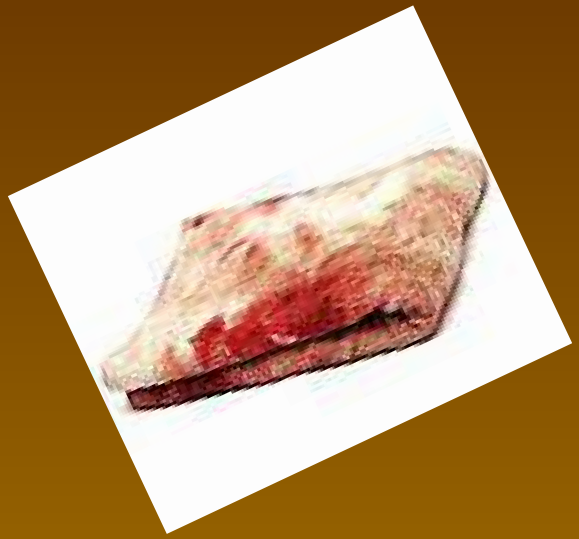
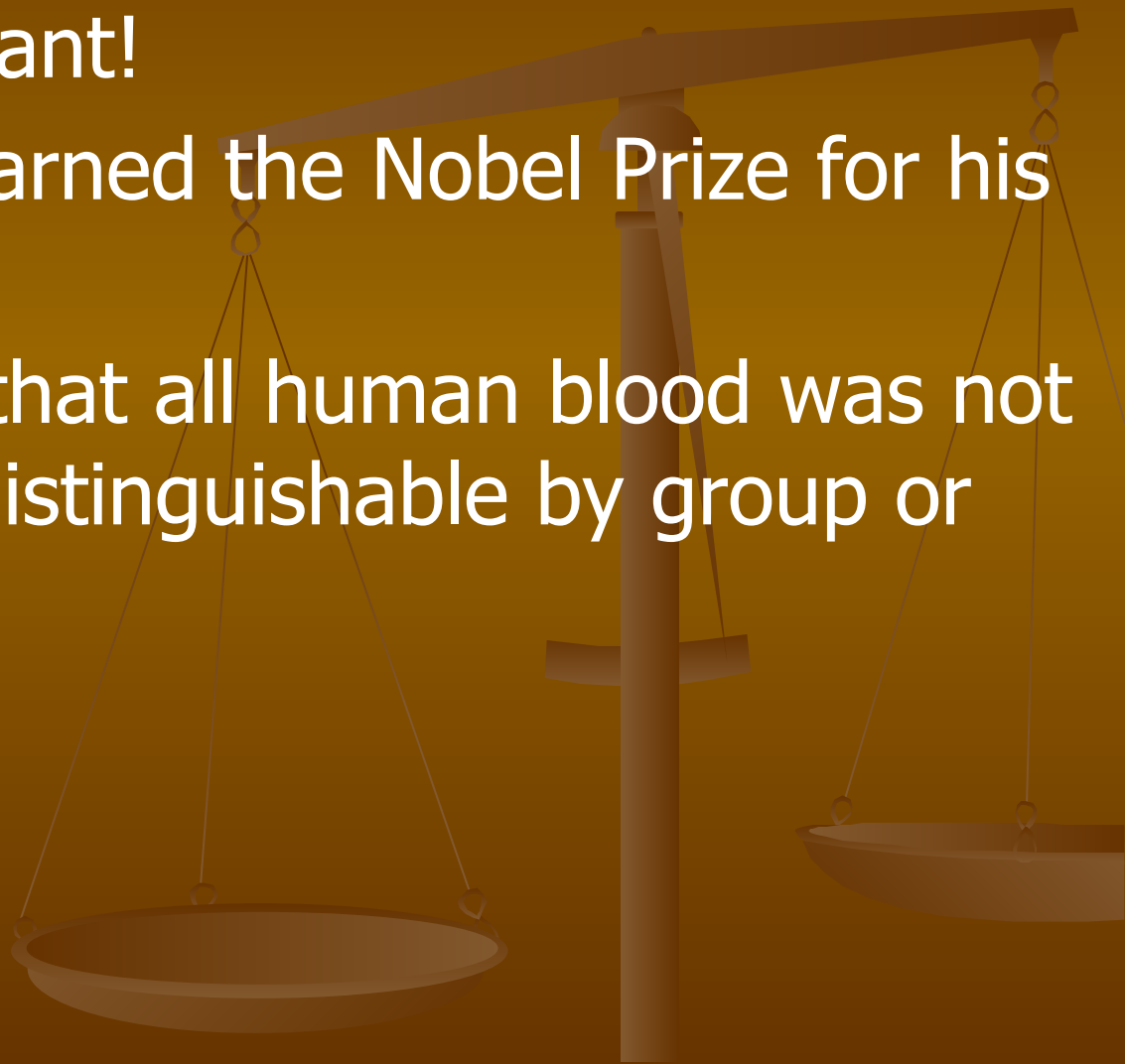


Serology

O'Connor

Typing of Blood

- Historically significant!
- Karl Landsteiner earned the Nobel Prize for his 1901 discovery.
- First to recognize that all human blood was not the same; it was distinguishable by group or type.



A-B-O System

- First classification system
- Allowed us to match donor to recipient. (saving millions of lives)
- This opened a new field of research
- By 1937 the Rh factor in blood was discovered allowing for further classification.

Additional Factors

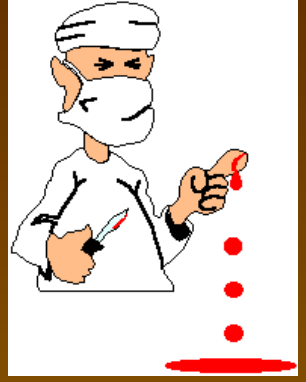
- Up to 100 different blood factors have been identified, A-B-O is still the most important.
- Used to identify individuals based on blood- in theory no two people (outside of identical twins) have the same combination of blood factors.
- Significant ~ because crime scenes, in particular those of a serious nature like homicide, assaults & rape are likely to have bloodstains left behind.

DNA and Blood stains

- DNA technology has altered the approach of forensic scientists toward the individualization of bloodstains & other biological evidence.
- Identifying blood factors has become obsolete. We now look for DNA, genetic information.

What is blood?

- Highly complex mixture of cells, enzymes, proteins and inorganic substances.
- The fluid portion is called plasma, composed principally of water & accounts for 55% of the blood content.
- Solids (45% of blood) are suspended in the fluid, primarily consisting of erythrocytes (red blood cells), leukocytes (white blood cells), and platelets.



Clotting

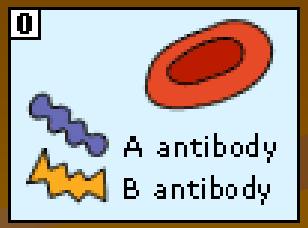
Red Blood Cell Cast

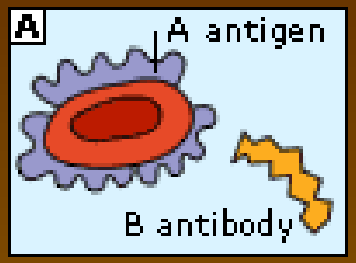
- Blood clots when a protein in the plasma known as fibrin traps and meshes the red blood cells.
- If the clotted material were removed, a pale yellowish liquid known as serum would be left.

Forensics & Blood

- For forensics we are concerned with red blood cells & blood serum.
- On the surface of red blood cells are millions of characteristic chemical structures called antigens.
- (a substance, usually a protein, that stimulates the body to produce antibodies against it) More than 15 blood antigens have been identified. The A-B-O and Rh systems are the most important.

Blood Typing



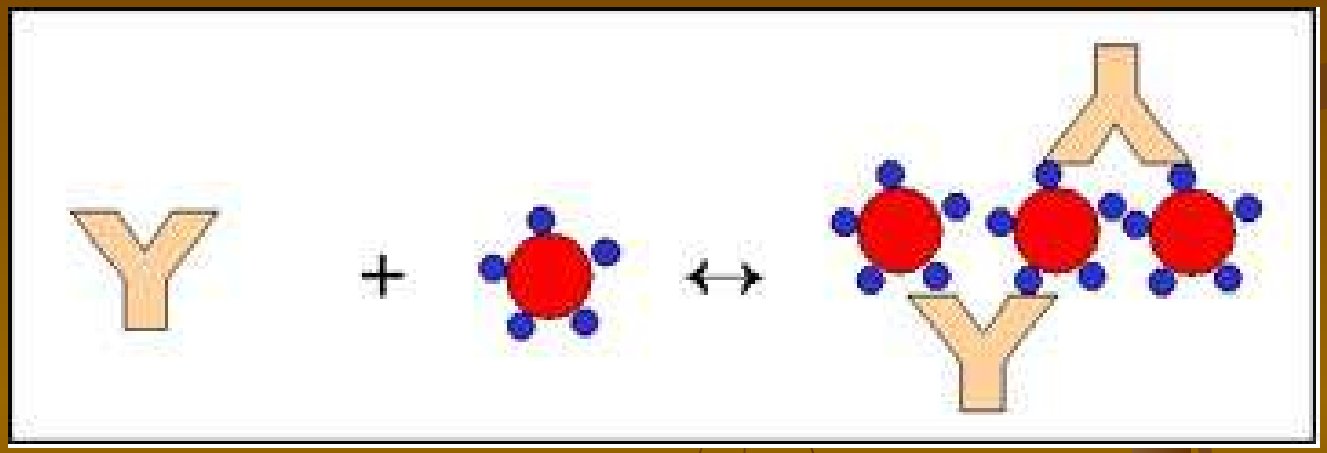


- Type A blood indicates the cell has A antigens on its surface. (AB has some of both) (Type O has neither A or B antigens)

- The Rh factor is also referred to as the D antigen. If it's present you are Rh+, if you don't you are Rh-

Serum

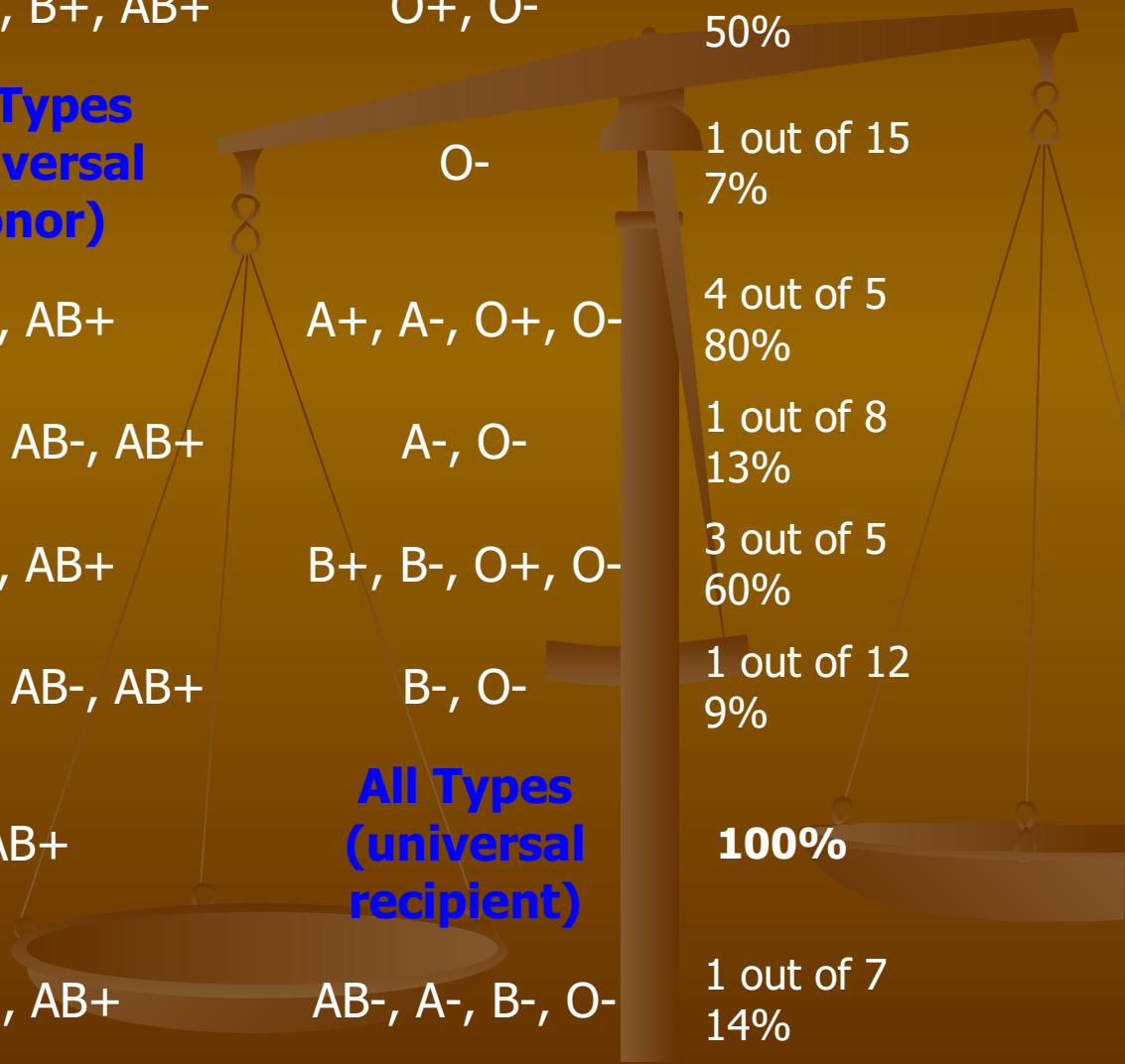
- Serum contains proteins known as antibodies. (For every antigen there exists a specific antibody)
- Naming antibodies, start with prefix anti- and add the name for the antigen; example anti-B
- A serum that contains antibodies is known as an antiserum. (it reacts against antigens- only the specific one it is named for)
- Antibodies are bivalent- meaning they have 2 reactive sites. Allows for them to link up, like in chains and is usually seen as clumping or agglutination.



Antibody Agglutination

Human Blood Type Chart - A, B, AB or O

ABO Blood Type	Per Cent of General Population	Can DONATE Red Cells To:	Can RECEIVE Red Cells From:	Chance of Finding A Compatible Donor
O+	**38.5%**	O+, A+, B+, AB+	O+, O-	1 out of 2 50%
O-	6.5%	**All Types (universal donor)**	O-	1 out of 15 7%
A+	**34.3%**	A+, AB+	A+, A-, O+, O-	4 out of 5 80%
A-	5.7%	A-, A+, AB-, AB+	A-, O-	1 out of 8 13%
B+	8.6%	B+, AB+	B+, B-, O+, O-	3 out of 5 60%
B-	1.7%	B-, B+, AB-, AB+	B-, O-	1 out of 12 9%
AB+	4.3%	AB+	**All Types (universal recipient)**	**100%**
AB-	0.7%	AB-, AB+	AB-, A-, B-, O-	1 out of 7 14%

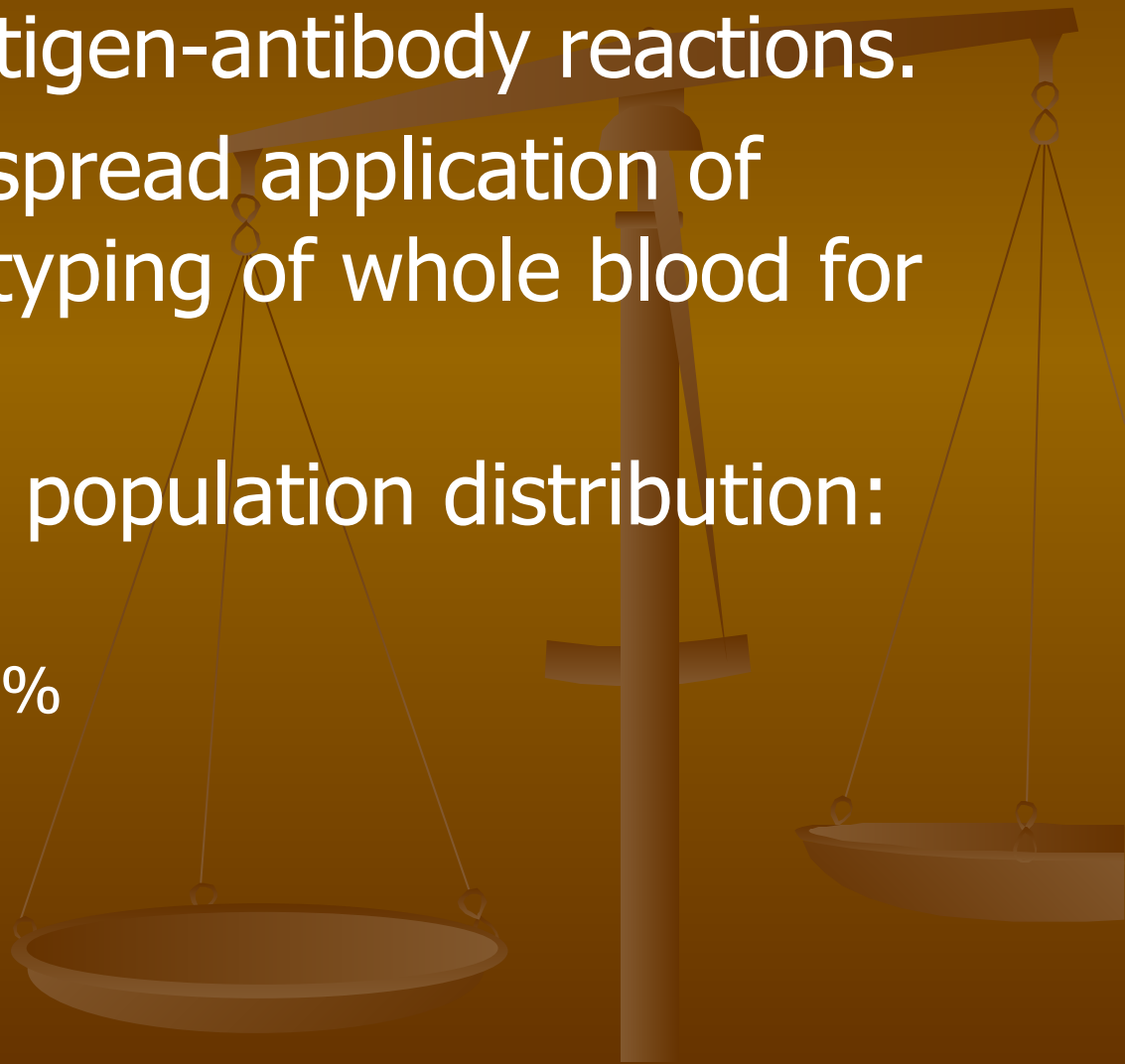


Mixing the wrong bloods

- There are fatal consequences for mixing the wrong blood types. It is why blood transfusions must be type specific.
- O is a universal donor – it won't react badly with A, B or AB.

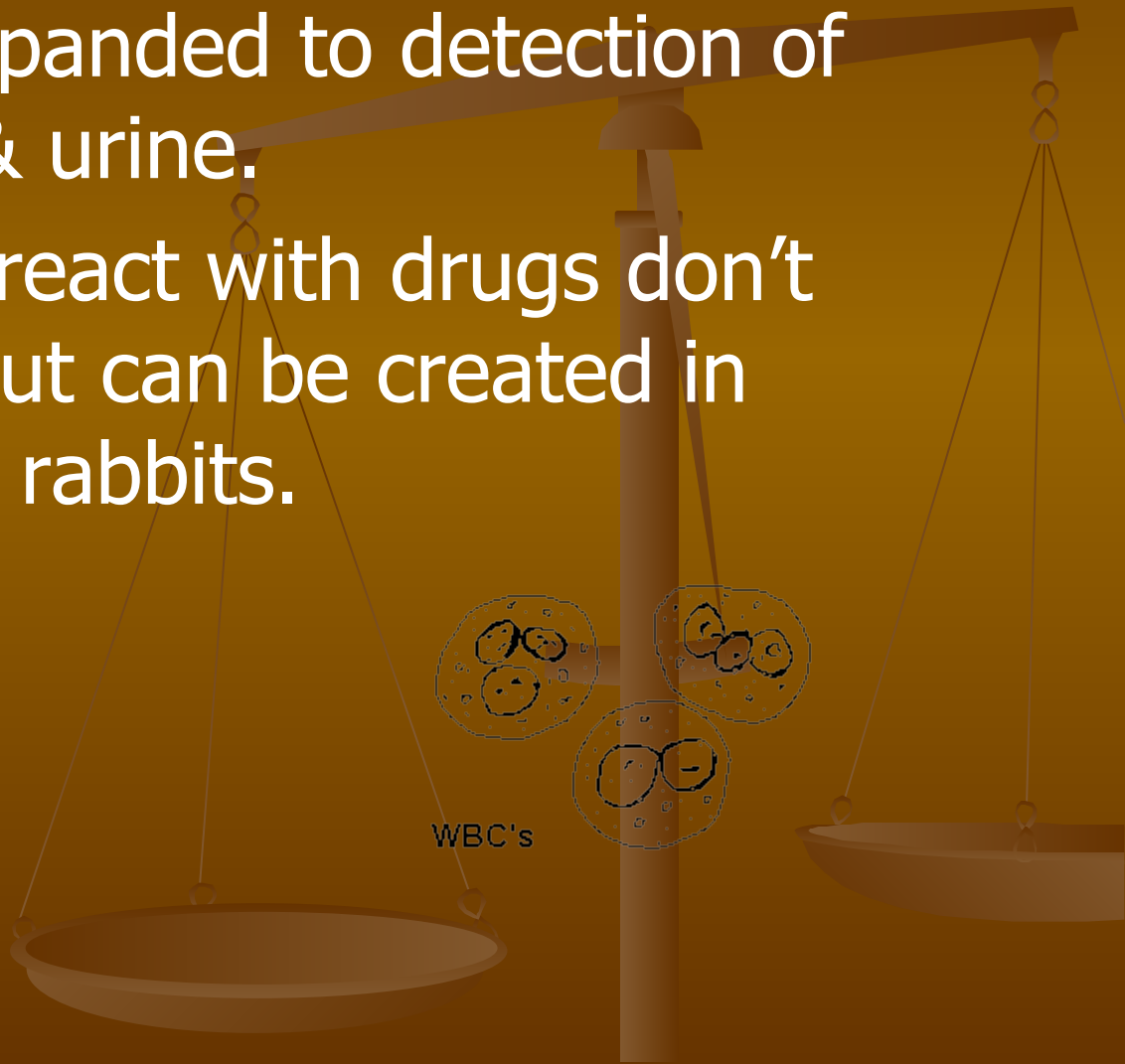
Serology

- The study of antigen-antibody reactions.
- The most wide spread application of Serology is the typing of whole blood for A-B-O identity.
- The generalized population distribution:
  - OABAB
  - 43%42%12%3%



Immunoassay Techniques

- Serology has expanded to detection of drugs in blood & urine.
- Antibodies that react with drugs don't exist naturally but can be created in animals such as rabbits.



Urinalysis

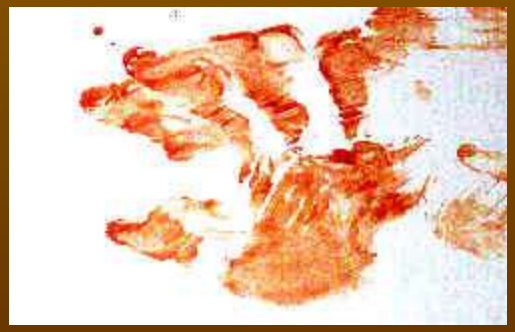
- Test to determine if drugs are present.
- Immunoassay testing for drugs has proven quite suitable for large volumes of specimens.
- Immunoassay tests are only presumptive in nature & results must be confirmed by additional testing.

Radioimmunoassay (RIA)

- Uses drugs labeled with radioactive tags. (ex. EMIT)
- They are not totally specific to any one drug. (This can hinder a case like it did in the Dr. Mario E. Jascalevich from ch. 1)

Forensic Characterizations of Bloodstains

- Criminalists must answer the following questions:
- 1. Is it blood?
- 2. From what species did the blood originate?
- 3. If human, how closely can it be related to a particular individual?



Color Tests

- Phenolphthalein is generally used now and it's known as the Kastle-Meyer color test
- It identifies not only blood, but some vegetables like potatoes & horseradish.
- It is highly indicative of blood & is used by field investigators.
- Hemastix strips are useful indicators- moisten with distilled water and placed in contact with bloodstains a green color will appear to indicate blood.

Luminol

- Presumptive ID test for blood.
- It doesn't change color, it produces light. You spray it on and turn off the lights, if the stain is blood it will have a faint blue glow (luminescence).
- Extremely sensitive
- Does not interfere with DNA testing
- Used for large areas like carpet, inside of a car, walls, etc.

Microcrystalline Tests

- Two most popular:
  - Takayama test
  - Teichmann test

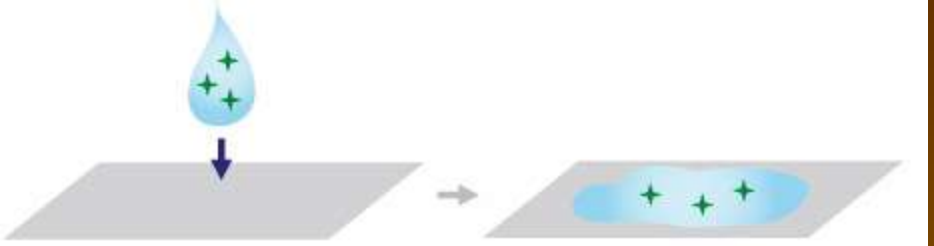
  - Form crystals when mixed w/ blood
  - Less sensitive
  - subject to interference of contaminants

Precipitin Test

- Once known to be blood, this test is used to determine, human or animal in origin.
- Add human antiserum and the blood sample in a tube- if human a cloudy ring or band will appear where the two substances meet.
- Gel Diffusion is another type of Precipitin test

Gel Diffusion

- You test in an agar plate.
- Two holes are made in agar, opposite of each other and add the sample to one & antiserum to the other.
- If they move towards each other across the gel agar, then it is positive for human blood.
- Can also be done through electrophoresis- using electrical current to draw them together.
- Highly sensitive & requires a small sample



A drop of specimen is placed on a card.

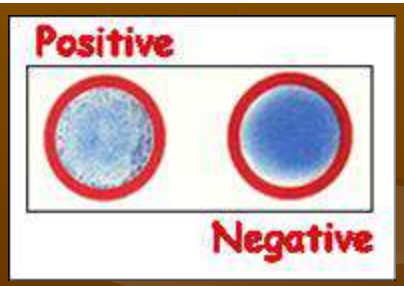
Analyte is floating freely in solution.

A solution which contains an analyte-specific detector molecule attached to a particle is added to the specimen on the card.

Analyte and detector molecules initially float free of one another causing the color and texture of the drop on the card to be uniform throughout.

The mixture is gently agitated for a number of minutes which causes the analyte and detector molecules to interact.

The interaction of analyte and detector molecules forms detectable aggregates. If analyte were not present in the specimen, aggregates would not form and the color and texture of the mixture would remain uniform throughout.



Bloodstain Pattern Analysis

- **is the examination of the shapes, locations, and distribution patterns of bloodstains, in order to provide an interpretation of the physical events which gave rise to their origin.**
- ***Based on the premise that all bloodstains and bloodstain patterns are characteristic of the forces that have created them.***

The determinations made from bloodstain patterns at the scene or from the clothing of principals in a case can be used to:

- **Confirm or refute assumptions concerning events & their sequence:**
  Position of victim. (standing, sitting, lying)
  Evidence of a struggle. (blood smears, blood trails)
- **Confirm or refute statements made by principals in the case:**
  Are stain patterns on a suspects clothing consistent with his reported actions?
  Are stain patterns on a victim or at a scene consistent with accounts given by witnesses or the suspect?

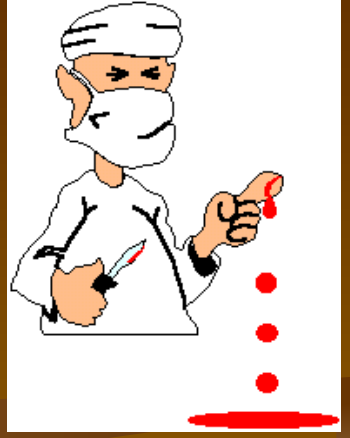
Blood Volume

- **On average, accounts for 8 % of total body weight**
- ***5 to 6 liters of blood for males***
- ***4 to 5 liters of blood for females***

- **A 40 % blood volume loss, internally or/and externally,**
  is required to produce irreversible shock (death).

- **A blood loss of 1.5 liters, internally or externally, is required to cause incapacitation**

Surface Tension

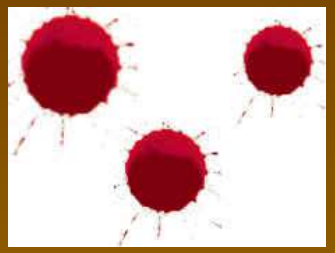


- **The elastic like property of the surface of the liquid that makes it tend to contract, caused by the forces of attraction between the molecules of the liquid.**

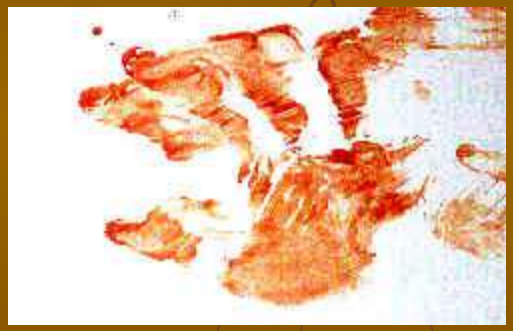
- **The cohesive forces tend to resist penetration and separation.** (blood drops will tend to stay clumped together)

Categories of Bloodstains

PASSIVE



TRANSFER

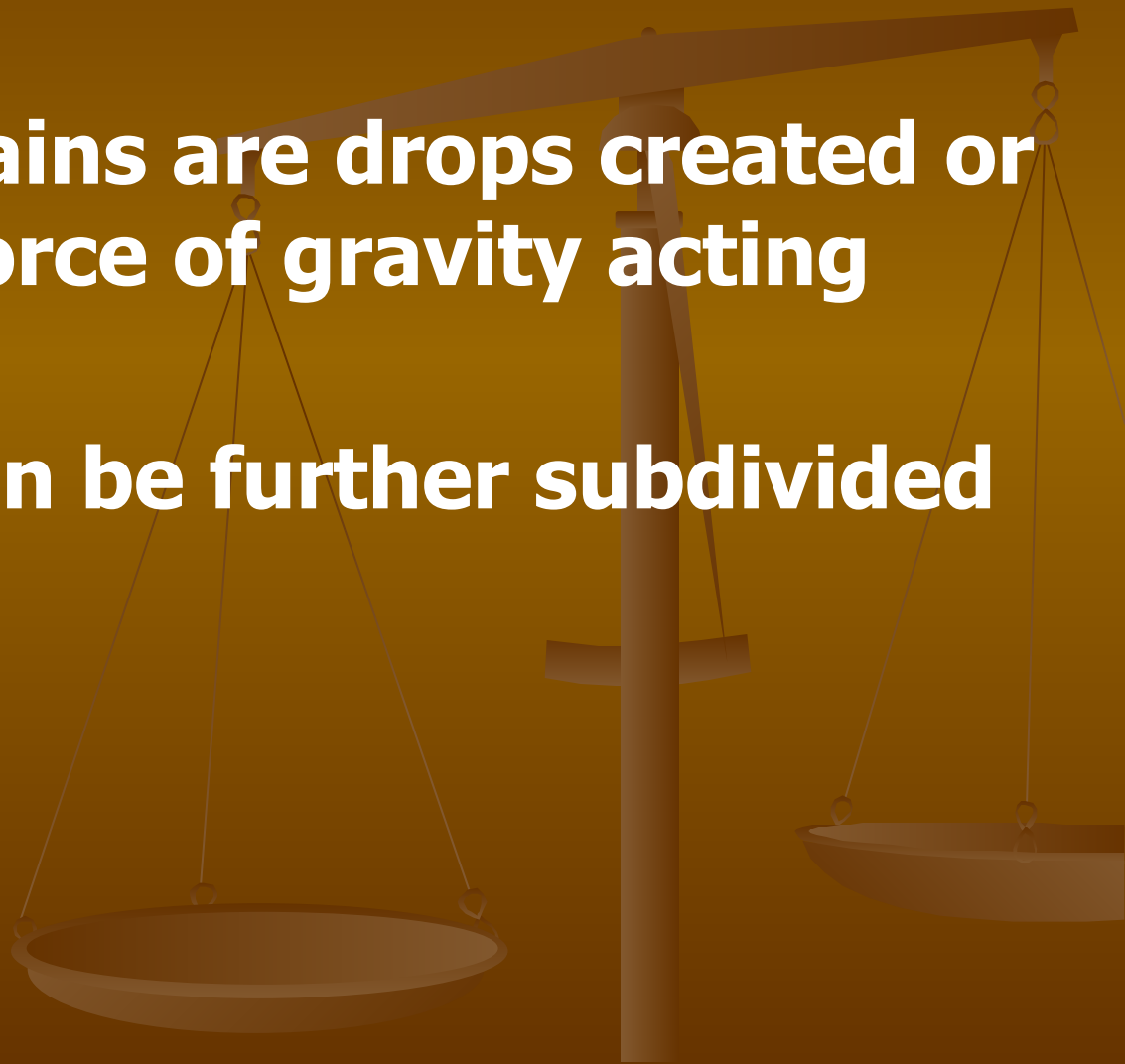


PROJECTED

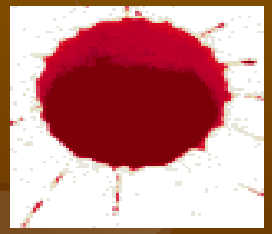
TRANSFER BLOODSTAINS

- A transfer bloodstain is created when a wet, bloody surface comes in contact with a secondary surface.
- A recognizable image of all or a portion of the original surface may be observed in the pattern, as in the case of a bloody hand or footwear.
- Transfer bloodstains can be further subdivided into;
  - Contact bleeding
  - Swipe or Smear
  - Wipe
  - Smudge

PASSIVE BLOODSTAINS

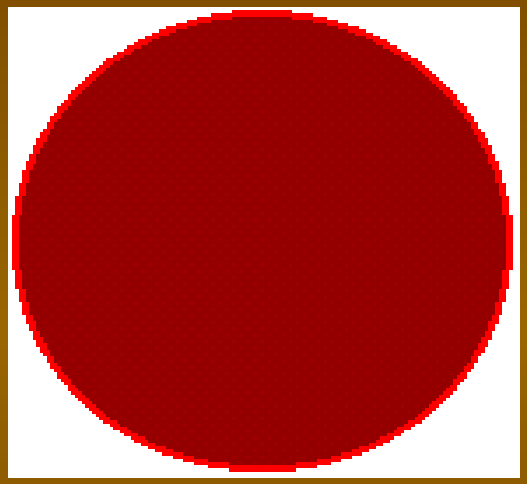


- Passive Bloodstains are drops created or formed by the force of gravity acting alone.
- This category can be further subdivided to include;
  - Drops
  - Drip patterns
  - Pools
  - Clots



TARGET SURFACE TEXTURE

- Bloodstains can occur on a variety of surfaces, such as carpet, wood, tile, wallpaper, clothing, & the list goes on……
- The type of surface the blood strikes affects the amount of resulting spatter, including the size & appearance of the blood drops.
- Blood droplets that strike a hard smooth surface, like a piece of glass, will have little or no distortion around the edge.
- Blood droplets that strike linoleum flooring take on a slightly different appearance. Notice the distortion (scalloping) around the edge of the blood droplets.
- Surfaces such as wood or concrete are distorted to a larger extent. Notice the spines & secondary splatter present.



Dripped Blood

Spilled Blood

"Projected Blood" (through syringe)

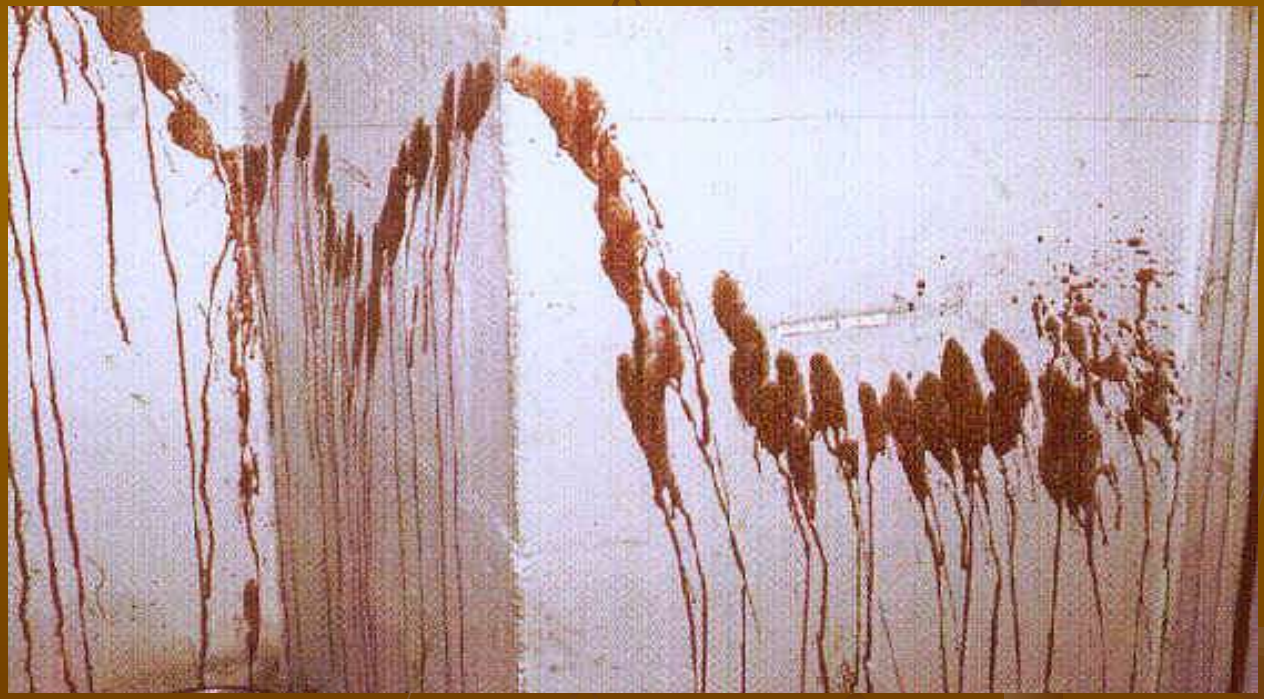
PROJECTED BLOODSTAINS

- **Projected bloodstains are created when an exposed blood source is subjected to an action or force, greater than the force of gravity. (Internally or Externally produced)**

- **The size, shape, and number of resulting stains will depend, primarily, on the amount of force utilized to strike the blood source.**

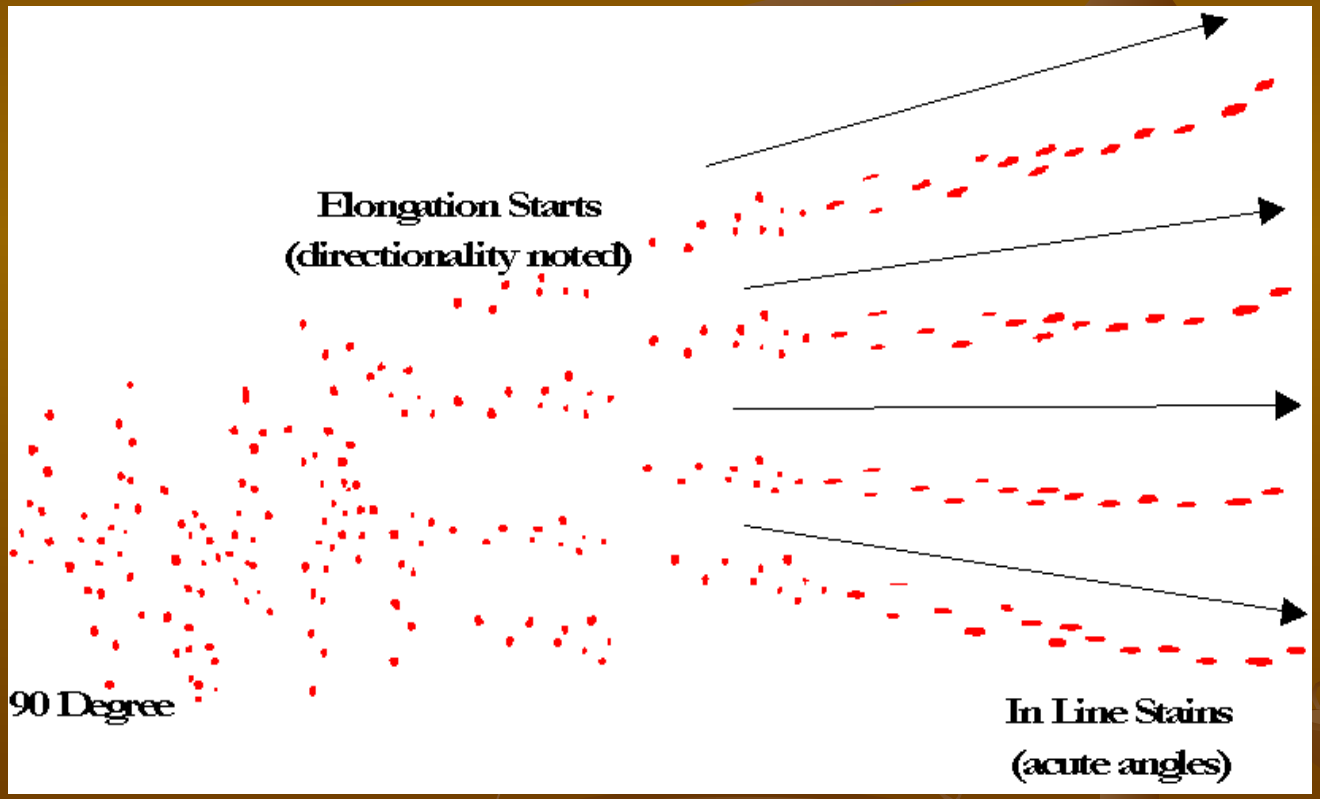
Arterial Spurt / Gush

Bloodstain pattern(s) resulting from blood exiting the body under pressure from a breached artery:



Cast-off Stains

Blood released or thrown from a blood-bearing object in motion:



Impact Spatter

- **Blood stain patterns created when a blood source receives a blow or force resulting in the random dispersion of smaller drops of blood.**
  This category can be further subdivided into;
  Low Velocity
  Gravitational pull up to 5 feet/sec.
  Relatively large stains 4mm in size and greater

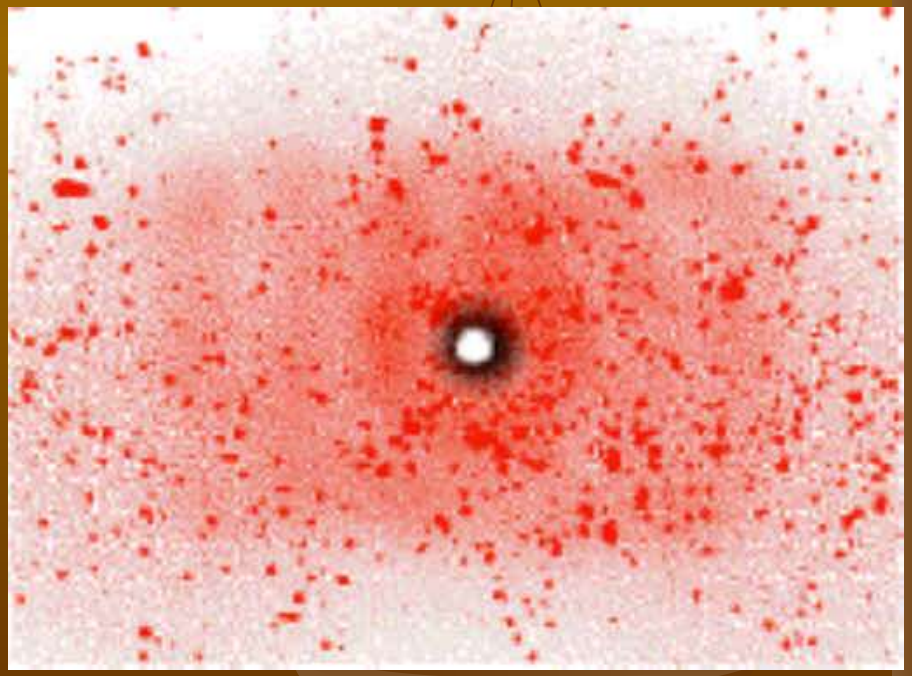
Medium Velocity

Force of 5 to 25 feet/sec.

Preponderant stain size 1 to 4mm in size

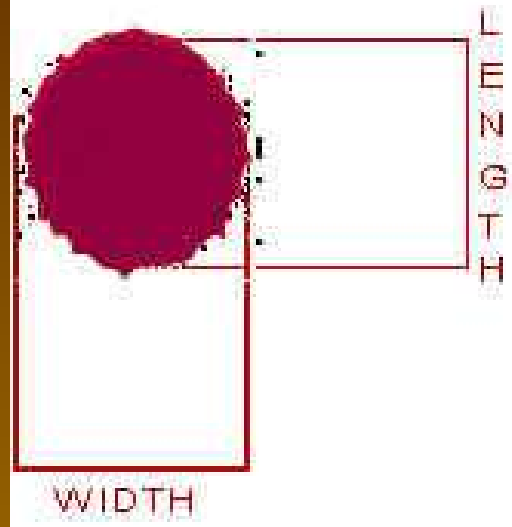
High Velocity

- **Force of 100 feet/sec. and greater**
  Preponderant stain size 1mm in size & smaller
  Mist like appearance



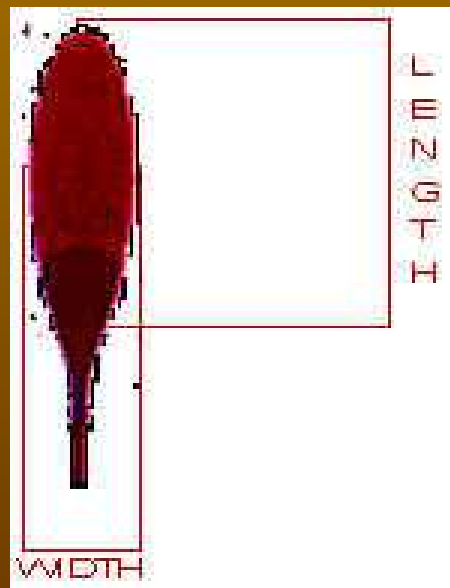
DIRECTIONALITY OF BLOODSTAINS

- **When a droplet of blood strikes a surface perpendicular (90˚) the resulting bloodstain will be circular.**
  That being the length & width of the stain will be equal.
- **Blood that strikes a surface at an angle less than 90˚ will be elongated or have a tear drop shape.**
  Directionality is usually obvious as the pointed end of the bloodstain (tail) will always point in the direction of travel.



90 Deg Stain

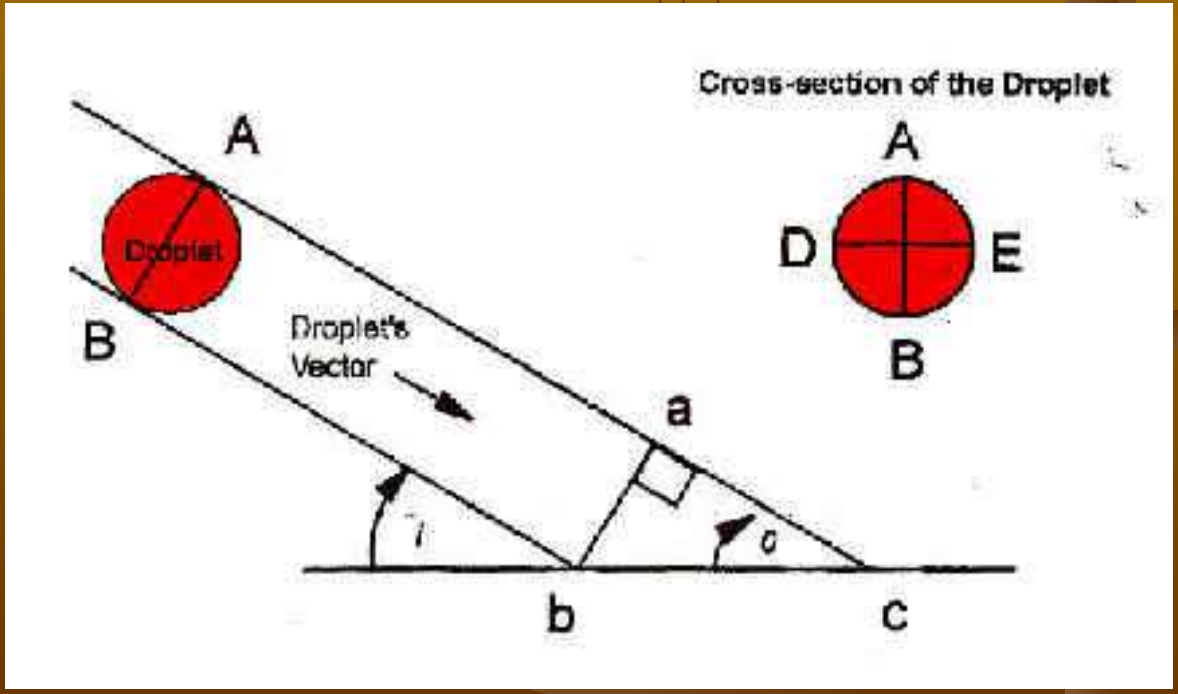
No Direction noted



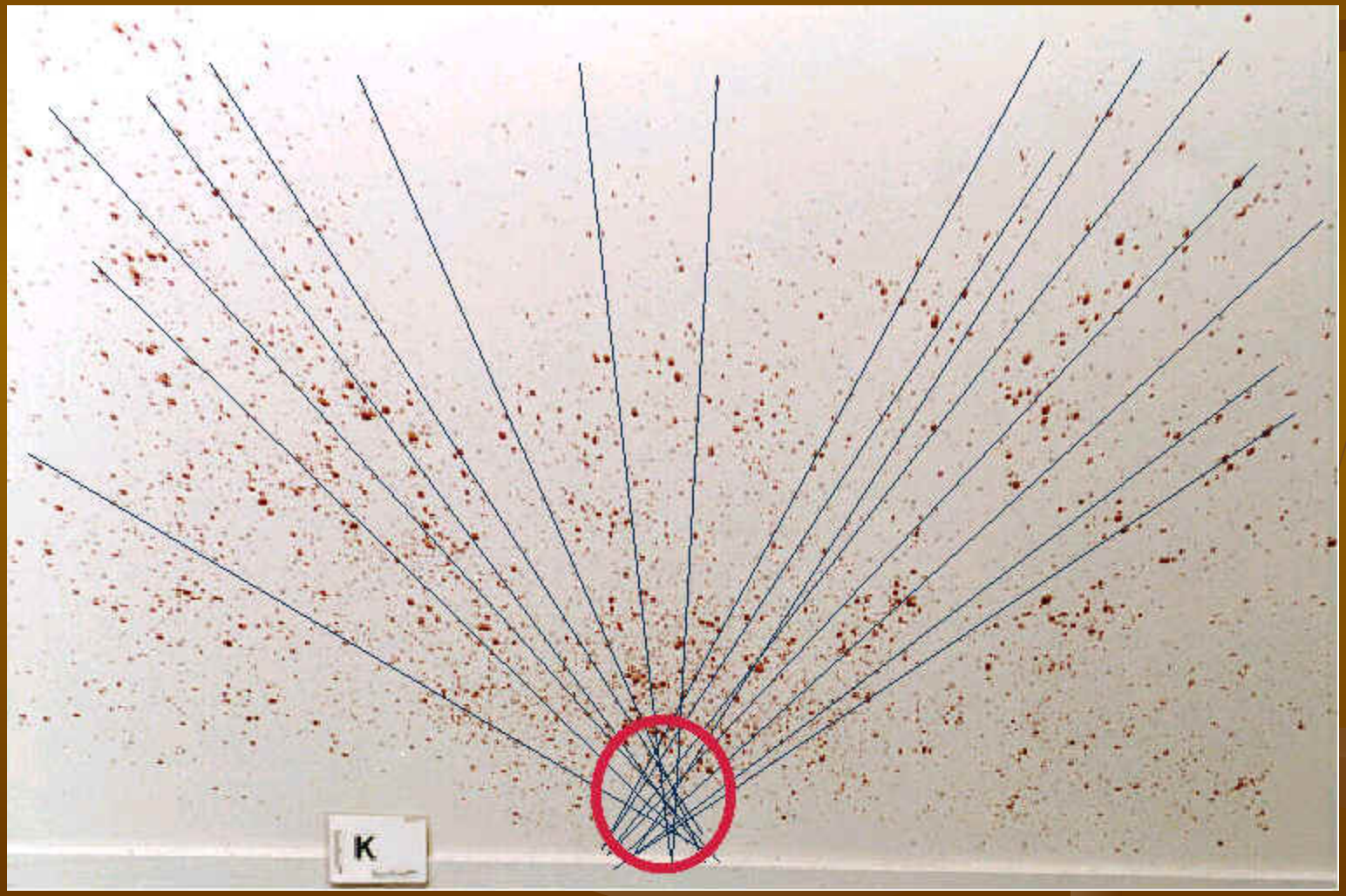
Direction of travel

IMPACT ANGLE DETERMINATION

- **ANGLE of IMPACT** ***is the acute angle formed between the direction of the blood drop & the plane of the surface it strikes***

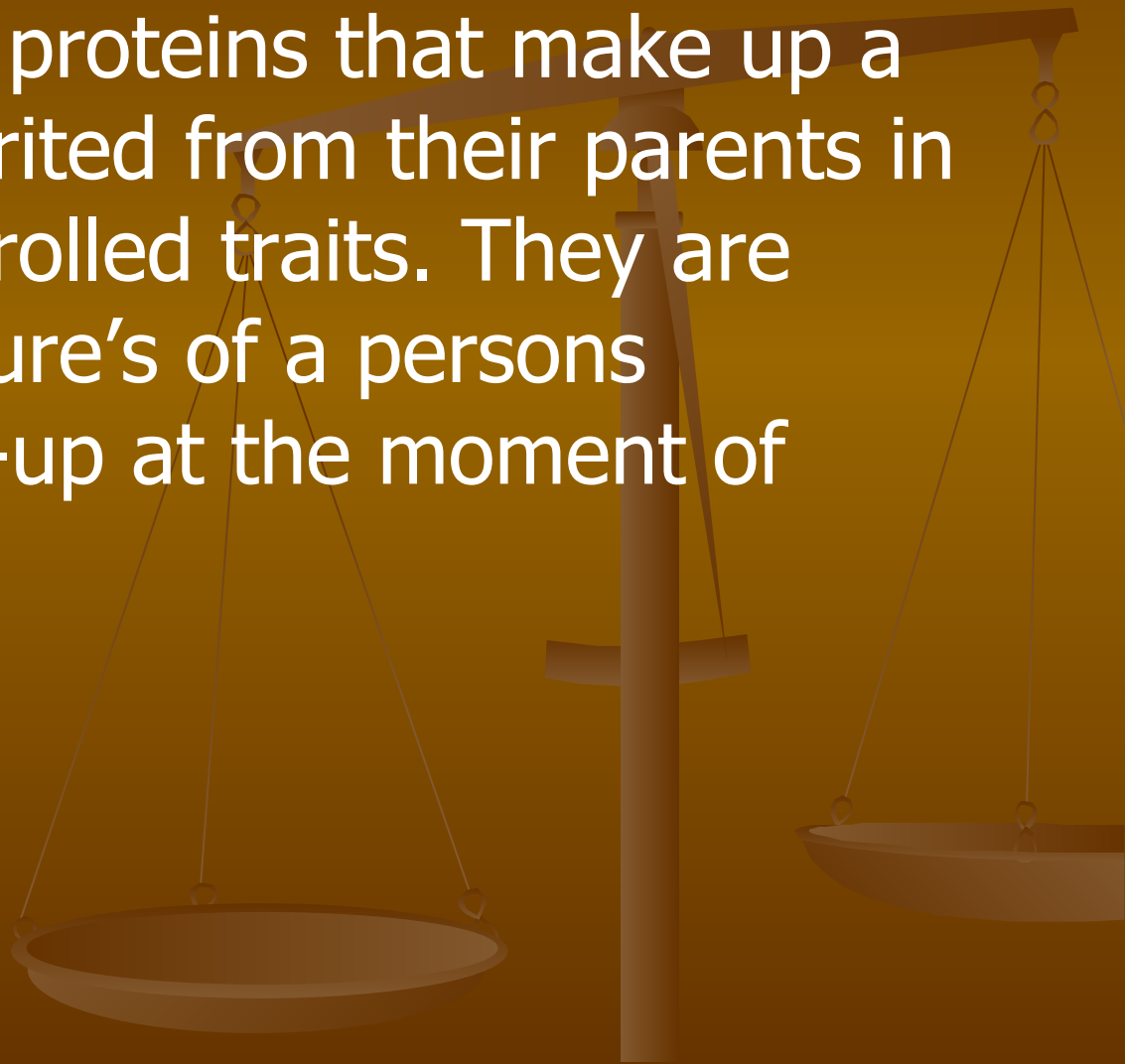


POINT OF CONVERGENCE AND ORIGIN DETERMINATION



Principles of Heredity

- The enzymes & proteins that make up a person are inherited from their parents in genetically controlled traits. They are permanent feature's of a persons biological make-up at the moment of conception.



Genes & Chromosomes

- Hereditary material is transmitted via microscopic units called genes. (They determine the nature & growth of virtually every body structure)
- Genes are on chromosomes that are in the nucleus of every body cell. They are in pairs & each human cell has 46 total, except the egg & sperm which have 23. (Once combined they are a zygote with 46.)

- The genes come in pairs that are called alleles and their position on the chromosomes is called the locus.
- An individual's blood type is determined by 3 genes, designated as A-B-O, if it is made up of 2 of the same alleles it is homozygous (AA, BB, OO) if it has 2 different it is heterozygous (AB, AO, BO)
- Codominant is both heterzygous & equal in representative allele strength- AB

Draw a Punnett square - 4 small squares in the shape of a window. Write the possible gene(s) of one parent across the top and the gene(s) of the other parent along the side of the Punnett square.

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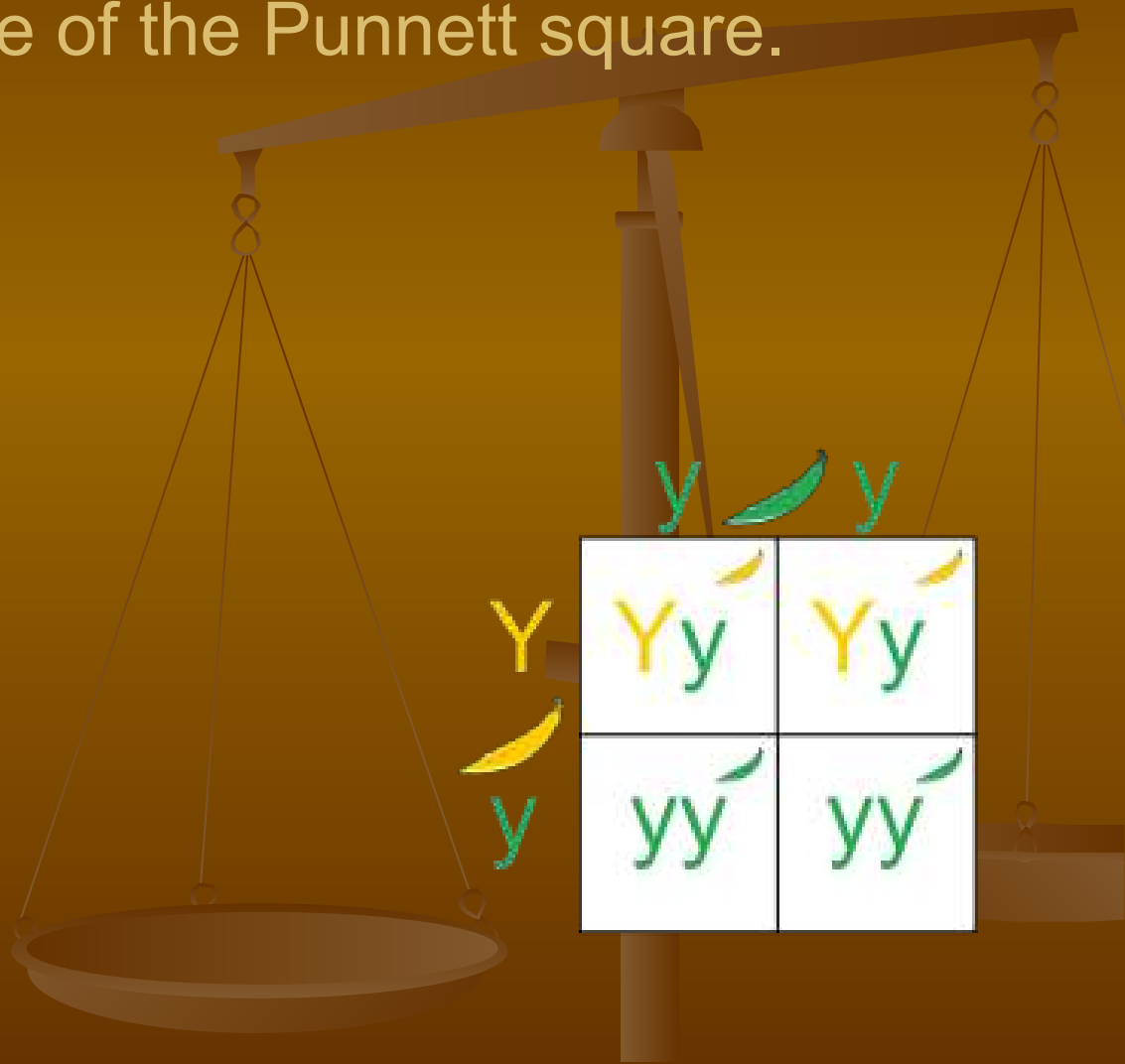


Forensic Characterization of Semen

- Many cases are sexual offenses & require the examination of exhibits for seminal stains.
- 2 step process:
- 1. locate stain (an arduous task)
- 2. stains must be tested to prove identity. (it may be tested for blood type of the individual it originated from or DNA extracted)

Acid Phosphatase Color Test

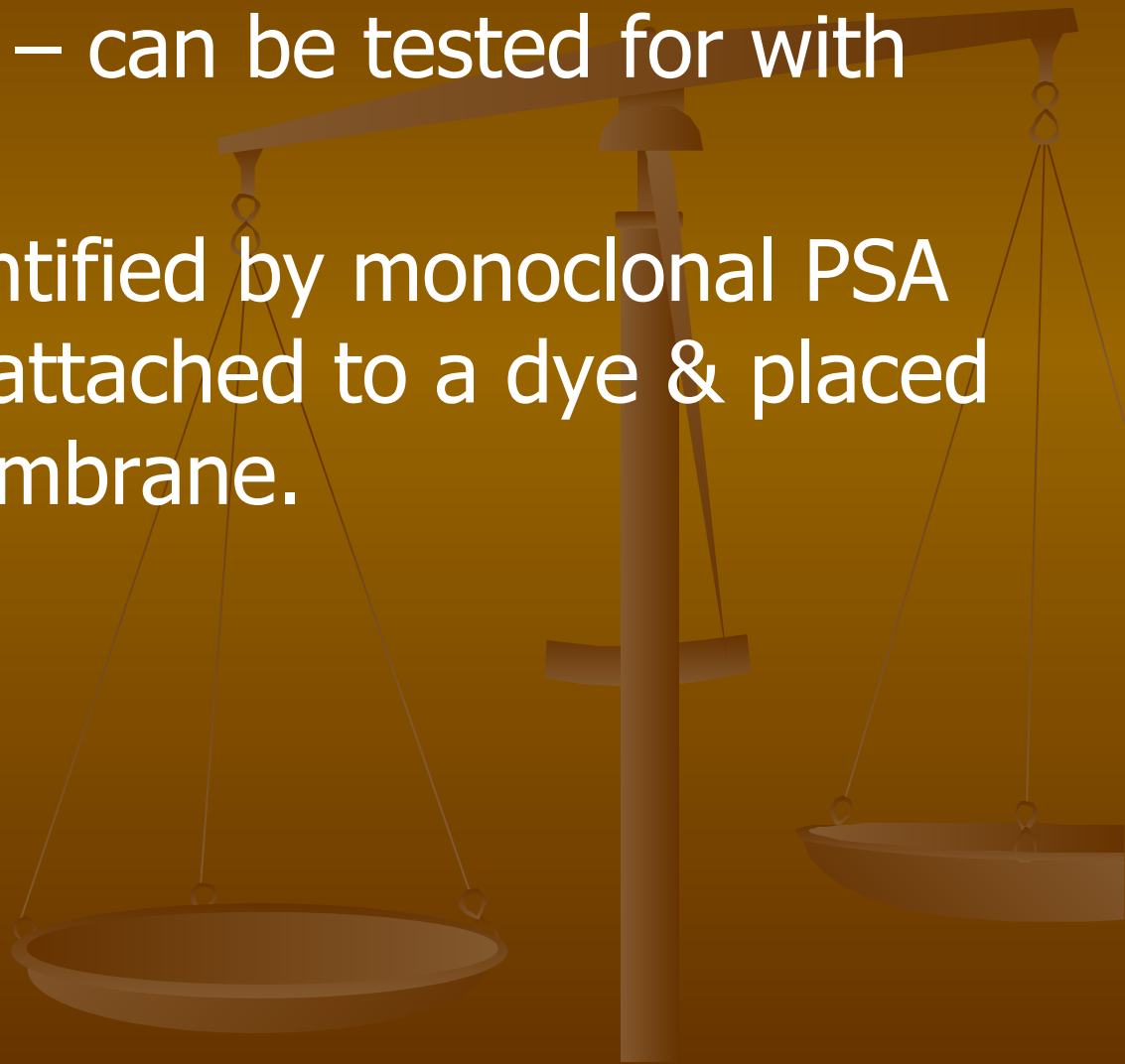
- Acid phosphatase is is an enzyme secreted by the prostate gland.
- It's presence can be detected when it comes into contact with an acidic solution of sodium alpha naphthylphosphate & Fast blue dye.
- (you can get it to emit light w/ exposure to 4-methyl umbelliferyl phosphate (MUP))

Semen Confirmation test

- Unequivocally identified by presence of spermatoza under a microscope. Usually found by immersing the stained material in a small volume of water, rapidly stirring the liquid, put a drop of water on a slide.

PSA- prostate specific antigen

- Seminal plasma – can be tested for with electrophoresis.
- Can also be identified by monoclonal PSA antibody being attached to a dye & placed on a porous membrane.



Collection of Rape Evidence

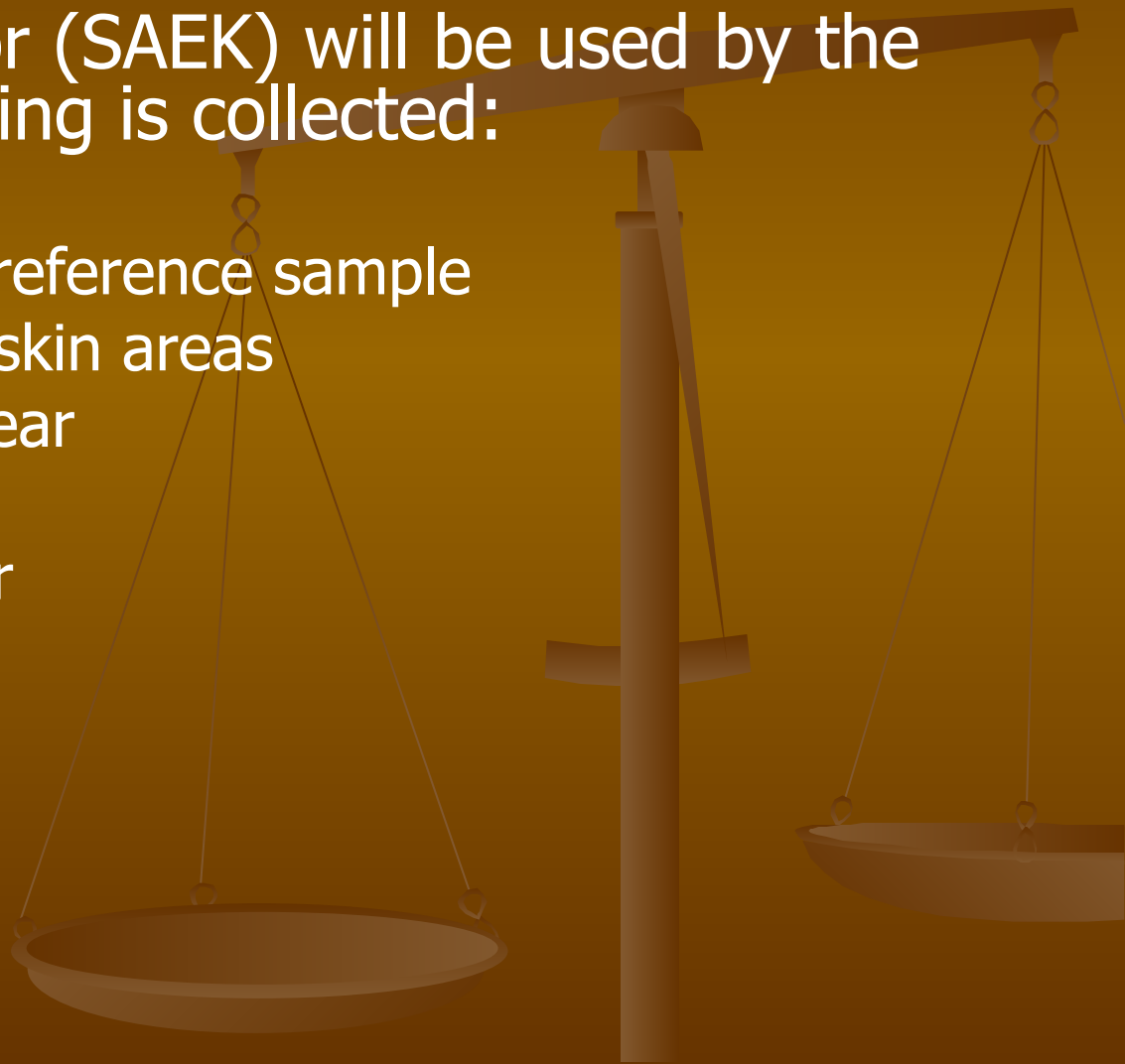
- Rape can be confirmed by the presence of seminal fluid, by bruising. Bleeding or tearing in the vaginal area. There may be a transfer of blood, hair semen or fibers in a sexual assault.
- The evidence must be collected and handled carefully.

Collection

- Items suspected of containing evidence must be collected (like outer and undergarments), packaged separately, in paper bags. (no plastic!)
- When a victim removed their clothing:
  - Lay clean sheet out
  - Place white paper on sheet
  - Undress on top of paper to gather anything that may fall, like hairs or fiber.
  - Fold the paper & package to send to the lab
  - Collect each piece of clothing separately- avoid cross-contamination

Medical Exam

- The victim will be medically examined as quickly as possible after the assault.
- Rape-collection kit or (SAEK) will be used by the medical staff, following is collected:
  - Pubic combings
  - Pubic hair/standard reference sample
  - External genital dry-skin areas
  - Vaginal swabs & smear
  - Cervix swab
  - Rectal swab & smear
  - Head hairs
  - Blood sample
  - Fingernail scrapings
  - All clothing
  - Urine specimen

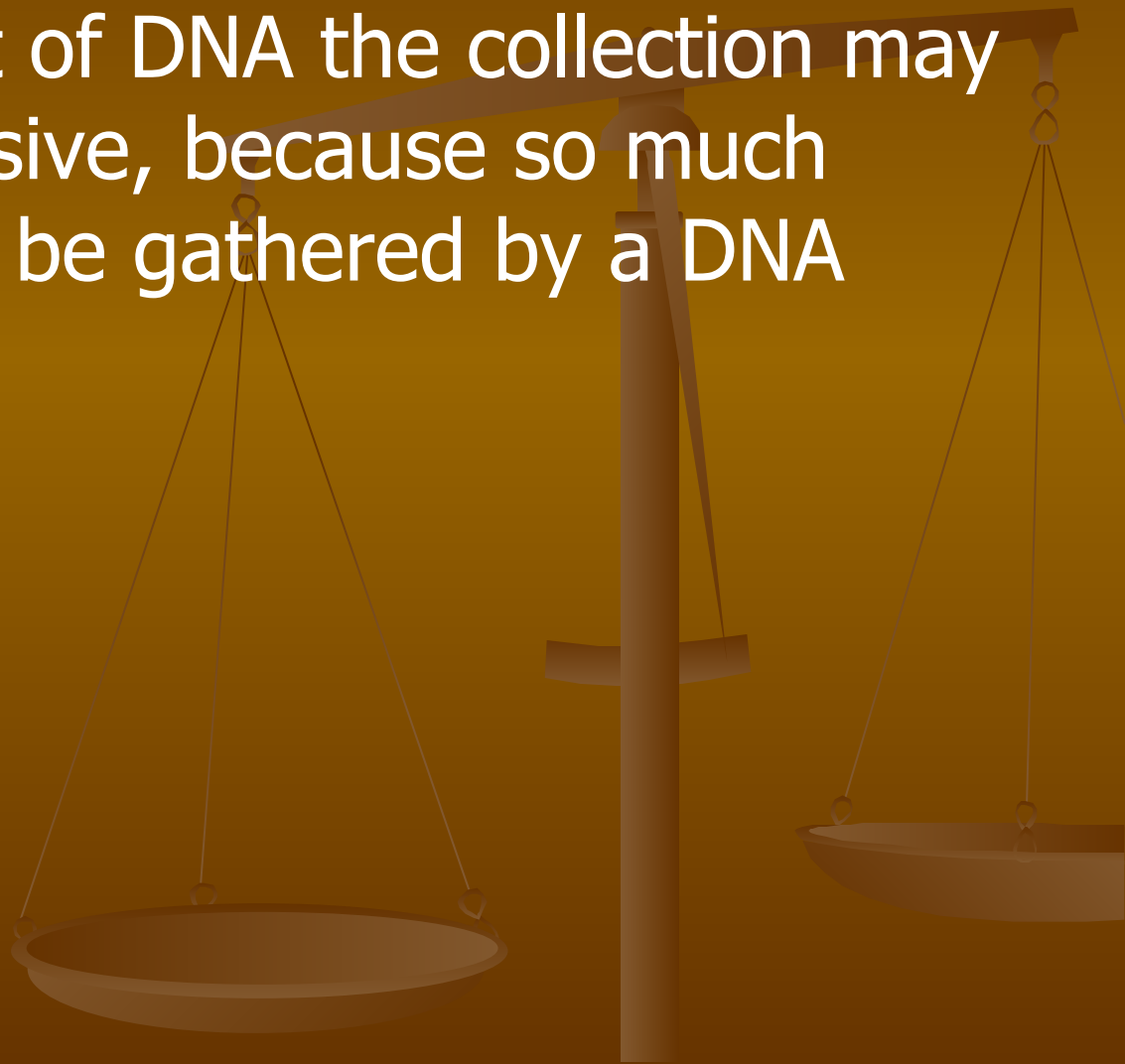


Collected from suspect if arrested

- All clothing (believed to be worn in assault)
- Pubic hair combings
- Pulled head & pubic hair standard/reference samples
- Penile swab – if within 24 hours of the assault
- A blood sample or buccal swab for DNA typing purposes.

DNA & Rape

- With the advent of DNA the collection may not be as extensive, because so much information can be gathered by a DNA sample.



What Samples can DNA be collected from?

- **Sweaty t-shirts**
- **Undergarments**
- **Semen stains**
- **Vaginal stains**
- **Paper or plastic cup**
- **Glass**
- **Ear wax**
- **Fingernail clippings**
- **Socks**
- **Urine**
- **Licked stamps**
- **(Inner) cheek swabs**
- **Hair with roots**
- **Dried blood**
- **Whole blood**
- **Chewed gum**
- **Dental floss**
- **Cigarette butts**
- **Used tissue**
- **Dried skin**
- **Used razor**