Forensic Science Exam Notes

- Dot - tiny round ridges
- Short ridge - small isolated segment of ridge
- Enclosure - ridge that forms forks, a complete circle, then becomes single ridge again
- Trifurcation - ridge that splits into three ridges

International Association for Identification (IAI) is an umbrella group of fingerprint experts that decided in 1990 no standard minimum number of points would be necessary for positive identification. They instead came up with three levels of friction ridge details that would be used to identify prints.

- Level 1 - general features and patterns that can be used to exclude a print only
- Level 2 - includes particular ridges (minutiae) in same place that allow individualization of an unknown print
- Level 3 - requires low power microscope, identifies minute imperfections, such as scars, edge shapes, sweat gland pores that are so unique their presence virtually assures individuality.

“A.C.E.V.” - is the description of a process used in comparing two different things and having someone else agree with the result of the comparison.

- A-Analysis (Classify print, determine suitability)
- C-Comparison (Overall pattern, Minutiae & other details)
- E-Evaluation (A conclusion is made.)
- V-Verification (A second examiner verifies the conclusion)

TYPES of Fingerprints:
- A friction ridge print (fingerprint) is a representation of a friction ridge pattern in some medium.
- Patent/Visible Fingerprint - can be seen by the naked eye
- Latent Fingerprint - A fingerprint made by the deposits of oils and/or perspiration. It is invisible to the naked eye.
- Plastic Fingerprint - A fingerprint impressed in a soft surface
- *Latent prints require some sort of assistance to make them visible. Visualization techniques may be physical, chemical or optical enhancements.

OPTICAL VISUALISATION OF FINGERPRINTS:
Sometimes a latent fingerprint can be visualized by simple oblique lighting. Different light sources equipped with different colour filters will filter the white light and allow the fingerprint to be viewed with light of a narrow range of wavelength. When a latent print is treated with chemicals, the filtered light may excite this chemical and not the background (substrate) allowing a clearer view of the print to be photographed.

CHEMICAL VISUALISATION OF FINGERPRINTS:
- Iodine Fuming
  - This is the oldest chemical method. The object being processed is exposed to iodine fumes. The oily substance of which the latent print is composed absorbs the iodine fumes
Kastle-Meyer (KM) Test (presumptive or screening)
- A simple colour indicating test to determine if substance IS blood or NOT
- 3 stage
  - 1) Alcohol
  - 2) Phenolphthalin
  - 3) Hydrogen peroxide
- Phenolphthalein (color indicator)
- Positive test is vivid fuchsia (pink) color after addition of 3rd reagent
- Two major chemical tests for presence of latent blood: Luminol and Fluorescein
- Tests for Human Blood: Hexigon OBTI or ABA card Hematrace (determine human vs animal), similar to home pregnancy test kit

What is Semen?
- Semen is a liquid from the male reproductive system that usually contains spermatozoa (sperm cells)
- Mature males emit semen during ejaculation
- Some males have low sperm counts (oligospermic) or no sperm (aspermic)
- The liquid component of human semen contains high levels of acid phosphatase (AP) and prostate specific antigen (PSA/p30)
- Examinations for semen:
  - Visual examination, Alternate Light Source (ALS) examination, colour indicating chemical test for presence of Acid Phosphatase (AP) – Fast Blue results in purple colour development (considered to be presumptive); AP Press test is used to localize or pre-screen areas on clothing such underwear, bedding, etc.
  - Confirmatory Tests for Semen:
    - 1) PSA/p30 – similar to home pregnancy test kit
    - 2) Microscopic identification of sperm cells (spermatozoa) – uses Christmas tree stain (red and green)

What is Saliva?
- Watery secretion produced in mouth for lubrication and preliminary digestion of food
- Consists of water, proteins, enzymes and salts
- Amylase is a substance, found in saliva, that is used to break down food starches
- Amylase is found in high levels in saliva but is also present in other body fluids, though normally at much lower levels (i.e. fecal matter)
- Examinations for saliva:
  - Visual examination, Alternate Light Source (ALS), Phadebas Press Test (test used to localize amylase-containing stains on item; filter paper coated with Phadebas chemical dampened and placed in contact with item, blue colour development indicates location of amylase.

Bloodstain pattern analysis (BSPA) provides an understanding of what happened in violent crime. It assists in reconstructing the incident.
- It can be used to provide evidence or exonerate a suspect.
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- It combines geometry, physiology, physics, and logic.
- Interpretation of Bloodstain patterns may provide the following type of information:
  - 1. Activity at scene
  - 2. Number of blows
  - 3. Position of victim and assailant
  - 4. Whether death was immediate or delayed
  - 5. Weapon characteristics

Physical Properties of Blood
- Blood is very viscous (flows more slowly than water).
- Blood tends to adhere to external surface.
- Blood that falls from a body will form a sphere, not a teardrop as commonly depicted.
- The average size of a drop of blood is 0.05 ml with an average diameter of 4.56 mm while in air.
- Note: that 5 ml in one teaspoon, so that the 10 drops of blood on average would fill a teaspoon and that 1 mm is the width of a dime, so that an average drop of blood is the width of about 5 dimes stacked up.

BSPA Principles
- A free falling drop of blood forms a sphere or ball.
- A spherical drop will break
  - 1. When it strikes another object
  - 2. When acted upon by some force
- When a drop of blood falls freely to the ground, the diameter of the impacted drop increases when dropped from greater heights (up to a max. height of approx. 7 feet.) No matter how far a drop of blood falls, it will not break into smaller droplets or spatter unless something disrupts its surface tension.
- Surface Tension is the tendency of molecules of a liquid to stick together at the surface.

NOTE: The first blow rarely produces spatters since exposed blood must receive the impact (with the exception of gunshots). Spatter pattern varies with the type of weapon used (sharp or blunt) and with the number of blows inflicted.

**Bloodstain Pattern Categories:**
1) Passive Bloodstains/Patterns
   - Move only under the influence of gravity and include: Passive drop, Drip pattern, Flow pattern, Pool, Saturation
2) Transfer Bloodstains/Patterns
   - Include prints, wipes, swipes, pattern transfers, and general contact bloodstains
   
   **Print** - a recognizable image of all or a portion of the original surface may be observed in the pattern (i.e. gun, knife, hand, foot…)
   
   A **wipe stain** is created when an object moves through a preexisting bloodstain.
   
   A **swipe stain** is the transfer of blood onto a target by a moving object that is itself bloodstained.
   
   REMEMBER: An object that is **stained** creates a swipe, and one that is unstained creates a wipe!
3) Projected/Impact Spatter
   - Include spatters, splashes, cast-off stains, and arterial spurts or gushes.
Genes on the chromosomes are the basic unit of heredity. They instruct the body’s cells to make proteins that determine everything from hair colour to susceptibility to diseases.

The human genome – (all of the genetic information for an individual combined) has about 3 billion base pairs of genetic information. More than 99% of human DNA is exactly the same, less than 1% differentiates one human being from another.

A locus is a location on a chromosome where a particular gene resides.
An Allele is a different version of a gene/trait at each locus. A single allele for each locus is inherited separately from each parent. Because there are multiple forms of the different genes, i.e. “alleles”, animals & humans are different!

Note: A recessive allele only shows if the individual has two copies of the recessive allele. (I.e. the allele for blue eyes is recessive. You need two copies of the allele to have blue eyes).

A dominant allele always shows, even if the individual only has one copy of it. (The allele for brown eyes is dominant. You only need at least one copy of it to have brown eyes).

In DNA analysis, polymorphic locations/loci are chosen.

Polymorphism = “Many Forms” – are the differences between/among individuals. Examples of Human Polymorphisms include eye color, hair color, height and blood type.

Types of DNA Polymorphisms—there are two types of variability in alleles:

- Sequence Polymorphism
  - The two sequences of double stranded DNA are exactly the same except at one location:
    - The cat is in the hat. (I.e. AGCT) is a different form from the rat is in the hat. (I.e. AACT)
  - Length Polymorphism—consists of a series of base pairs that are repeated i.e.
    - The cat ran very fast. (I.e. ACTC) is a different form from the cat ran very, very, very fast. (I.e. ACTCACTCACTC)

Forensic Examination of DNA

**Short Tandem Repeat Testing (STR)**—1990’s is currently the most powerful method for DNA analysis
It looks at DNA fragments 2-7bp (base pairs) i.e. short in length. STR testing is PCR based.

**STR: THE PROCESS**

(i) **Isolation**—Scientists extract DNA from the nucleus of cells in tissue
(ii) **Quantification**—Tests are run to determine the amount of DNA recovered. The targeted amount is 1 nanogram (billionth of a gram). If inadequate quantity, isolation must be repeated
(iii) **Amplification**—PCR sees notes below. DNA is amplified/photocopied
(iv) **Profiling**—Capillary Electrophoresis is used for separating DNA fragments. When the voltage is applied the fragments move at different speeds depending on their size and charge. The fragments are seen as peaks as they pass through the detector.
(v) **Interpretation**—the DNA profile from an “unknown” sample (from crime scene) to that of a “known” sample (person) is compared and a report is written.
**BULLET INDIVIDUAL CHARACTERISTICS**
When the barrel of a gun is made there are striations (scratches) or irregularities in the Lands & Grooves of the barrel. These striae are also due to wear and use or to neglect and abuse of the firearm. These striae are imparted onto the bullet as it passes through the barrel. No two rifles barrels even those manufactured in succession (one directly after the other) will have identical striation markings. Striations within two bullet’s lands & grooves will “align” (match up) if fired from the same firearm. This is an individual/unique characteristic.

**CARTRIDGE CLASS CHARACTERISTICS**
- Shape- such as Rimmed, Rimless or Straight
- Caliber (i.e. .22 Rimfire, .40 S&W, 30-06 Springfield)
- Size & Shape of Firing Pin
- Size/Shape & Location of Extractor, Ejector

**CARTRIDGE INDIVIDUAL CHARACTERISTICS**
- Firing Pin Impressions- The shape of the firing pin is impressed into the soft metal of the primer cup.
- This reveals minute distortions of the firing pin.
- Breech Face Marks- The cartridge head is seated against the breechblock of the weapon. The breechblock has striations from the machining process that individualize its surface. When the bullet is fired, the cartridge case is shoved back into the breechblock with the same amount of force. This imprints the striations of the breechblock onto the cartridge casing.
- Ejector Marks- are imparted to the cartridge case when it is ejected out of the weapon.
- Extractor Marks- are imparted onto the cartridge case when the case is extracted from the barrel.

**Report Conclusions:**
Positive/Negative - The Bullet, item 1 was/not fired from the Rifle, item 2.
Inconclusive - The Bullet, item 1, could neither be identified nor eliminated as having been fired from the Rifle, item 2.

**Firearms Databases & Automated Search Systems:**
- Firearm evidence can link a person or persons to multiple crimes. Difficulties arise in searching & comparing numerous bullets or casings.
- Two automated search systems were developed in the 1990s: DRUGFIRE and IBIS (Integrated Ballistic Identification System). Both systems integrated digital imaging, novel data collection, computerized databases of images, and communications technology
- DRUGFIRE and IBIS were not compatible with each other & required specialized hardware.
- In 1997, the National Integrated Ballistics Information Network (NIBIN) was developed as an answer to the discrepancies between DRUGFIRE & IBIS, it links up both collections/databases.
- Will cover every state and major population center. Over 5,300 “hits” have been logged