Introduction to Forensic Science – (Criminalistics)

Basic

Crime **S**cene **I**nvestigation Techniques

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Introduction to Forensic Science – (Criminalistics)

Basic

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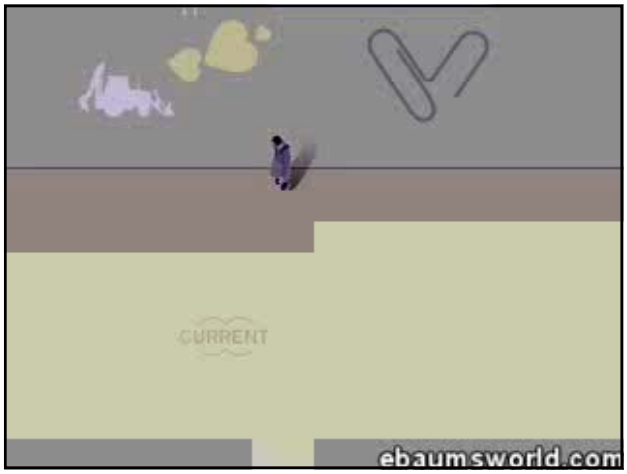

This week the student will learn:

- The origin and parts of a microscope
- Different uses for different types of scopes
- Component parts of hair
- Different types of fiber evidence
- Collect, compare, preserve and identify fibers
- There will be a quiz
- HOMEWORK
  - Read chapters 9 & 10 - Turn in lamp assignment

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Review – The Microscope

- A Microscope is an optical instrument that uses a lens or a combination of lenses to magnify and resolve the fine details of an object.
- The earliest and simplest is the magnifying glass.
- It produces an image called a VIRTUAL IMAGE because it can only be seen when looking through the lens.
- Can achieve only about 5x-10x mag.
- Higher x requires a compound microscope

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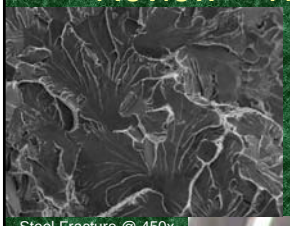
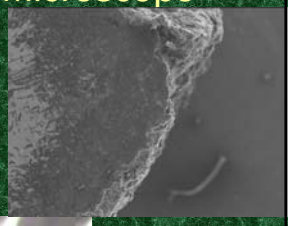
Review – The Microscope



Steel Fracture @ 450x



Paper Clip end @ 450x

Lamp Filament @ 200x

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Review – The Microscope

- A compound microscope is comprised of two lenses, one at each end of a hollow tube.
- The lower lens is called an "objective lens"
- The upper is the "eyepiece" or "Ocular"

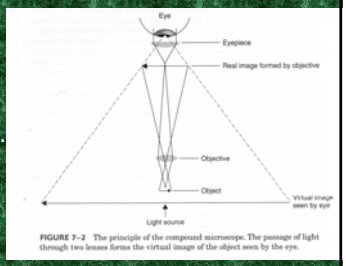

FIGURE 7–2 The principle of the compound microscope. The passage of light through two lenses forms the virtual image of the object seen by the eye.

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Review – The Microscope

- The magnifying power of both lenses can produce an image magnified up to 1,500 times.
- Each lens is inscribed with a magnifying power.
- The total power is the product of the two lenses combined.
- The most appropriate scopes to forensic science are:
  - Compound
  - Comparison
  - Stereoscopic
  - Polarizing
  - Microspectrophotmeter
- SEM will be covered a little later.

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Review – The Microscope

Digital Computer Microscope

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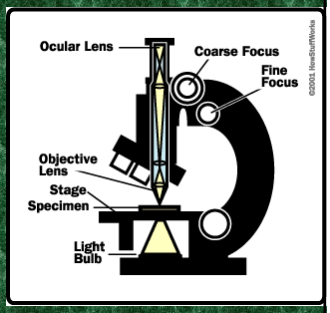
Let's Leap In

Review – The Microscope

- Basically it is a system to support the lens, light and specimen.
- There are typically 6 mechanical parts
- There are typically 4 optical parts.



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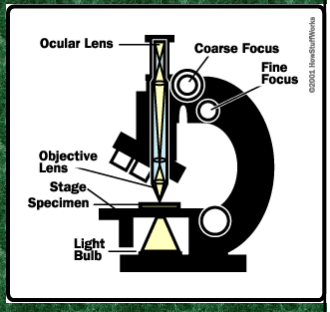
Review – The Microscope

- Mechanical
  - Base
  - Arm
  - Stage
  - Body Tube
  - Coarse Adjustment
  - Fine Adjustment



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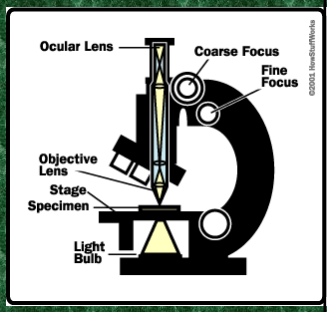
Review – The Microscope

- Optical
  - Illuminator
    - Transmitted
    - Vertical/reflected
  - Condenser
  - Objective Lens
    - Parfocal
  - Ocular Lens (eyepiece)
    - Monocular
    - Binocular



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Review – The Microscope

- The ability of an objective lens to resolve an image into details rather than a blurred mess is proportional to its aperture value.
  - A 1.30 N.A. lens can separate details that are twice as close as a 0.65 N.A. lens.
- The maximum useful magnification of a compound microscope is 1,000 times the N.A.
- Field of View
  - The viewing area.
- Depth of Focus
  - Thickness of area capable of being in focus at the same time.

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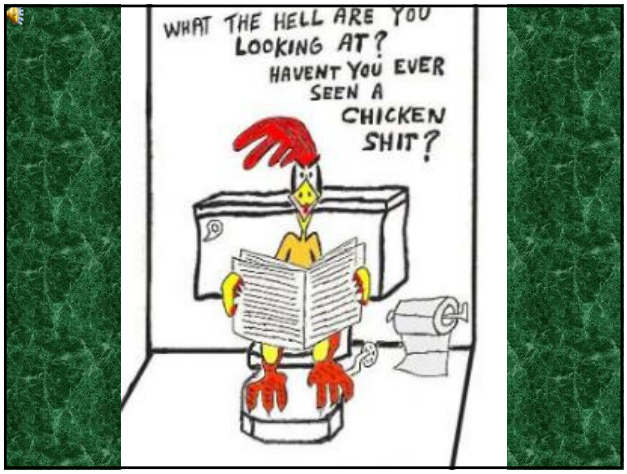
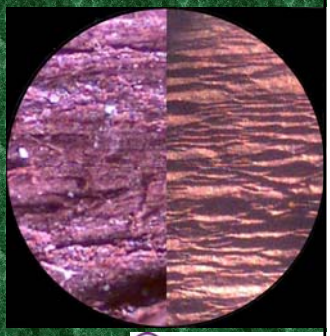


Review – The Microscope

- The comparison microscope
  - For side-by-side comparison of specimens
  - When looking through the eyepiece, the image is cut down the center and an image appears on either half.



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Review – The Microscope

- Stereoscopic microscopes have magnifications of 10x – 125x
- They present a 3D image of the specimen.
- Have a large specimen distance.
- It is considered the most used and most versatile in the lab.
- Ideal for locating trace evidence in debris, and on garments, weapons, and tools.

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Review – The Microscope

- Waves of light vibrate in all directions.
- When light passes through special crystalline surfaces, it emerges vibrating in only one plane, it is polarized.

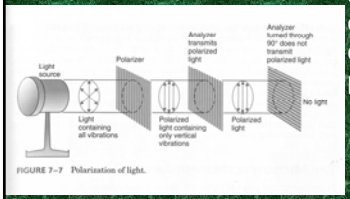

FIGURE 7–7 Polarization of light.

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Review – The Microscope

- Compound and stereoscopic microscopes can be fitted with a polarizing unit. It is then called a polarizing microscope.
- Many crystalline substances are birefringent, (split a beam of light into two light ray components having different refractive index values).
- They will be at right angles to each other.

Review – The Microscope

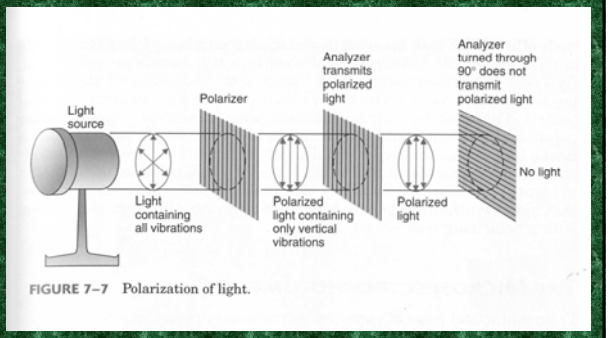
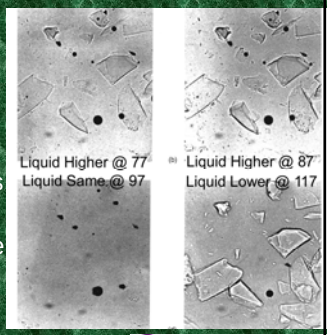
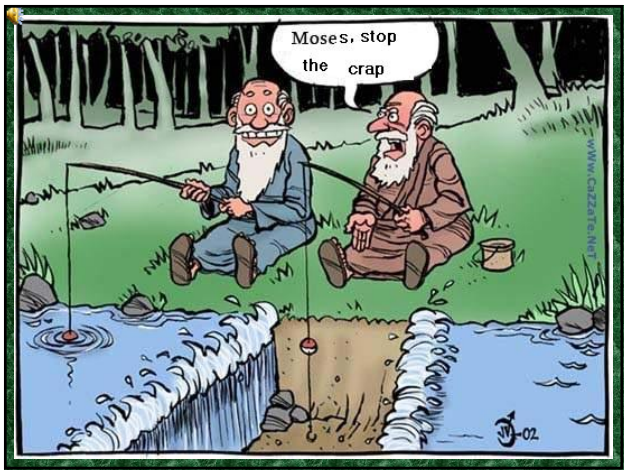


FIGURE 7–7 Polarization of light.

Review – The Microscope

- When a mineral is viewed under polarized light in a liquid of matching refractive index, the Becke line disappears
- This permits the scientist to identify the mineral.





Review – The Microscope

- Microspectrophotometer
  - An instrument linking a microscope to a spectrophotometer.
  - Spectrophotometers are not well suited to examine minute particles.
- When examining paint, fibers, ink, etc., a visual comparison of color is first step.
- With this instrument, an absorption spectrum can be plotted at the same time.
- Great for comparing real from counterfeit currency by looking at spectral patterns of inked lines.

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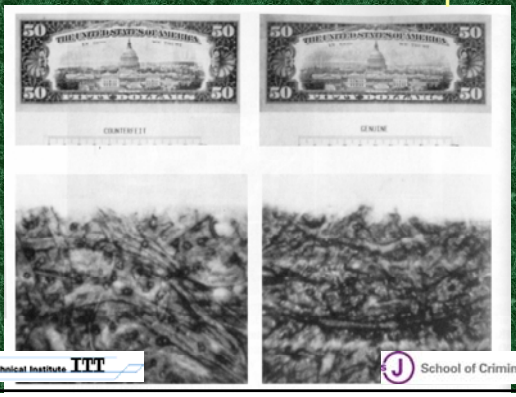
Review – The Microscope



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Review – The Microscope

- On a visible light microscope, a beam of light is focused on the specimen and the reflected light is analyzed.
- Magnified up to 1,500 times.
- On a Scanning Electron Microscope, a beam of electrons is focused on the specimen and the reflected electrons are collected and observed on a monitor.
- Magnified up to 100,000 times.

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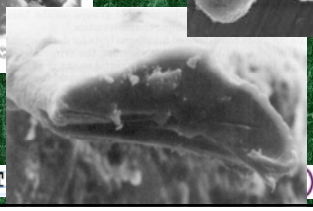
Review – The Microscope



Grain of Iron Oxide @ 10,000 x

Cross section of a Single nylon fiber

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Review – The Microscope

- The Scanning Electron Microscope has ultra high magnification (100,000 x), ultra high resolution, great depth of focus (300 times that of optical) and appears stereoscopic.
- In addition, x-rays are generated by it.
- The x-ray analyzer can identify the elements in the specimen.
- It can also determine the concentrations of the elements present.

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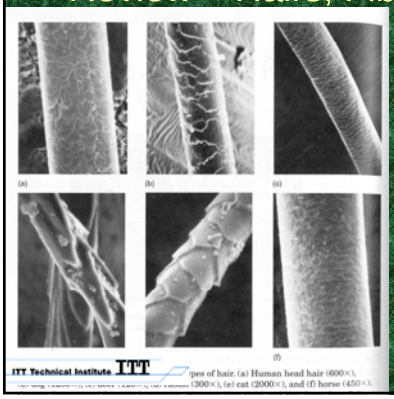
Review – Hairs, Fibers, Paint

- It is not yet possible to individualize a human hair to head or body through its morphology.
- Hair does still possess some evidentiary value.
- Hair is an appendage of the skin that grows from an organ known as a hair follicle.
- The shaft is comprised of three layers, Cuticle, Cortex, Medulla.

Review – Hairs, Fibers, Paint

- The Cuticle makes the hair resistant to chemical decomposition and enables it to retain structural features over a long period of time.
- It is the outer sheath of the hair shaft.
- It is comprised of overlapping scales that always point towards the tip.
- A cast can be made by placing the hair in clear nail polish and let it harden, remove the hair and study the cast.

Review – Hairs, Fibers, Paint



Human @ 600x, dog@ 1250x deer@ 120x, rabbit @ 300x, cat @ 2000x, horse @ 450x

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Review – Hairs, Fibers, Paint

- The Cortex is under the cuticle.
- Made up of spindle shaped cells aligned in an array parallel to the length of the hair.
- Imbedded with pigment providing hair color.
- This portion is examined after the hair is wet mounted in a medium that has a matching refractive index (to the hair) to minimize reflected light, and let light penetrate hair shaft.

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Review – Hairs, Fibers, Paint

- The Medulla are cells running down the center of the hair shaft and resemble a canal.
- Medullary index is the diameter of the medulla relative to the entire hair shaft (usually fractional).
- For humans, the index is usually about 1/3.
- For other animals, the index is ½ or greater.
- The appearance varies from person to person and even hair to hair on the same person.

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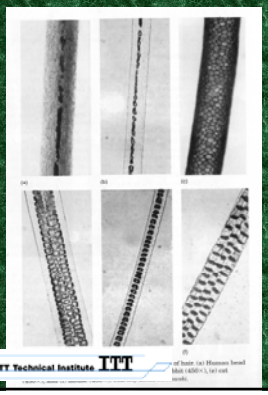
Review – Hairs, Fibers, Paint



Human head @ 450x, dog @ 450x,
Deer @ 100x, rabbit @ 450x,
Cat @ 450x, mouse @ 450x

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Review – Hairs, Fibers, Paint

- The Mongoloid race have head hairs with continuous medullae, most all others are fragmented or non-existent.
- Other animals have a patterned shape.
- Hair has three growth phases, Anagen, Catagen and Telogen
- The Anagen can last up to six years.
- The Catagen is two to three weeks.
- The Telogen is two to six months.

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Review – Hairs, Fibers, Paint

- A follicular tag can be found on some Anagen phase hairs, permitting DNA analysis.

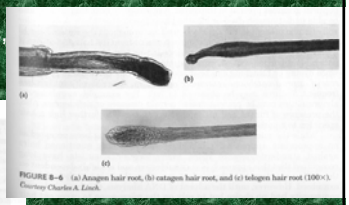

FIGURE 8–6 (a) Anagen hair root, (b) catagen hair root, and (c) telogen hair root (100×). Courtesy Charles A. Linch.

FIGURE 8–7 Forcibly removed head hair, with follicular tissue attached. Courtesy New Jersey State Police.

Telogen phase hairs contain Inadequate amounts of DNA for a Full analysis.

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Review – Hairs, Fibers, Paint

- Use comparison microscope when analyzing hair.
- Match color, length and diameter
- Presence or absence of medulla
- Distribution shape and color of pigment in cortex.
- Hair grows at the rate of 1 centimeter per month.
- 0.4 inches per month
- Hair analysis is very subjective and dependent upon the skills and integrity of the analyst.

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Review – Hairs, Fibers, Paint

- In 2000, FBI re-analyzed all hair cases since 1996.
- 11% (9 out of 80), where a positive match had been determined, were found to have different DNA.
- Area of body hair originated can be determined.
  - Scalp hairs have little diameter variation and more uniform color.
  - Pubic hairs are short, curly with wide variation in diameter and continuous medulae.

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Review – Hairs, Fibers, Paint

  - Beard hairs are coarse, have a triangular cross section and blunt tips from shaving.
- Race can usually be determined from hair.
- If a follicular tag is attached, it was probably forcibly removed.
- A follicular tag offers a chance of obtaining Nuclear DNA.
  - Found in nucleus of a cell, from both parents
- Mitochondrial DNA can be obtained without a tag.
  - Found outside of cells, obtained only from mother.
  - Need 1-2 cm for test.

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Review – Hairs, Fibers, Paint

- When collecting hairs from a subject, they must come from the same area of the body as the specimen.
- Pubic hairs cannot be compared to head hairs.
- Head hairs require 50 full length hairs from around the head.
- Pubic hairs require 24 full length hairs.
- When combing for stray hairs on a victim, package the comb separately.

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Review – Hairs, Fibers, Paint

- It is extremely unusual for fibers at a crime scene to provide individual identification.
- The first manufactured fiber – rayon (1911)
  - Nylon (1939)
- The most prevalent plant fiber is cotton.

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Review – Hairs, Fibers, Paint

- Hemp is used in many items - rope
- Wool is one of the most common animal.

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Review – Hairs, Fibers, Paint

- Man-made fibers consist of polymers
- If the polymer is derived from a natural material it is called a regenerated fiber,
  - Rayon
  - Acetate
  - Triacetate
- If the polymer is derived solely from man-made materials it is called a synthetic fiber,
  - Nylons
  - Polyesters
  - Acrylics
- Polymers are the basic substance of all synthetic fibers.

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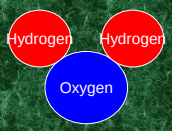
Review – Hairs, Fibers, Paint

- Most materials are comprised of just a few atoms.



- Polymers are formed by linking a large number of molecules containing thousands or millions of atoms.
- Resembles a long repeating chain.
- Individual units within are called monomers.

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Review – Hairs, Fibers, Paint

- Fibers are first examined using a micro spectrophotometer, then a chromatographic separation.
  - Usually TLC method
- Tests are to determine that all fibers come from same class.
- Then to determine if they come from the same sub-class
  - 4 types of nylon
  - 24 groups of acrylic fibers

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Review – Hairs, Fibers, Paint

- Many manufactured fibers exhibit birefringence
- Light passing through a synthetic fiber emerges polarized.
- A Becke line analysis permits non-destructive testing of a minute amount.

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Review – Hairs, Fibers, Paint

- Fiber Evidence can be associated with virtually any type of crime.
- It is the kind of evidence that will not usually be seen with the naked eye & is easily overlooked by the untrained.
- The CSI's job is to look for carriers of potential fiber evidence.
- Suspect articles cannot even be put on the same surface prior to packaging.

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Review – Hairs, Fibers, Paint

- Cover car seats with polyethylene sheets to protect them
- Cover knife blades to protect trace evidence
- A body thought to have been wrapped, should be swabbed with adhesive tape lifts.
- If removal of a fiber is necessary, use clean forceps and place in a small sheet of folded paper, then into a sealed container.
- The CSI should collect only relevant items for exam.

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Review – Hairs, Fibers, Paint

- Paint is the most prevalent type of physical evidence submitted.
- Auto paint is most common submitted.
- The analyst need not rely on comparison alone.
- Auto finishes (steel) are comprised of four layers
  - Electrocoat primer – black or grey on metal
  - Primer surfacer – to smooth surface
  - Basecoat – the color coat of paint
  - Clearcoat – clear overcoat for protection

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Review – Hairs, Fibers, Paint

- The importance of layers is vital to exam
- Most samples have a duplicate layer structure and cannot be individualized.
- Comparison involves chemical analysis of binder and/or pigment
- Pyrolysis gas chromatography is very good for paint testing with as little as 20 micrograms.
- Infrared spectrophotography is also utilized to analyze binder.
- Two vehicles being identical are 33,000 to 1

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Review – Hairs, Fibers, Paint

- When collecting paint chips, keep chip intact
- Collect sample from as close to damaged area as possible
- Include all layers down to bare metal surface
- Avoid cross contamination

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Class to date Review

- What is the definition of forensic science?
  - the application of science to those criminal and civil laws that are enforced by criminal justice agencies.
- How can glass place a person at a crime scene?
- A hair is comprised of what three parts?
  - Cuticle
  - Cortex
  - Medulla
- The most used microscope in a lab is?
  - Stereoscopic

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Class to date Review

- Common types of physical evidence.
  - Blood, semen, saliva
  - Documents
  - Drugs
  - Explosives
  - Fibers
  - Fingerprints
  - Firearms/ammunition
  - Glass
  - Vehicle lights
  - Impressions
  - Organs/physiological fluids
  - Paint
  - Petroleum Products
  - Plastic bags
  - Plastic, rubber, other polymers
  - Powder residues
  - Serial numbers
  - Soil and Minerals
  - Tool marks

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Class to date Review

- The physical properties of matter are?
  - Anything that has a mass and occupies space.
- The physical states of matter are?
  - Solid, Liquid, Gas
- Basic services of a crime lab.
  - Physical Sciences
  - Biology
  - Firearms
  - Document Exam
  - Photography

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Class to date Review

- The simplest microscope is?
- A hair can tell a scientist what?
- The stages of decomposition.
  - Algor mortis
  - Liver mortis
  - Rigor mortis
- The bigger hole is on which side of the glass?
- What is sublimation?
- Two types fibers are?
  - Natural
  - Man-Made
- Synthetic fibers are comprised of?

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Class to date Review

- Algor mortis
  - Changes in the body, after death, that cause it to lose heat.
  - Begins about one hour after death,
  - Loses about 1-1.5 degrees per hour.
- Liver Mortis
  - Blood pools at the lowest parts of the body due to lack of circulation.
  - Begins immediately and lasts 12 hours

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Class to date Review

- Rigor mortis
  - The tightening of the muscle tissues within the body without the shortening of the muscles.
  - Stiffening begins about 24 hours after death and disappears about 36 hours following death.
- Vitreous Humor
  - Fluid in the eyeball
  - Following death, cells in the eye release potassium into the fluid.
  - Measuring the amount of change over time, can permit a back figure to time of death.

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Class to date Review

- Identification is?
  - the determination of the physical or chemical identity of a substance with as near as absolute certainty as existing analytical techniques will permit.
- Comparison is?
  - subjecting a suspect specimen and a standard to the same tests for the ultimate purpose of determining whether or not they have common origins.
- Individual characteristics are:
  - Properties of evidence that can be attributed to a common source with an extremely high degree of certainty.
- Class characteristics are:
  - Properties of evidence that can only be associated with a group and never with a single source.

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Class to date Review

- Radial fractures are?
  - Those that form first and radiate away form the fracture site like the spokes of a wheel.
- Concentric fractures are?
  - Those that form second and circle the fracture site.
- An Autopsy is?
  - An inspection by the coroner to determine the cause of death.
- Celsius scale.
  - A temperature scale placing the 0 point at the freezing temperature of water and the 100 point at the boiling temp.

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My youngest student
And most faithful employee

Quiz Week #3