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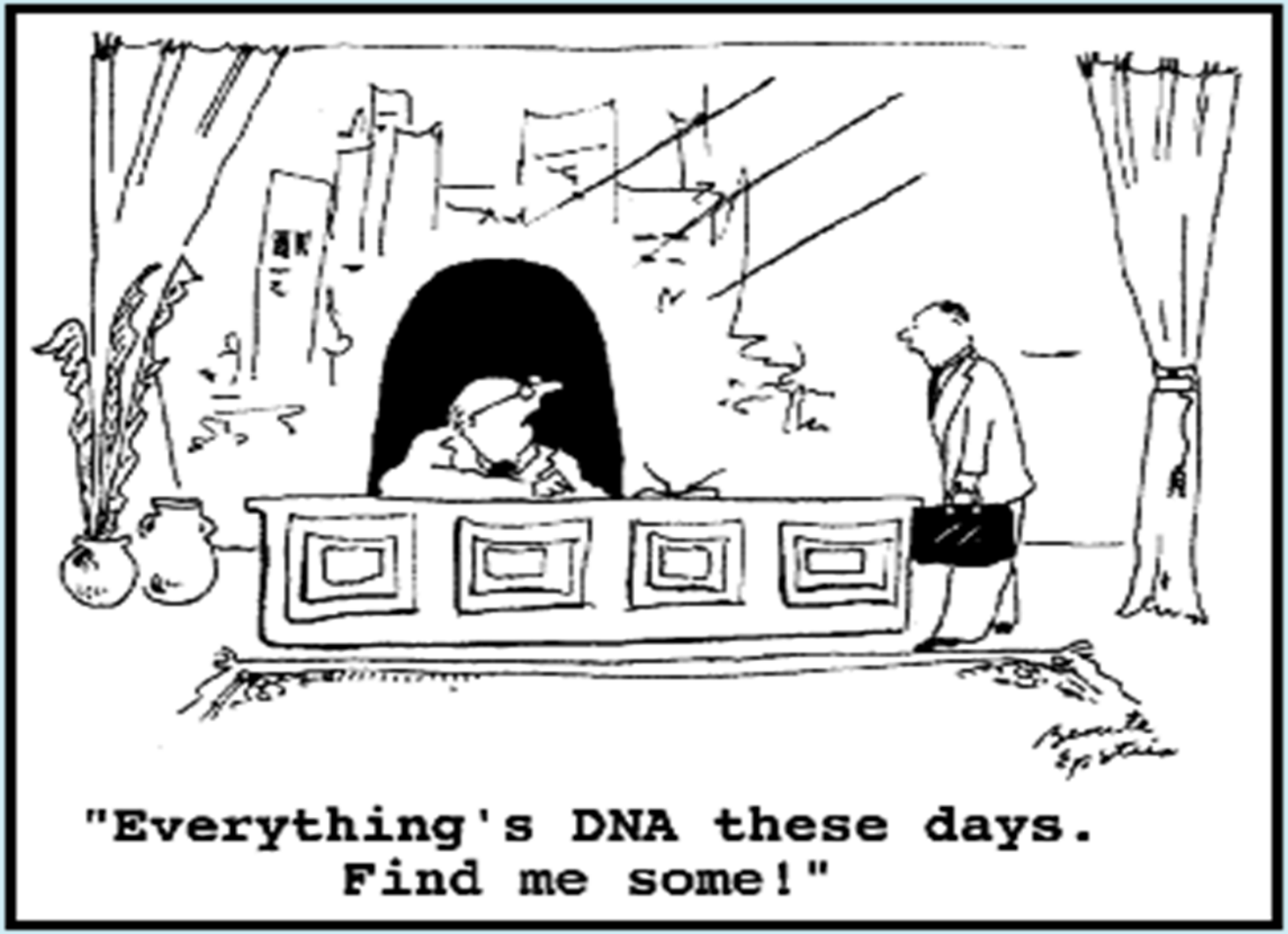
Biological Screening Workshop | *Beth Ordeman*

Serology and DNA Testing



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Topics

- **Typical cases / evidence**
- **Serology screening**
- **DNA analysis**
- **Reports – what do we mean?**
- **CODIS**
- **New trends – touch DNA**

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Typical Cases

- **Burglary**
- **Sexual Assault**
- **Assault / Homicide**
- **Missing persons – unidentified human remains**
- **Paternity**

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Burglary

- **Ski masks**
- **Gloves**
- **Clothing**
- **Blood at point of entry**

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Sexual Assault

- **Sexual Assault Evidence Kit – vaginal swabs, etc.**
- **Panties**
- **Clothing**
- **Bedding**
- **Fingernail scrapings**

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Assault / Homicide

- **Swabs of possible blood from the scene**
- **Clothing**
- **Fingernail scrapings**
- **Weapons**
- **Miscellaneous items from the crime scene**

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Missing Persons

- **Sample from unidentified human remains**
  - **Bone**
  - **Tissue**
  - **Blood**
- **DNA from family members**
  - **Typically go straight to FBI for typing**
    - **Perform mDNA and nDNA for a better search in the database**
  - **Lab may need if asked to confirm unidentified remains**

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Paternity

- **DNA from mother**
- **DNA from alleged father**
- **DNA from baby**
  - **Blood**
  - **Saliva**
  - **Fetus or fetal tissue**

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Serology Testing – Blood

- **Visual exam for staining**
  - **Look for red/brown staining**
  - **Blood can also appear different colors with age and exposure to harsh environments**
- **Presumptive tests**
  - **Kastle-Meyer**
  - **TMB**
  - **Luminol**
- **Cuttings or swabbings are taken of positive stains and are sent on for DNA analysis**

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Serology Testing – Blood

- **Luminol**
  - **Not a confirmatory test for blood**
    - **Has many false positives**
  - **Use wisely – can dilute stains that can not be visibly seen so that a DNA profile may not be developed**

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Serology Testing – Semen

- **Visual exam**
- **Alternate light source exam**
  - **Not a confirmatory test for semen**
- **Presumptive test**
  - **AP**
- **Confirmatory test**
  - **Microscopic exam**
  - **P30***
- **Cuttings of the positive stains or the submitted swabs are sent on for DNA analysis**

* Not all labs use P30 as a confirmatory test.

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Sexual Assault Evidence

- **In most instances, identifying semen on the suspect's own clothing/bedding is not probative**
- **Amylase, a component of saliva can be detected in the case of oral assault, licking or biting or in juvenile assault cases (possibly used as lubrication)**

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Serology Testing – Amylase

- **Visual exam**
- **ALS exam**
- **Presumptive test**
  - **Radial diffusion**
  - **Many false positives**
    - **Vaginal fluid, sweat, tears, fecal material, breast milk**
- **Cuttings of the positive stains or the submitted swabs are sent on for DNA analysis**

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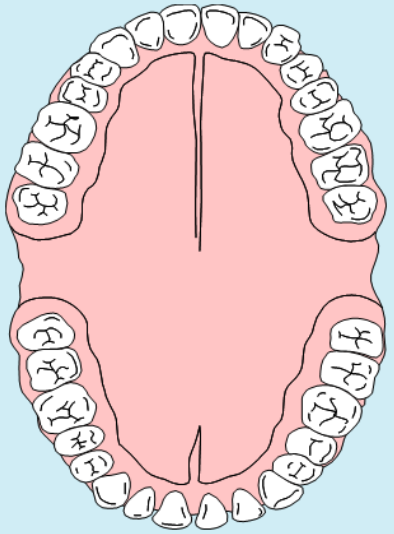
Possible Saliva (Bite Marks, etc.)



- **Swab the suspected area the same way you would a dried blood stain**
- **Don't over moisten the swab**
- **Swab the suspected area with a dry swab after the moist swab**
- **Submit both swabs**

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Serology Testing – Hair

- **Examine for presence of root**
- **Perform DNA analysis on root material or possible adhering tissue**
- **Perform DNA analysis on shaft of hair (as control)**
- **Biology section does not compare micro characteristics (i.e., color)**
- **Mitochondrial DNA (mDNA) for hairs lacking root material**

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Hair Collection

- **Do NOT use vacuum to collect hairs – this voids possible DNA analysis**
- **For DNA analysis we need the root of the hair**
- **Shed hair is NOT good for STR DNA testing**
  - **Most hairs from crime scenes are shed**
  - **Easily transferred so the value in a case will vary**

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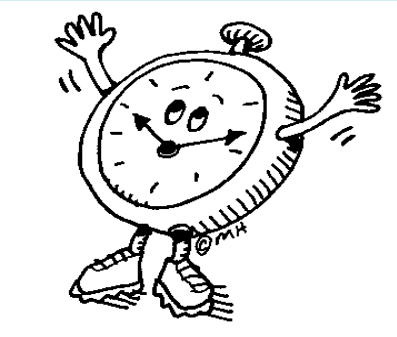
Serology Testing Takes Time!

- **Sexual Assault Kit**
  - **Microscopic exams for sperm**
- **Bedding / clothing**
  - **Visual and ALS exams**
- **Multiple exhibits per case**
- **May be looking for more than one body fluid**



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DNA Testing

- **Once we find biological material on the evidence…**
  - **Generate a DNA profile which takes several steps:**
    - **Extraction**
    - **Quantitation**
    - **Amplification**
    - **Electrophoresis**

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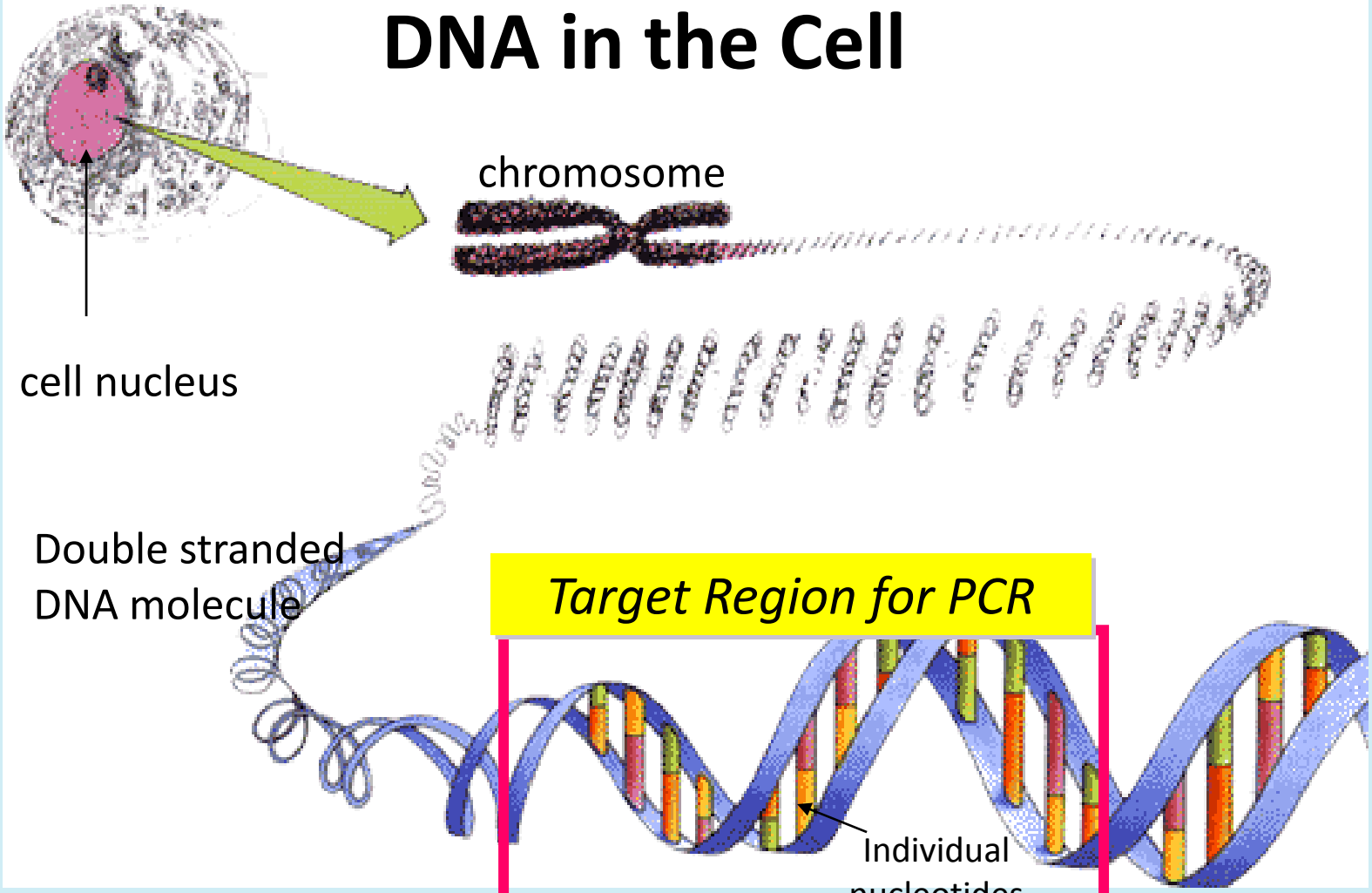
DNA in the Cell



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Ability to Develop a DNA Profile

- **How much DNA do we need?**
  - **1 nanogram**
    - **1 billionth of a gram**
    - **A packet of sugar = 1 gram**
- **Blood stain → about 3mm² cutting**

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Extraction of DNA From Forensic Samples

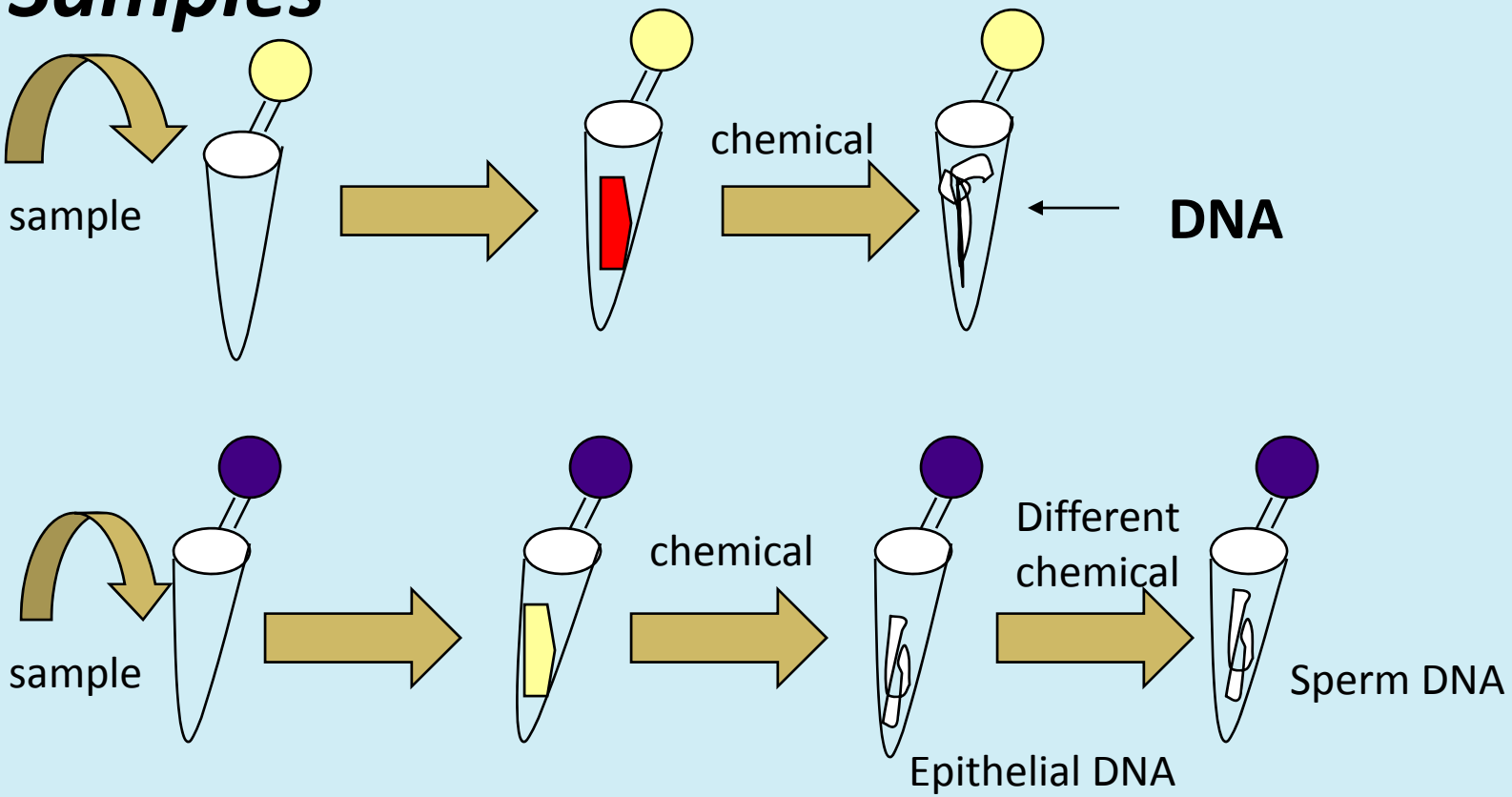

Diagram courtesy of Beth Ordeman

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DNA Quantitation

- **Determine how much DNA is present**

Quantifiler®

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PCR Amplification

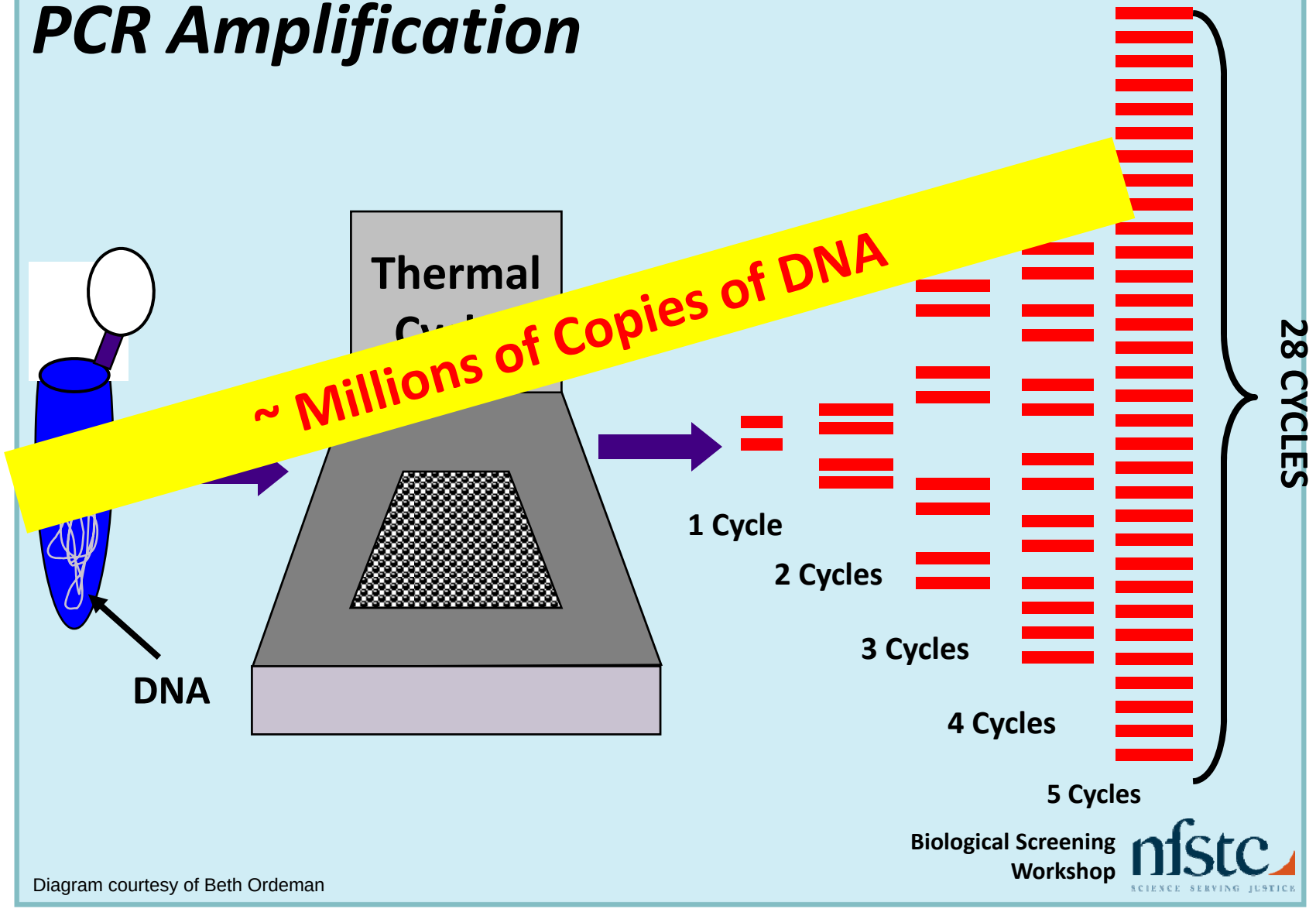

Diagram courtesy of Beth Ordeman

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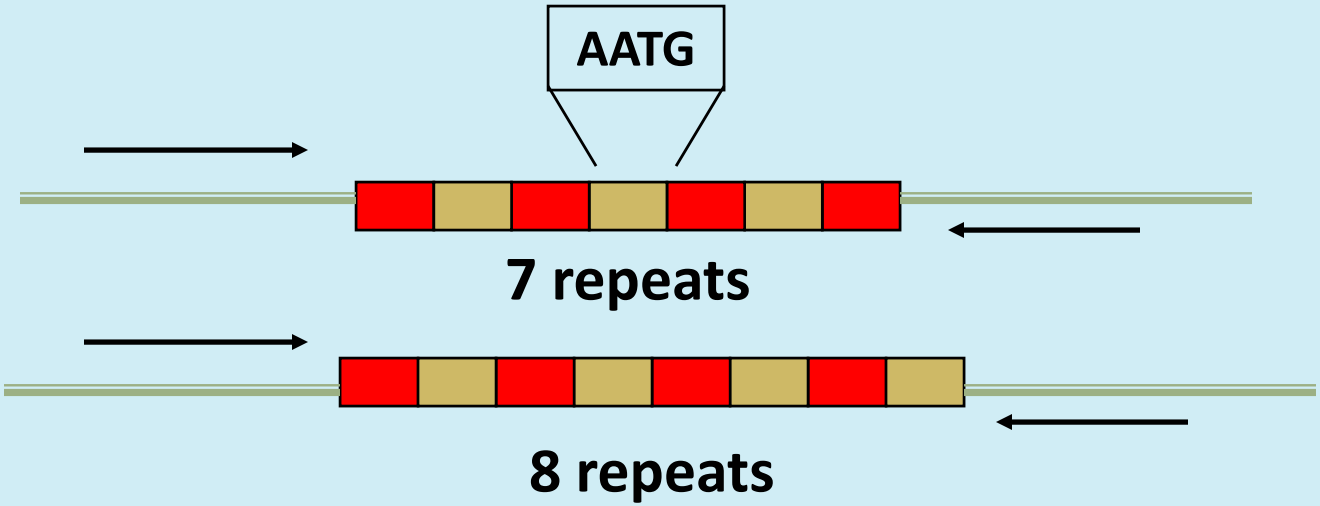
Short Tandem Repeats (STRs)



Homozygote = both alleles are the same length

Heterozygote = alleles differ and can be resolved from one another

Diagram courtesy of Beth Ordeman

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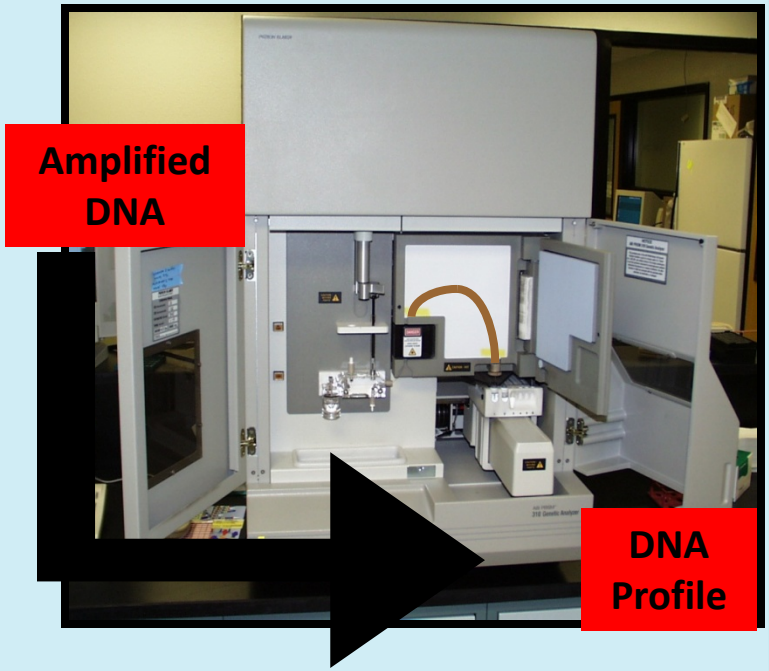
DNA Separation / Detection

- **Separates by repeat size**
- **Characterizes the STR repeat regions**
- **Generates peaks on a graph**



What Do The Results Look Like ?

Image courtesy of Beth Ordeman

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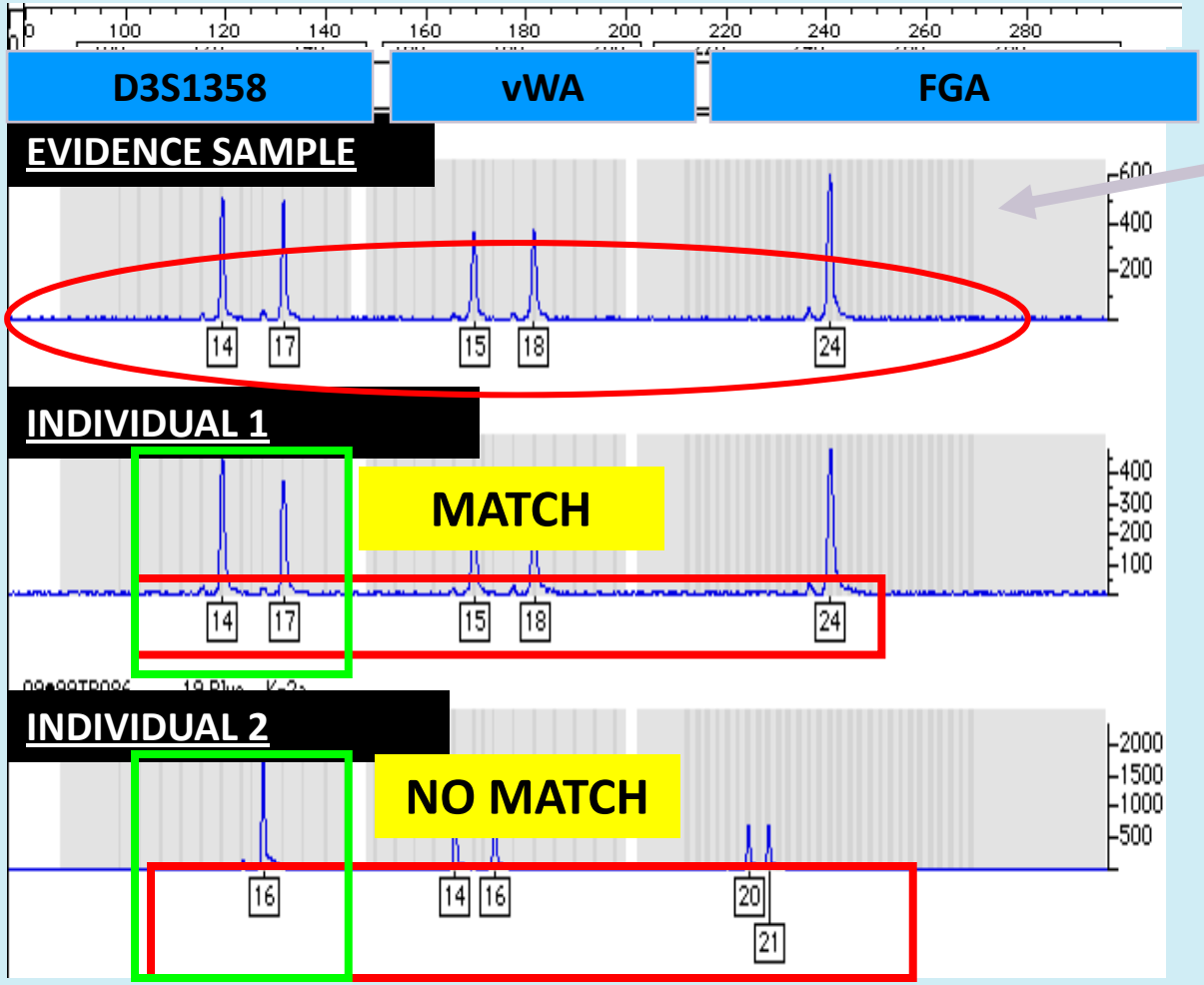
The Results



3 of 13 STR's

- 13 STR Areas of the DNA Strand

INDIVIDUAL 1 : Matches the DNA Types at 3 STR Areas

INDIVIDUAL 2 : Does Not Match the DNA Types

Image courtesy of Paulina Berdos

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Possible DNA Outcomes

- **Single source**
  - **Match**
  - **Non match**
- **Mixture**
  - **2 people**
    - **Intimate/indigenous versus environmental**
  - **> 2 people**
- **Low level sample**

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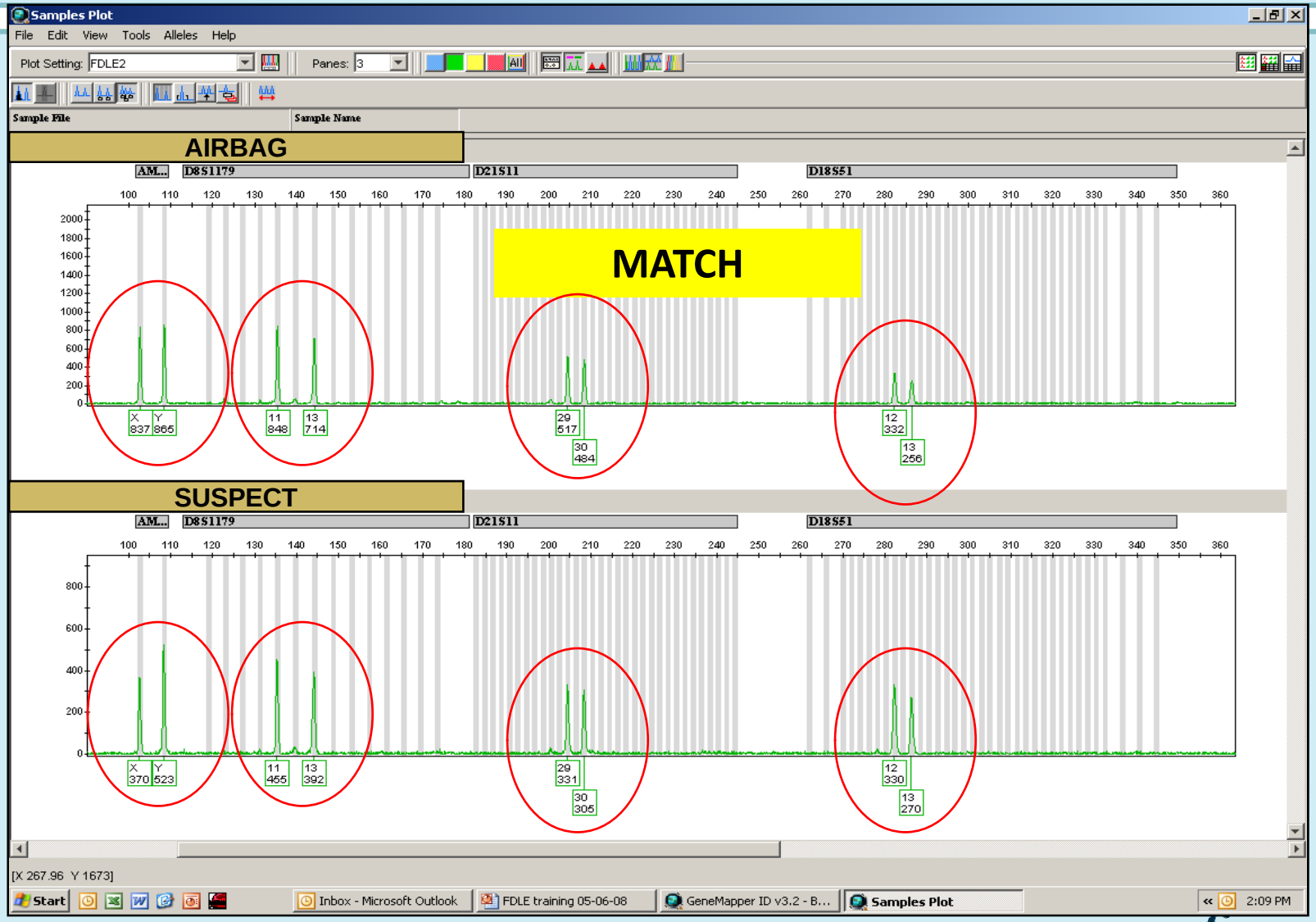

Image courtesy of Beth Ordeman

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Match – What Does it Mean?

1. **The person is the source of the DNA on the evidence sample**

OR

2. **Someone else in the general population has the same exact DNA profile and is the source of the DNA on the evidence sample**

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Statistics – Random Match Probability

- **When there is a match between a known person and an evidence sample:**
  - **Statistics are calculated**
  - **The more loci that match, the larger the statistic will be**
  - **The statistic tells us the frequency of occurrence of that profile in the chosen reported racial groups**
    - **Lends weight to the match**

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What a Report May State

- **The frequency of occurrence of the profile in unrelated individuals in the following populations is approximately:**
  - **1 in ??? Caucasians**
  - **1 in ??? African Americans**
  - **1 in ??? Southeastern Hispanics**
- **The results of the amelogenin locus are not used in the statistical calculation**

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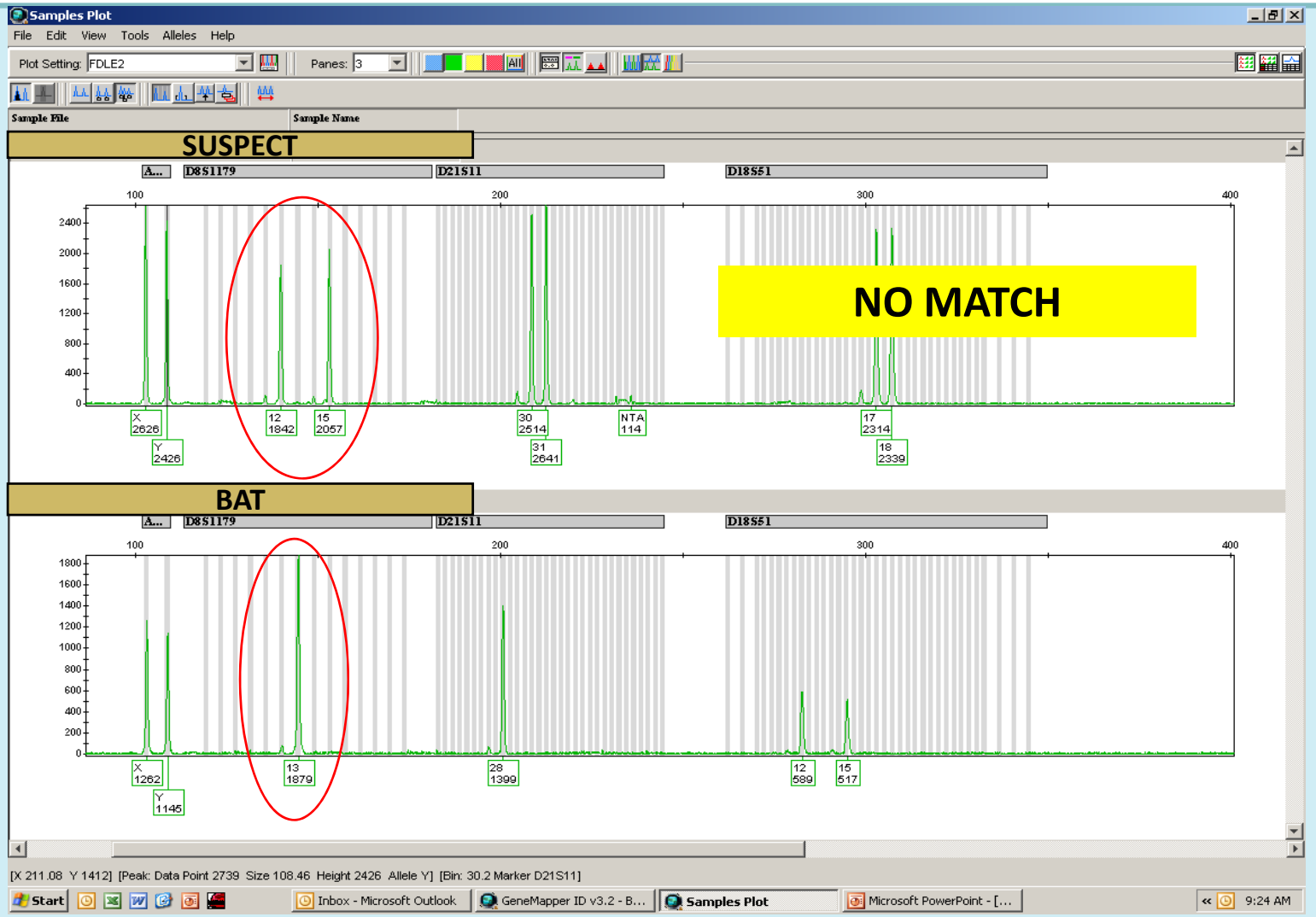

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No Match – What Does it Mean?

- **The person could absolutely not be the source of the DNA on the evidence sample**
- **Requires only one allele difference to be deemed a non-match**
- **Report may state:**
  - **The DNA profile from person X does not match the DNA profile from Exhibit__**

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Intimate Samples

- **Collected directly from a person's body**
  - **i.e., vaginal swabs**
- **Can remove that person's profile from a mixture to leave the remaining FOREIGN profile**

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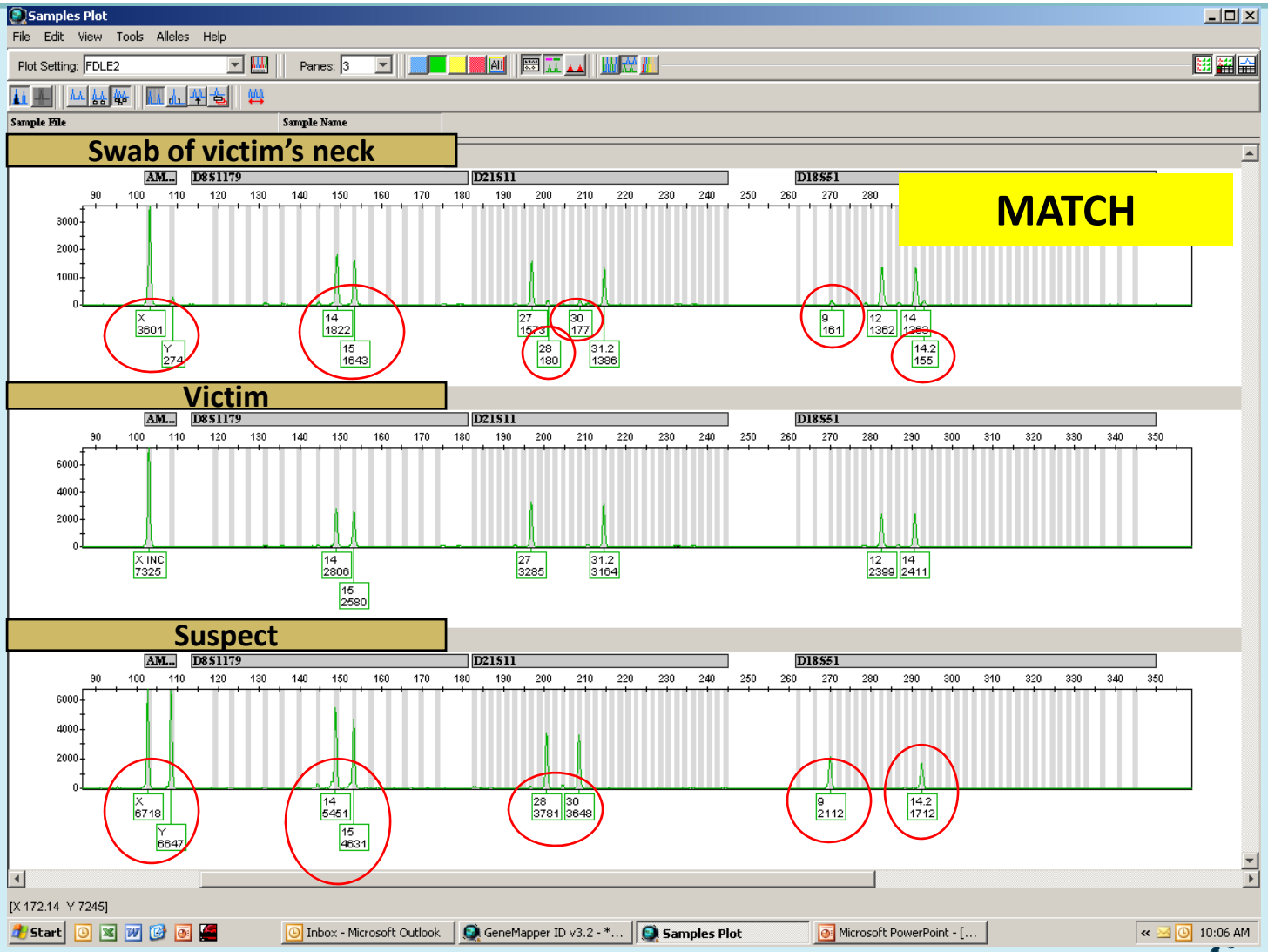

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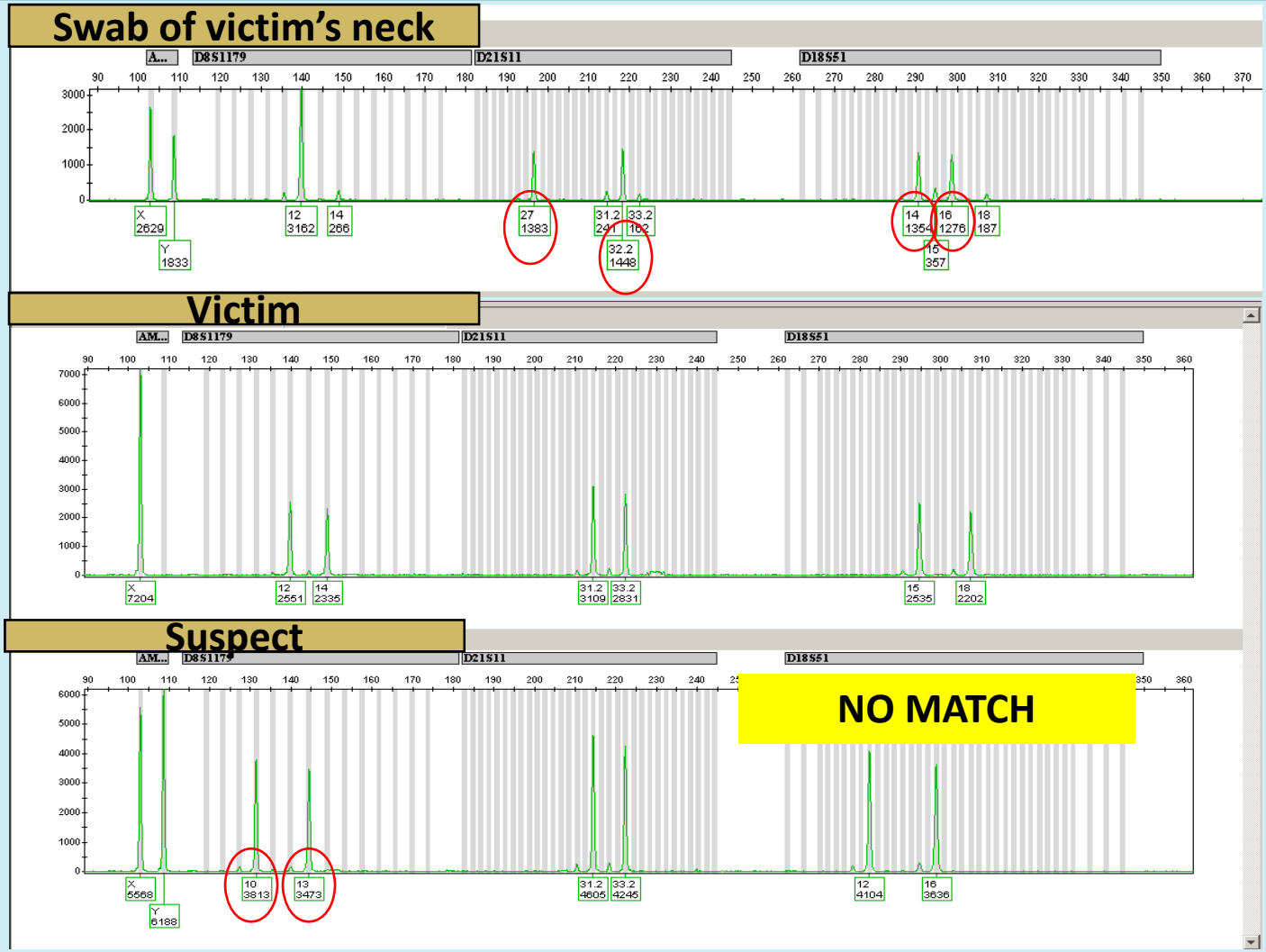

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Intimate Samples – Report

- **A DNA profile foreign to (victim) was resolved from Exhibit X**
- **Statistics**
  - **Random match probability**
  - **Stats on a single profile because it was resolved from the mixture into a single profile**

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Indigenous Samples

- **Items that can be assumed to have come from a person**
  - **i.e., shorts removed from a person**
  - **Important to have communication between agency and analyst regarding these assumptions**
- **Can assume that person's DNA is on that item**
- **If a mixture of DNA is found on this item**
  - **Can back the owner's DNA profile out of the mixture to leave the remaining DNA**
  - **Report the assumption that you make**

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Environmental Samples

- **Samples that are found at a crime scene that can not be directly linked to a person**
  - **i.e., shorts in a dumpster**
- **No assumptions can be made regarding these samples**
- **If a mixture occurs**
  - **Attempt to resolve into major and minor components**

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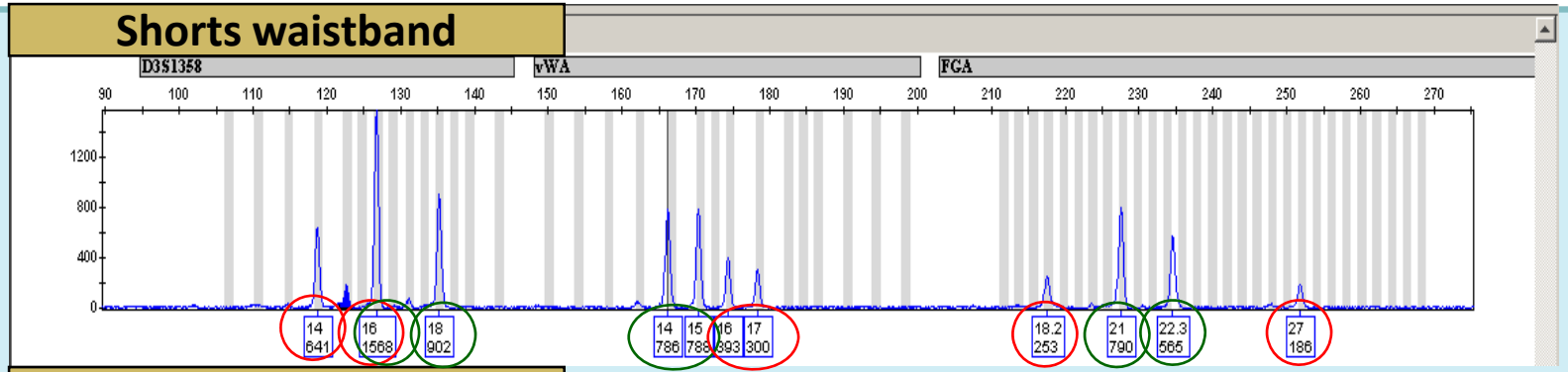
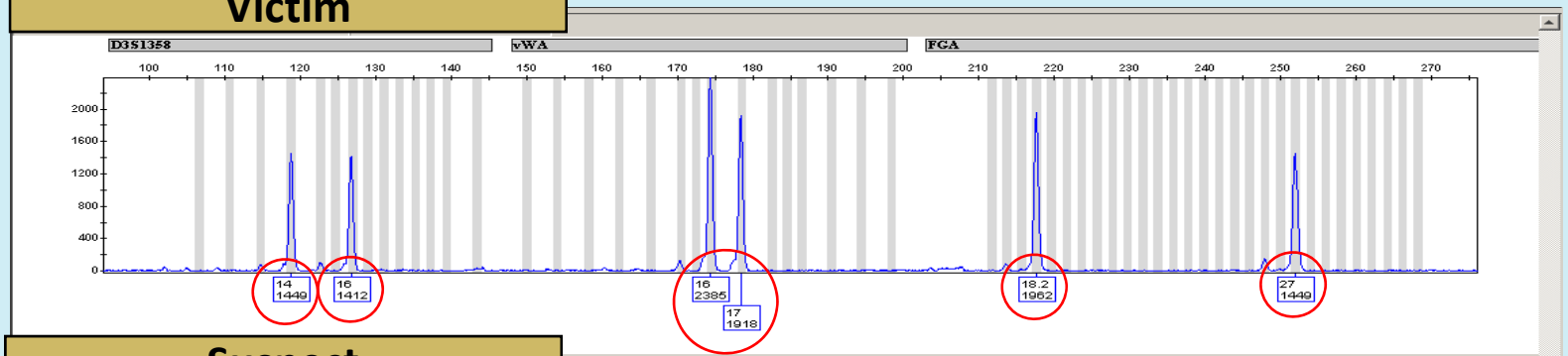
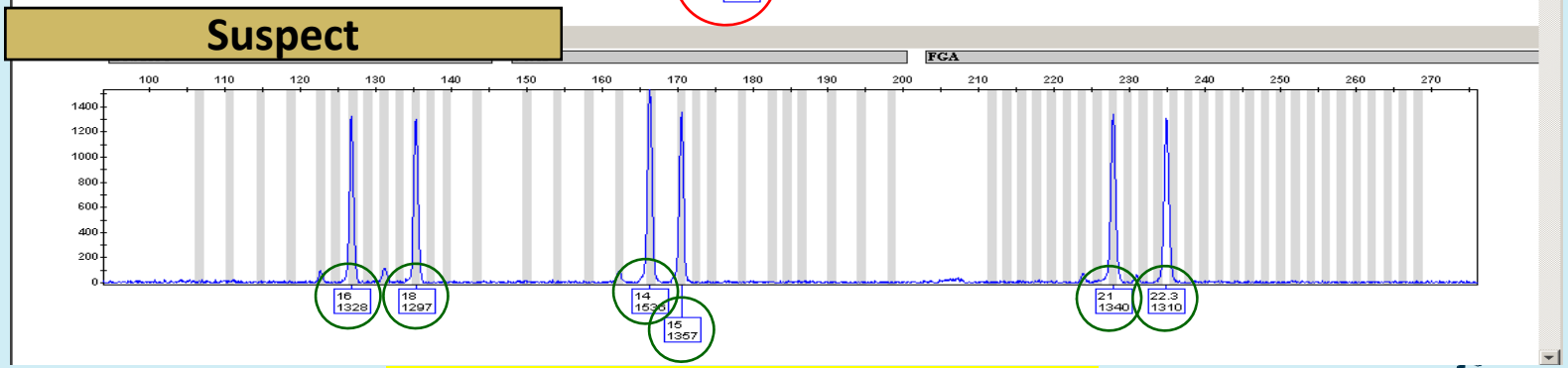
Shorts waistband



Victim



Suspect



MAJOR = SUSPECT MINOR = VICTIM

Image courtesy of Beth Ordeman

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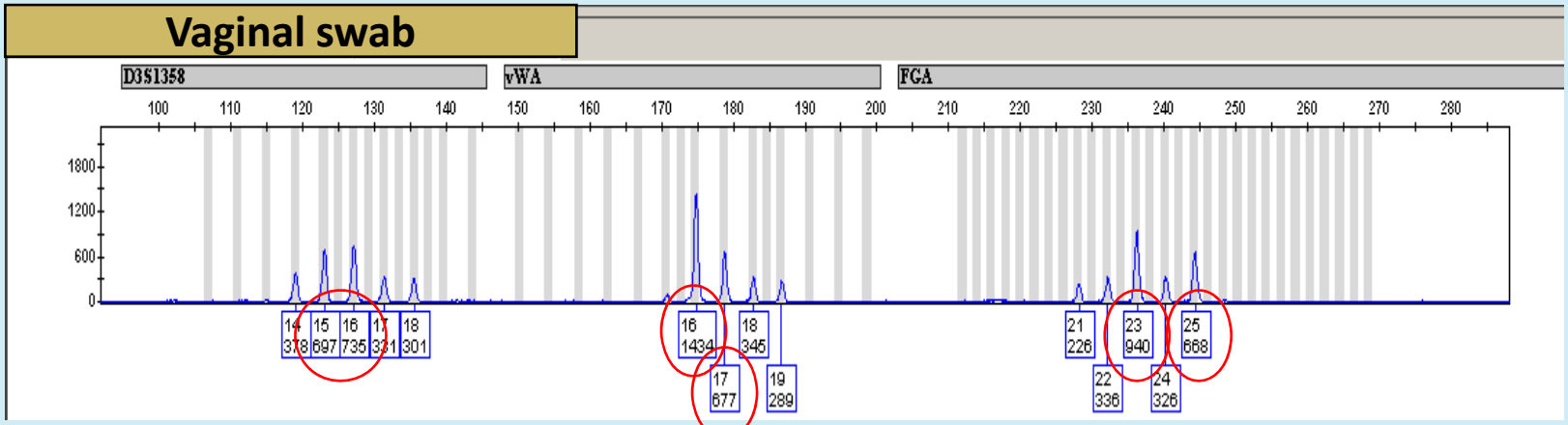
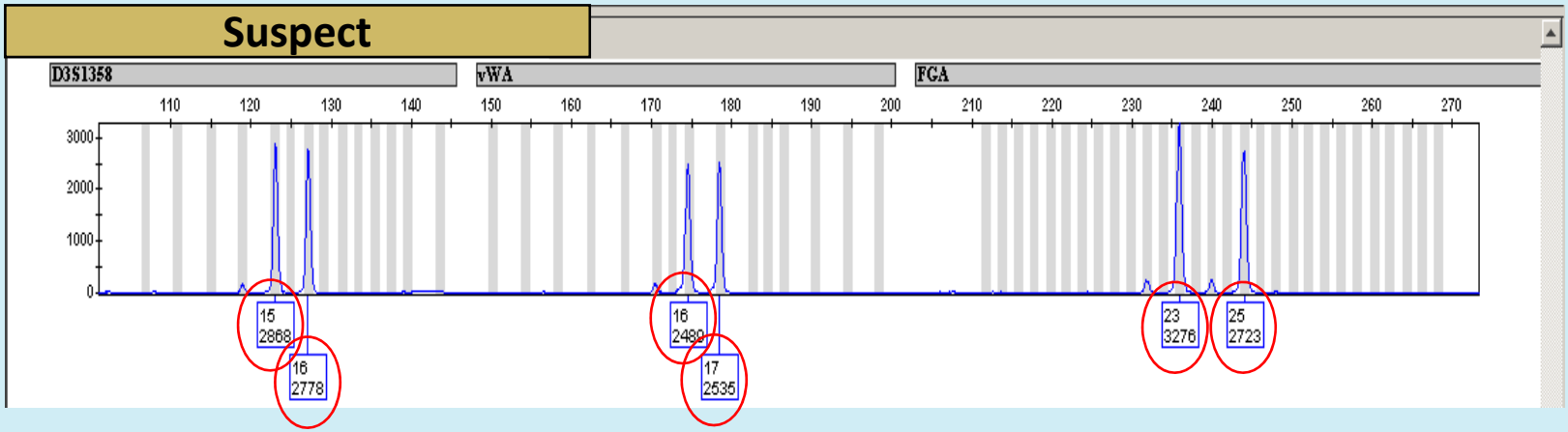
Vaginal swab



Suspect



Suspect is INCLUDED in the mixture

Image courtesy of Beth Ordeman

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Mixtures of > 2 people

- **Presence of more than 4 alleles at any given locus**
- **In some cases, it may be possible to determine a major contributor from this type of mixture**

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Mixtures

- **If the mixture can not be resolved into its separate components:**
  - **Included**
    - **We have all the information present**
    - **This person is INCLUDED in the mixture**
  - **No determinations**
    - **Not enough information to state whether a person is or is not present in the mixture**
  - **Excluded**
    - **Enough information to state with certainty that the person is not present in the mixture**

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Inclusions – What Does it Mean?

- **Person X can be included as a possible contributor to the mixture**
- **An inclusion statistic may be calculated**
- **This states the frequency of occurrence of all the different combinations of DNA profiles in the mixture**

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Paternity Cases

- **Can determine if an alleged father could be the biological father**
- **Given the mother and child profile – determine the obligate DNA types of the biological father**
- **Compare to alleged father**

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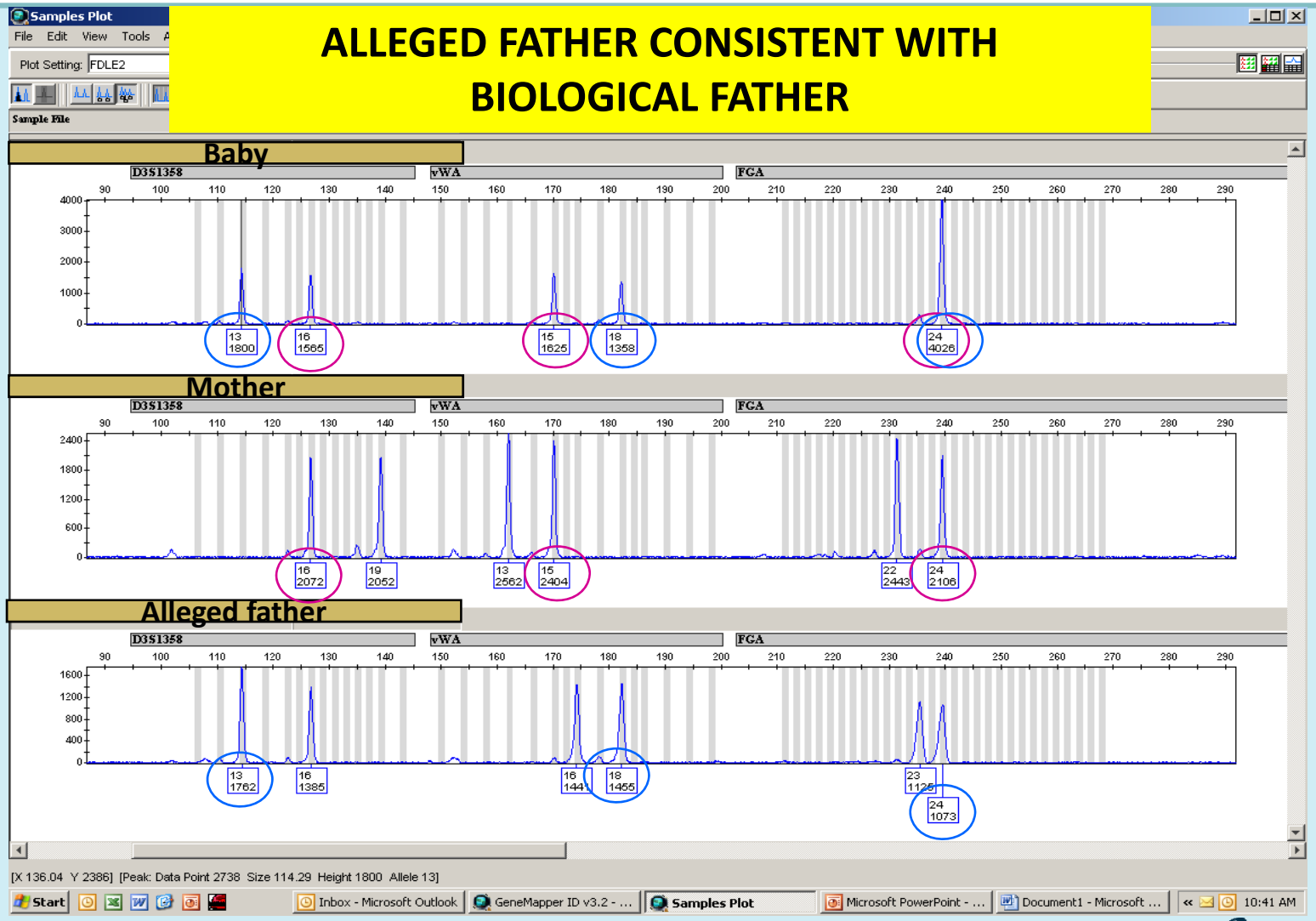
ALLEGED FATHER CONSISTENT WITH BIOLOGICAL FATHER



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Paternity Statistics

- **Paternity Index**
  - **Determines how much more likely the alleged father is the biological father than a random man from a given population**
    - **i.e., 1 million**
- **Probability of Parentage**
  - **The chance that the alleged father is the biological father when compared with a random man in a given population**
    - **i.e., 99.99%**

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There is no easy button for DNA analysis!!!!

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Setbacks During the DNA Process

- **Not everything goes according to the plan!**
  - **Inhibition**
  - **Problem / difficult samples**
    - **Old samples**
    - **Dirty samples**
    - **Degraded samples**
  - **Instrument issues**

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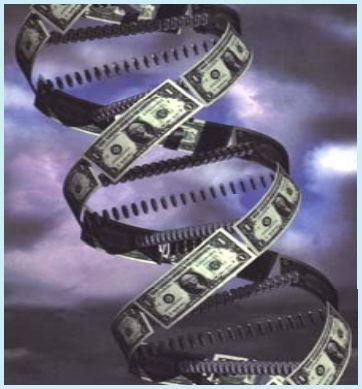
Other Factors That Affect Turnaround Time



- **Case backlog**
- **Cost to run samples**
- **In cases with multiple items or stains, may need to do more than one round of testing to find probative evidence**
- **Mixtures or low level samples**
  - **May be difficult to develop profiles and to interpret data**

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New Trends

- **Touch DNA**
  - **Attempt to develop a DNA profile from skin cells that have transferred from a person to an object by touching or handling that object**
  - **i.e., Gun handle, steering wheel**
  - **DNA from cigarette butts or saliva on cans is not considered "touch DNA"**
- **Is this feasible??**

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Touch DNA

- **Factors**
  - **Person who touched item**
    - **Shedders versus non shedders**
  - **Sweat provides vehicle for transfer**
  - **Material of item being touched or handled**
    - **Plastic / metal**
    - **Fabric**
    - **Duct tape**
  - **Length of time item was touched or handled**

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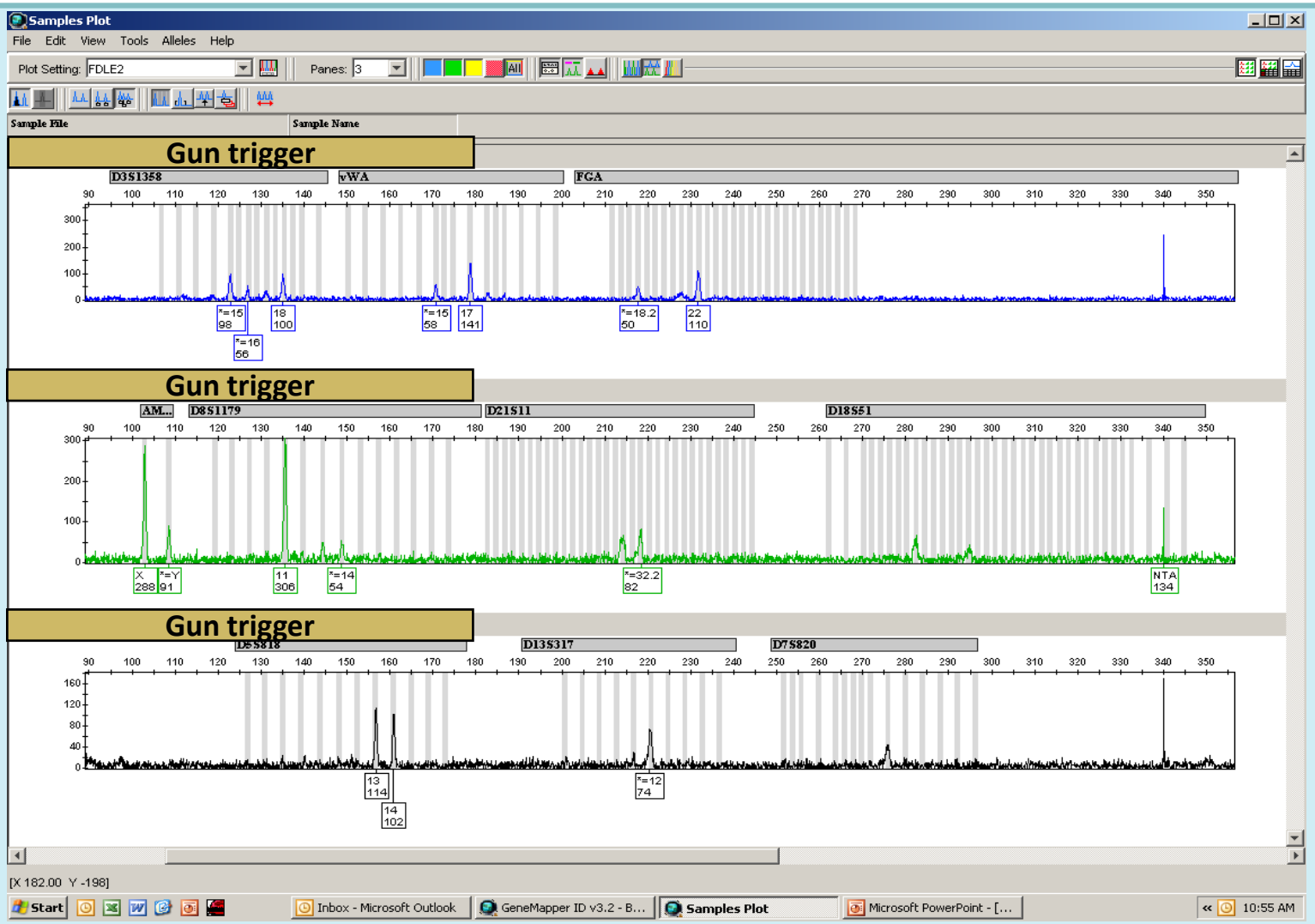

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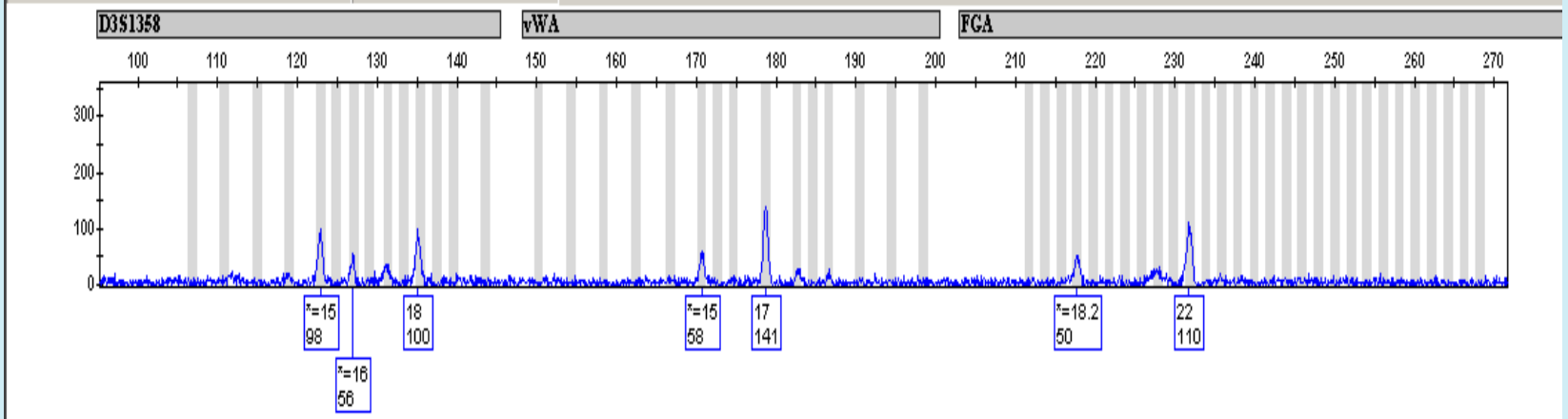
Gun trigger



Suspect

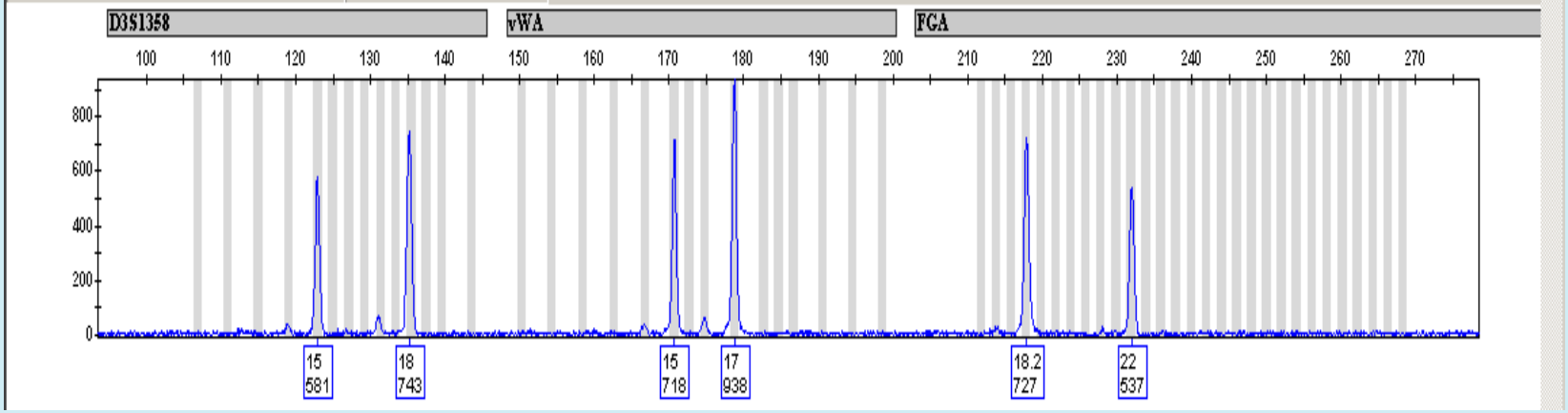


Image courtesy of Beth Ordeman

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How Can the DNA Database Help Solve Crimes?

- **Linking an unknown sample to a convicted offender**
- **Linking an unknown sample to a solved case**
- **Linking two or more unsolved cases**
- **Identify missing persons**
  - ****Note that not all DNA profiles developed in a case are OK for entry into CODIS due to FBI regulations**

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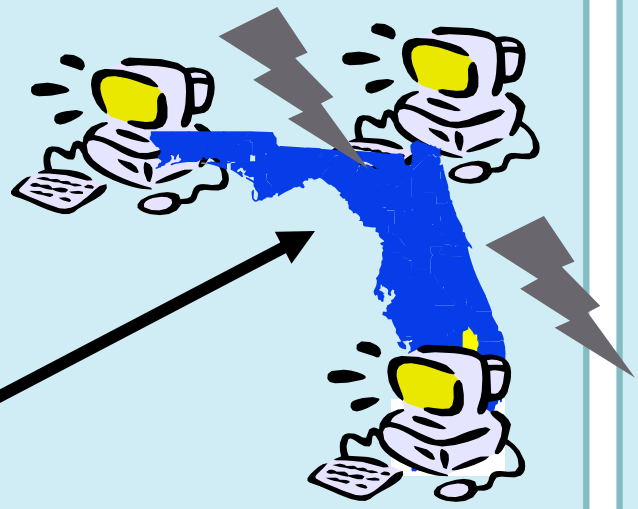
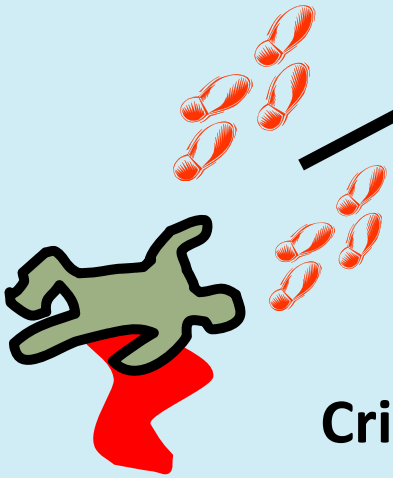
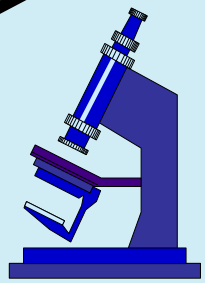
CODIS: How Does It Work?

Convicted Offender
DNA Profiles



Statewide DNA
Database





Crime Lab

Case! Solved

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Current Offenses Requiring Blood Collection

- **Sexual assault**
- **Lewd acts; indecency**
- **Murder**
- **Aggravated battery**
- **Carjacking**
- **Burglary**
- **Home invasion**

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CODIS Statistics

- **Many states now require all felons give a DNA sample for CODIS**
- **This has drastically increased the number of convicted offender samples in CODIS**

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Officers of the Court Training

- http://www.dna.gov/training/otc/
- The biology of DNA including statistics and population genetics
- DNA laboratories, QA in testing, understanding a lab report
- Forensic databases
- Victim issues
- The presentation of DNA at trial
- Post-conviction DNA cases
- To order a CD, go to http://www.ncjrs.gov/App/Publications/AlphaList.aspx and search for publication # NCJ 212399

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Questions?

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