: What is Dental Evidence?

- Teeth are sometimes all that remains of a body in catastrophic conditions.
- Dental evidence includes anything relating to human dental anatomy or derived from the oral environment such as:
  - Tooth shapes
  - Metal restorations
  - Skull and jawbone irregularities
  - Skull fragments

# Q: How are Teeth Used in Forensics?

- The individual pattern of teeth is used in forensic investigations in two ways.
  - Teeth can be used to **identify remains**
  - Teeth can also be used in **profiling and identifying a suspect** from unique bite patterns or bite marks left at the scene of the crime



## Q: How are Teeth Used in Forensics?

- The bite pattern of a suspect can be **matched to the bite marks associated with a crime scene**, just as fingerprints of suspects can be matched to fingerprints at a crime scene



# Q: How are Teeth Used in Forensics?

- Up to **76 points of comparison** may be used when comparing bite marks
  - Including **dental chipping**, surface indentations, **distances between teeth**, individual tooth dimensions, alignment of teeth, and the **angle of the mouth arch**.



# Q: How are Teeth Used in Forensics?

- The presence or absence of certain teeth can be an indication of age, diet, economic status, and country of origin. Dental procedures and materials may also vary from country to country. All of these factors can provide clues leading to a crime suspect.

# Q: How are Teeth Used in Forensics?

- If an assailant bites a victim, it is important that the bite marks be photographed while the impression is still visible.
- The photographs should include a ruler to establish a reference for size to better compare bite marks to a suspect's bite pattern.
- When an attacker bites a victim, saliva may be left on the victim's skin.
  - If the bite mark is swabbed with a sterile cotton swab, DNA from the saliva may be collected and analyzed.
  - The DNA profile can then be compared to the DNA of suspects.

## Q: How are Teeth Used in Forensics?

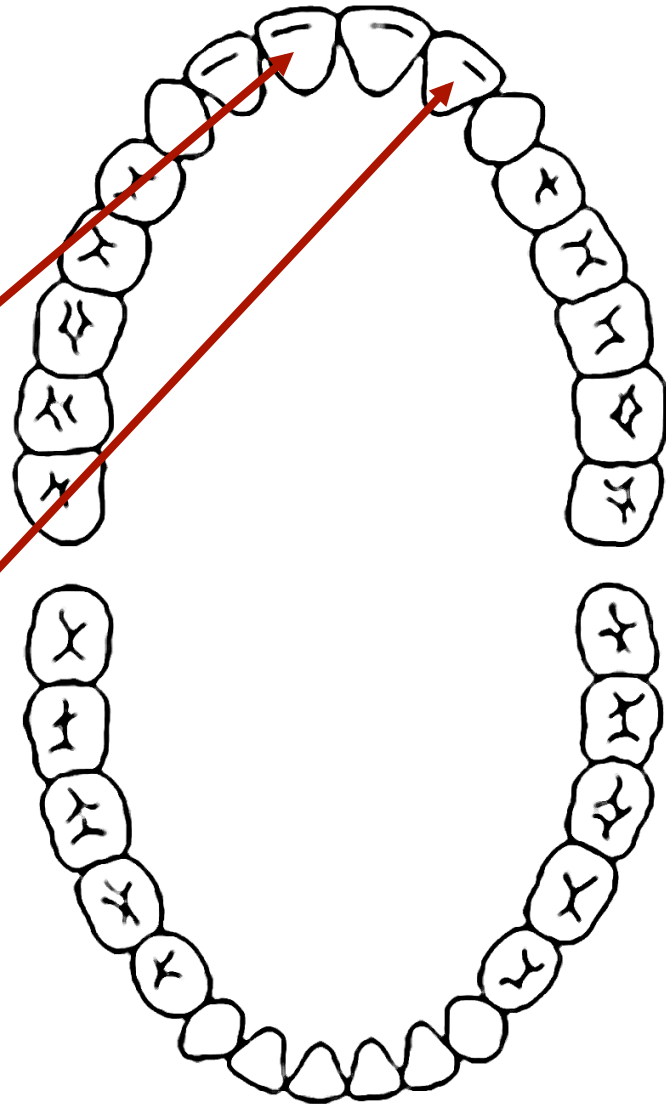
- Unlike fingerprints, teeth change greatly throughout a person's lifetime.
  - These changes are based on activity, health, and dental treatment.
- They can result in the creation of a unique dental profile for an individual but may also prove to be a false negative if much time has passed between the collection of evidence and the collection of dental standards from the suspect.

## Q: How are Teeth Used in Forensics?

- The first step in bite mark analysis is to determine which marks are from the upper and lower jaws.
  - Front teeth are seen as primary biting teeth.
    - There are 6 upper and 6 lower front teeth.
    - A bite mark will show 12 teeth severely marking the skin.
  - The upper jaw is wider than the lower jaw.

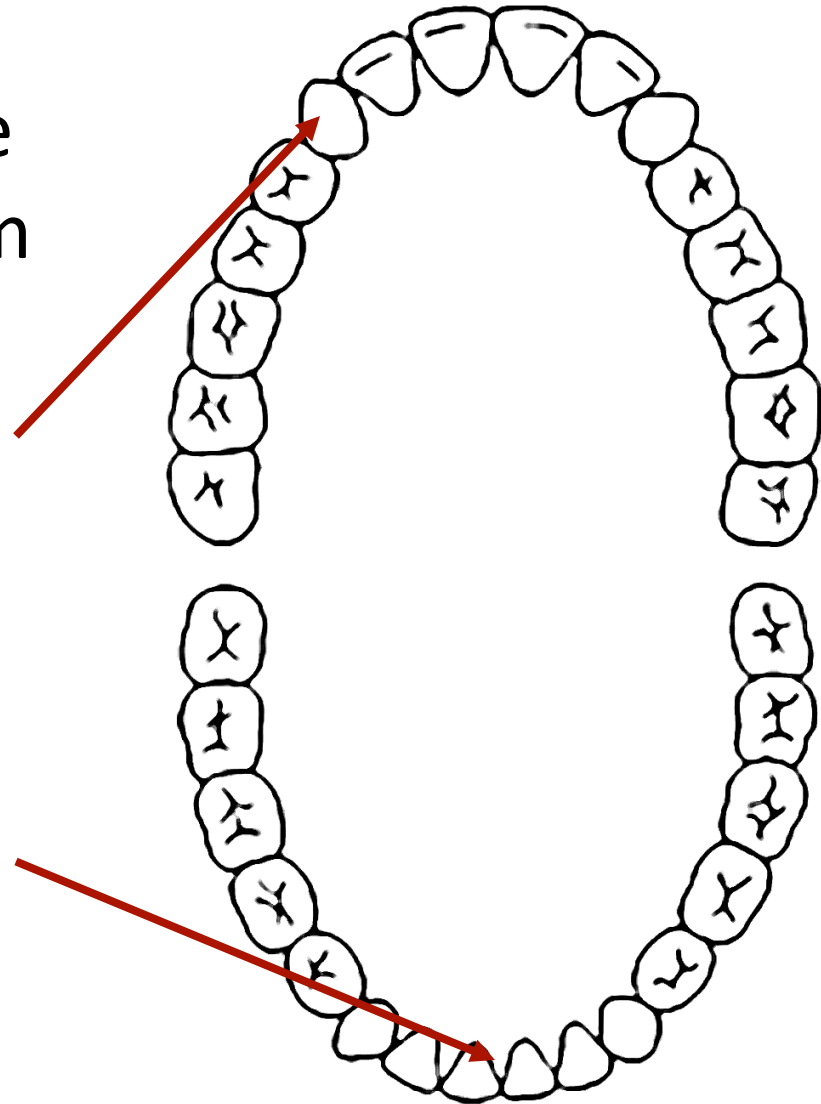
# Q: How are Teeth Used in Forensics?

- The next step is to determine which marks were made from which teeth
  - The **upper 4 front teeth** make **rectangular** marks.
  - The **central incisors** are wider than **lateral incisors**.



# Q: How are Teeth Used in Forensics?

- The next step is to determine which marks were made from which teeth.
  - The **upper and lower cuspids** tend to leave round or oval-shaped marks.
  - The **lower 4 front teeth** make rectangular marks that are all **similar in width**.



# Q: How are Teeth Used in Forensics?

- Areas between biting teeth that exhibit less bruising are attributed to **a missing, short, or damaged tooth**.
- This can also be caused by an **object becoming trapped** between the skin and tooth, the **skin could have moved** to relieve stress, or there was **variation in the biting mechanism** itself.





## Q: How are Teeth Used in Forensics?

- After the teeth have been identified, the bite mark pattern is **measured**.
- The tooth mark size as well as distances between teeth are measured.
- **Skin stretching may deform the pattern** to make these measurements of little value.

## Q: How are Teeth Used in Forensics?

- Once the data has been collected, the forensic dentist is asked to compare the evidence to the suspect's teeth.
- For standards to compare the forensic dentist may **make castings of the suspect's bite with dental stone.**
- Notes on tooth damage are taken and checked against the unknown bite mark.

## Q: How are Teeth Used in Forensics?

- The photographs of the unknown bite mark are reproduced at **1:1 scale** and compared to the casting.
- Transparent overlays of the bite mark photos may be used to aid in comparison.

# Q: How are Teeth Used in Forensics?

- The first characteristics considered are the **arch size and shape**.
  - This can quickly eliminate a suspect with no additional analysis.
- If the suspect has not been eliminated, studies of the **prominent dental features** are inspected for agreement with the bite mark. Secondary features must also match.
- **Wax bite impressions** may be used to capture the biting edges of teeth and are useful for comparison purposes.

# Drawing Conclusions

- Although the forensic dentist is an expert, the forensic importance of a bite mark is an educated opinion.
- There are **no guarantees** that the same bite mark evidence would be interpreted in the same way by two or more forensic dentists.
- Specialized expertise is needed to understand the strengths and limitations of bite mark analysis.

## Q: What is footprint evidence?

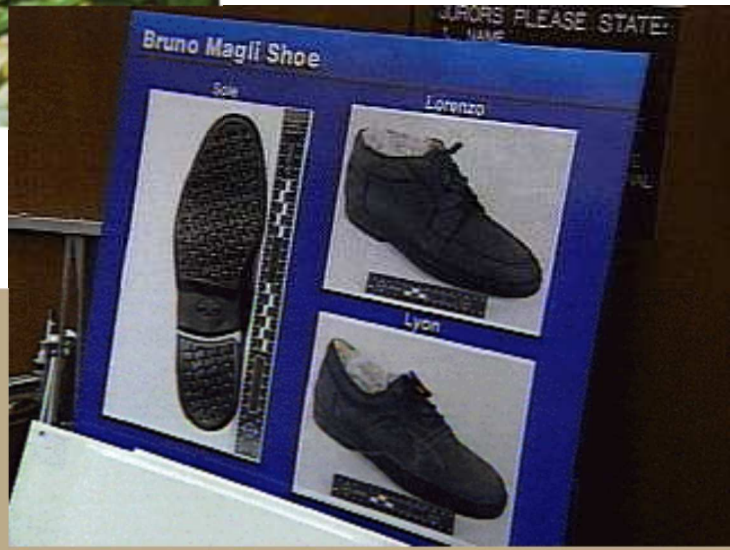
- Footprint evidence is typically a shoe print.
- Footprints are always left at a crime scene.
  - However, it may be impossible to locate them or differentiate them from other prints.
  - Usable footprints are found at approximately 40% of crime scenes.



# Q: What is footprint evidence?

- The first recorded forensic use of footprints was Warwick, England in 1816.
- A young maidservant had been drowned in a shallow pool of water.
- While investigating the damp ground around the pool, police discovered footprints and an impression of corduroy cloth with a patch sewn on it.
- Bits of grain were found surrounding the footprints.
- When police searched a nearby farm, they found that a laborer's pants matched the patch, his footprint was the same size, and the wheat he was threshing matched the grains at the crime scene.










# Q: How can we use footprints as evidence?

- **Class characteristics:**
  - Aid the investigators in determining the manufacturer of the shoe.
  - The type or brand of the shoe is always determined so the exact size of shoe can then be appraised.
    - In many cases, the impression may be such that experts can identify the specific brand and style of shoe that the criminal used, even to the possible exclusion of other brands or sizes.



# Q: How can we use footprints as evidence?

Each shoe has individual characteristics which are unique to that shoe.

- Individual characteristics of a shoe would include manufacturing irregularities, chips or holes in the tread, and any substance added to or removed from the shoe during wear.
  - During normal wear, shoe rubber can crack or warp, and pieces of rubber may be removed. Rocks or other sharp objects may create a hole or indentation. Those individual characteristics can help narrow down the search for a specific shoe.
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# Q: How can we use footprints as evidence?

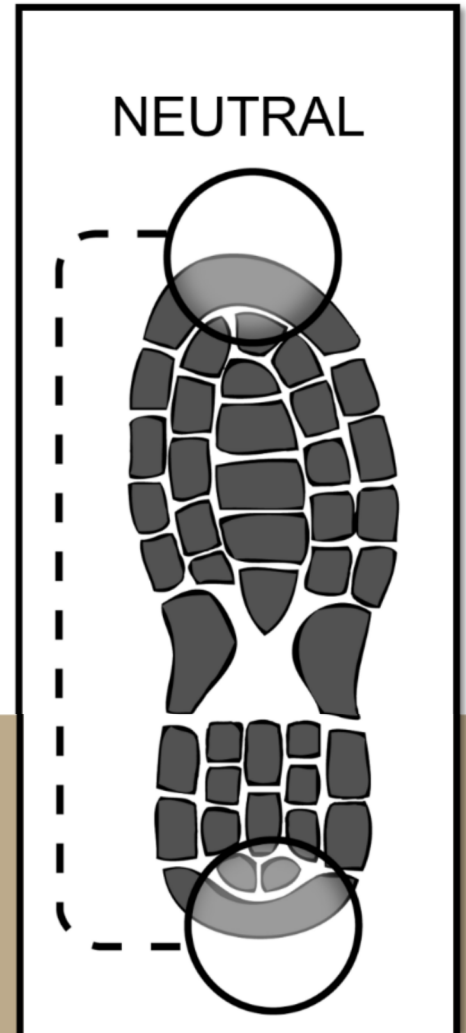
## Wear Patterns:

- Formed by the gradual wearing away of rubber by the friction created between the walking surface and the sole of the shoe
  - The longer the shoe is worn, the more pronounced the wear pattern becomes.
- Wear would be more pronounced where the foot first makes contact with the ground.
- By looking at the wear pattern, investigators are able to assess the walking pattern of the individual.

# Q: How can we use footprints as evidence?

## Wear Patterns

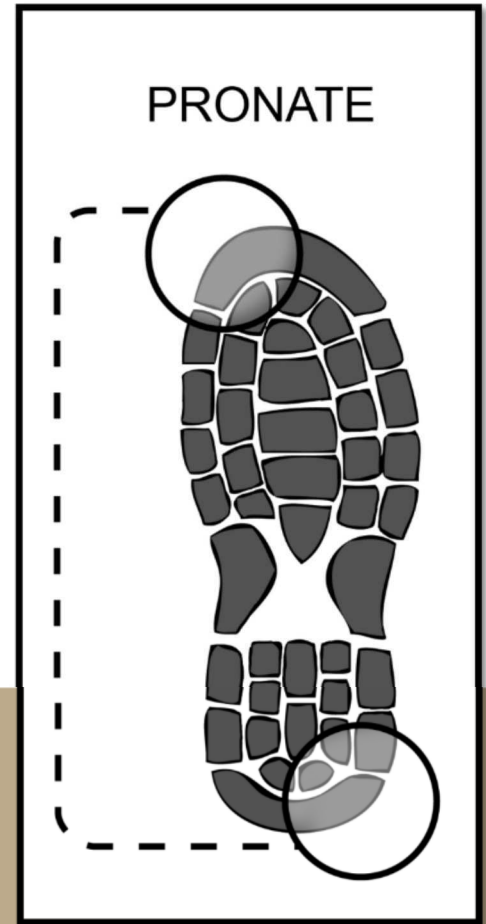
- A person with neutral pronation (arch flattening) will have even wear on the front and rear.
- Foot comes in contact with the ground evenly



# Q: How can we use footprints as evidence?

## Wear Patterns

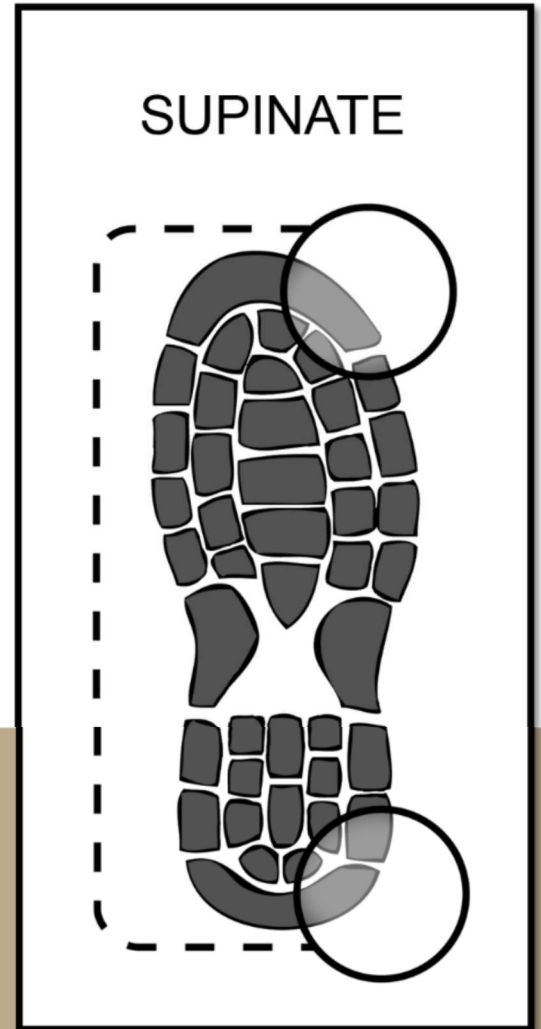
- A wear pattern on the inside of the shoe indicates a person who walks with over pronation.
  - The ankle is turned in, toward the other foot.



# Q: How can we use footprints as evidence?

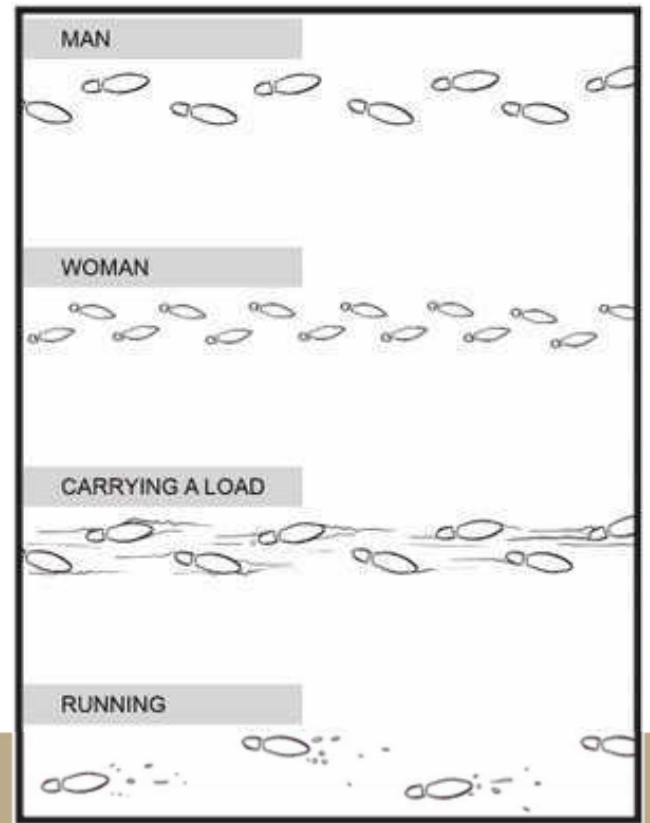
## Wear Patterns

- A wear pattern on the outside of the shoe indicates a person who walks with under pronation or supination.
  - The ankle is turned out, away from the other foot.




# Q: What else can we learn from footprints?

- Smaller footprints that are slightly pigeon-toed with a small stride would indicate that the prints likely belong to a woman
- Men tend to walk with their toes pointed straight forward or tilted slightly outward.





# Q: What else can we learn from footprints?

- Deep prints and a long stride would indicate a faster pace of walking or running.
    - Prints that appear consistently deeper on one foot indicates that the person was carrying something on that side
  - Depth of a footprint can also be useful in giving a rather accurate weight for the person (if the weight was evenly distributed along the print)
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- A decorative graphic at the bottom of the slide consisting of several overlapping geometric shapes in shades of brown and tan, creating a modern, abstract design.

# Q: What else can we learn from footprints?

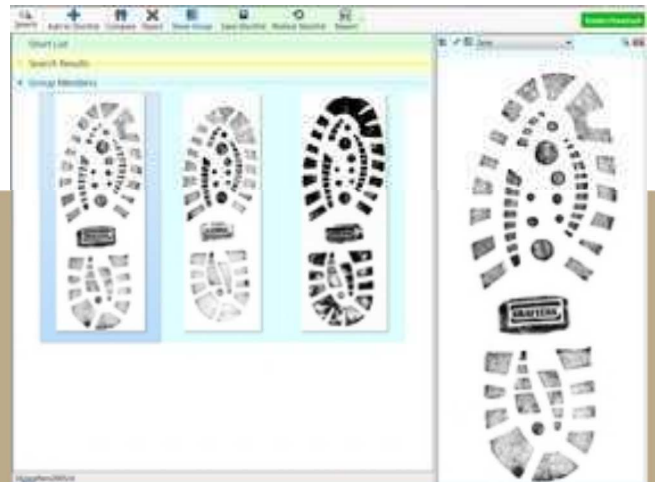
- A person's gait can also be determined by footprints.
  - Investigators will study the stride length
  - Stride length + shoe size = investigators can make an estimation of height.
    - **Foot length is approximately 15% of the person's height.**
      - Though this ratio does not apply to 10-20% of the population, it does help to narrow down the suspects and give a very good idea of the individual sought.

# Q: How can we use footprints as evidence?

- **No minimum** number of class or individual characteristics needed to establish identification
  - One characteristic alone could be used to identify a shoe, as long as the characteristic was clear, detailed, defined, and contained significant features in common with the impression.
- The United States **does not** currently have a national database exclusively for footprints
  - Research funded by the U.S. Department of Justice is currently being completed by computer scientists
    - Working on developing algorithms for matching shoe prints

# Q: How can we use footprints as evidence?

- There are two commercial databases that help identify the types of shoes found at a crime scene.
  - **Treadmark** uses four parameters to help identify outside sole impressions to ease time-consuming recovery.
  - **Solemate** is a database holding manufacturer information and several pictorial images to help determine the type of shoe the print belongs to
    - This database has over 12,000 different shoes including work, sports, and casual shoes.



# Did You Know...?

- In 2007, the United Kingdom Forensic Science Service launched the world's first national database of shoe imprints.
- Foster + Freeman Ltd. (Worcestershire, England,)
  - **SICAR** : frequently used by police departments in Europe, the United Kingdom, and the United States.
    - Coding technique that can create a coded description from the shoe mark's patterns in as little as two minutes
    - Image compositor that will aid in identifying partial prints.



# Q: How do we categorize footprint evidence?


## Visible two dimensional print

- Material picked up by shoe and deposited onto flat surface.
- Recovery is complex due to the variety of surfaces and materials deposited (dust, residue, soil, blood, petroleum products, etc.)

## Latent two dimensional print


- Dirty shoe on clean floor (dust)
- Clean shoe on dirty floor (dust, wax/polish)

## Three dimensional impression

- Found in soft dirt, sand, mud, or snow
  - Requires making a cast of the print
- 
- A decorative graphic at the bottom of the slide consisting of several overlapping geometric shapes in shades of brown and tan, creating a modern, abstract design.

# Q: How do we categorize footprint evidence?

## Impressions:

- Positive impressions result when a shoe sole accumulates and then deposits material that is transferred in the shape of the areas of the sole that actually contact the ground surface.
    - A positive (2D) impression is created by a person transferring matter, such as dust or blood, from their shoe to the surface they walk on
  - Negative impressions are produced when the shoe sole removes residue (dust, blood) from a surface, leaving the residue where the areas of the sole did not come in contact with the substrate.
    - A negative (3D) impression is created when the shoe removes residue from the surface it walks on, as would happen when a person walked through mud or cement.
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# Q: How do we Recover Footprint Evidence?

When considering the vast variety of surfaces that yield prints, it has become necessary to develop multiple techniques to lift the prints with the least amount of distortion.

- **\*\*Crime scene access must be controlled to reduce potential damage to latent prints.**
- **All footprints should be well documented by photographs**
  - **A photograph will depict the footprint in relation to the crime scene, allowing investigators to view the complete scene after all of the evidence has been collected.**
- When photography is complete, objects containing footprints should be removed if possible (paper, glass) for further analysis.






# Q: How do we Recover Footprint Evidence?

Many chemical methods exist for treating a footprint for detection or enhancement.

## Reagents for this purpose include:

- Leuco Crystal Violet
  - Amido Black 10B
  - Diaminobenzidine
  - Luminol
  - Fuchsin acid
  - Patent Blue V
- 

# Q: How do we Recover Footprint Evidence?

## Lifting:

- Lifting improves the visibility and detail of the impression by transferring it to a surface that provides better contrast.
- Electrostatic dust print lifting devices charge a plastic film which is placed over a dust print. This causes the dust to adhere to the film.
  - The print must be composed of loose dry residue for this method.

# Q: How do we Recover Footprint Evidence?

## Lifting:

- Depending upon the surface and location the print was left, forensic investigators may have a narrow window in which to lift the print.
  - Prints left in blood may last for years, whereas prints left in water may evaporate, and prints made with sand may be brushed away.


# Q: How do we Recover Footprint Evidence?

## Lifting:

- Latent prints may be dusted with fingerprint powder and lifted with gelatin lifters.
  - These lifters have a thick layer of gelatin on a vinyl or cloth backing that is covered with a protective clear cover sheet. They can lift impressions from any surface, porous or nonporous.

# Q: How do we Recover Footprint Evidence?

## Impressions:

- Impressions are three dimensional.
  - Casting, or taking a mold of the impression, will provide a true-to-size physical model of the print.
    - A description of the impressions, their position and direction, substrate, and weather conditions should be recorded before casting.
    - General scene photographs are taken in series from long to middle to close distances to document the relationship of the impressions to the scene.
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# Q: How do we Recover Footprint Evidence?

## Impressions:

- For impressions in **snow**, Snow Print wax or an aerosol paint can be lightly sprayed at an angle, from 50-60 cm away, to highlight the ridges or high spots of the impression. This will add contrast.
- **Prints left in the rain** may be full of water.
  - Water can be drawn away from the surface of a muddy print by using a pipette, followed by a hot air source, such a hair dryer.

# Q: How do we Recover Footprint Evidence?

## Impressions:

- Place a frame around footprint evidence before casting to make a studier casting.
- Before casting, **fixatives such as dust hardeners are sprayed into the impression to stabilize it during the casting pour.**
- **Dental stone is usually used to make a casting.**
  - This is a gypsum-based product that has been modified for use in the dental industry. It has minimal shrinkage when cured and captures minute details.

