

Forensic Biology



BIOLOGY/DNA UNIT
ISP LABORATORY SYSTEM

Biology Unit Casework



- Homicide
- Sexual assault
- Child molest
- Assault/Battery
- Burglary
- Robbery
- Questioned driver
- Threatening letter
- Fraud

- Hit and run
- Criminal paternity
- Death investigation
- Controlled Substances
- Voyeurism
- Cold cases
- Unidentified remains
- Missing person

Types of Biological Evidence



- Blood
- Semen
- Saliva
- Hair
- Bone/Teeth
- Tissue
- Epithelial (skin) cells



Evidence Collection Guidelines



Universal Precautions



- When collecting evidence treat every item as though it were contaminated with blood or other body fluids
- Use Personal Protective Equipment
 - Gloves
 - Face mask
 - Safety glasses
 - Shoe covers (as necessary)
 - Disposable cover-alls (as necessary)



Protects you from the evidence and the evidence from you.

Collection Rules for DNA



1. Package item in **PAPER**

- Paper bag
- Envelope
- Cardboard box

2. Don't package it until it's **DRY**

3. Use appropriate size packaging for the item



Evidence must not be able to puncture package
(i.e. knife)

Evidence must not be able to escape out of package
(i.e. flakes of blood)

Collection – small items



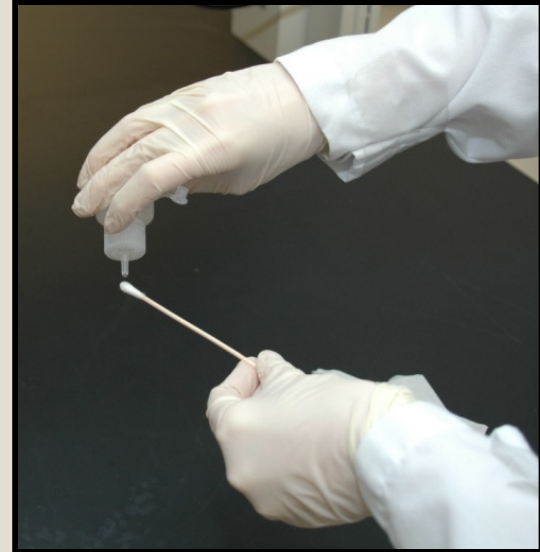
- If small and portable, collect entire item
 - Clothing
 - Cans or bottles
 - Most weapons
 - Cigarette butts
- Paper bag or envelope



Collection – large items



- If blood or other body fluid on large item (car, window, floor, wall, etc.)
 - Moisten a sterile cotton swab
 - Allow to dry and package in paper
 - No need for control swabs
 - Swabs from different areas should be packaged separately



Collection – liquid body fluids



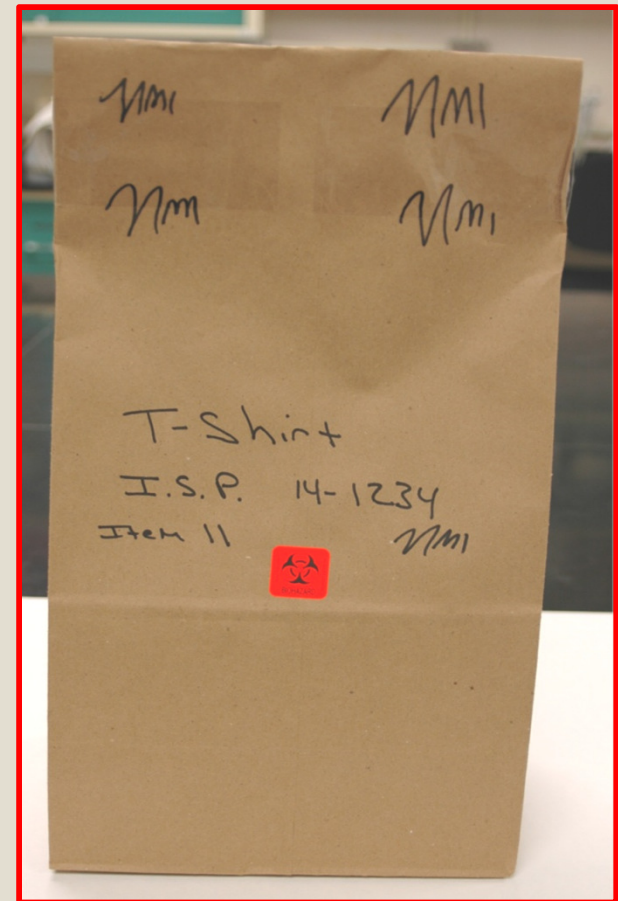
- Pooled blood, saliva
- Collect with dry swab
- Dry swab before packaging in paper



Properly sealed



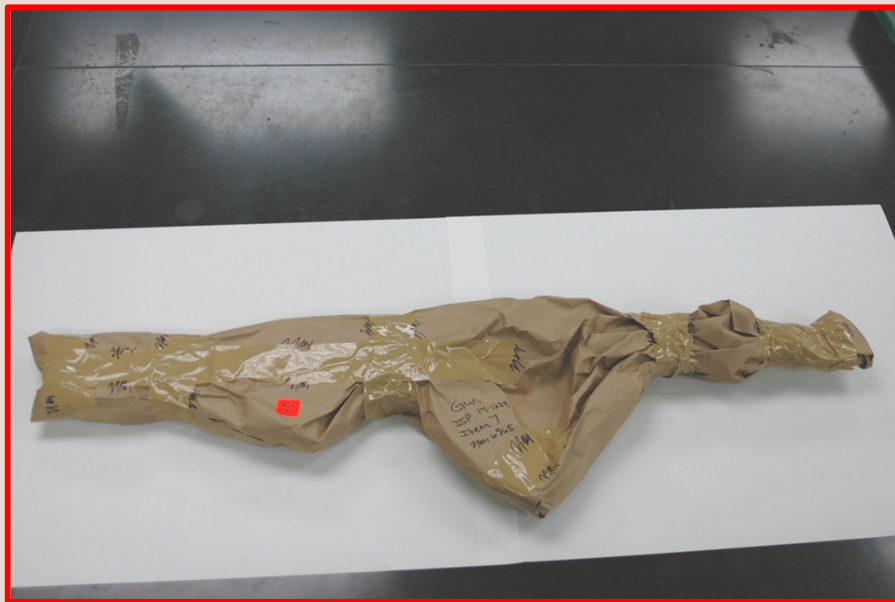
- QUALITY packaging tape or evidence tape
- Initials across seal
- Proper identifiers on the package
 - Case number
 - Item number
 - Item description
- Biohazard sticker



Evidence Packaging

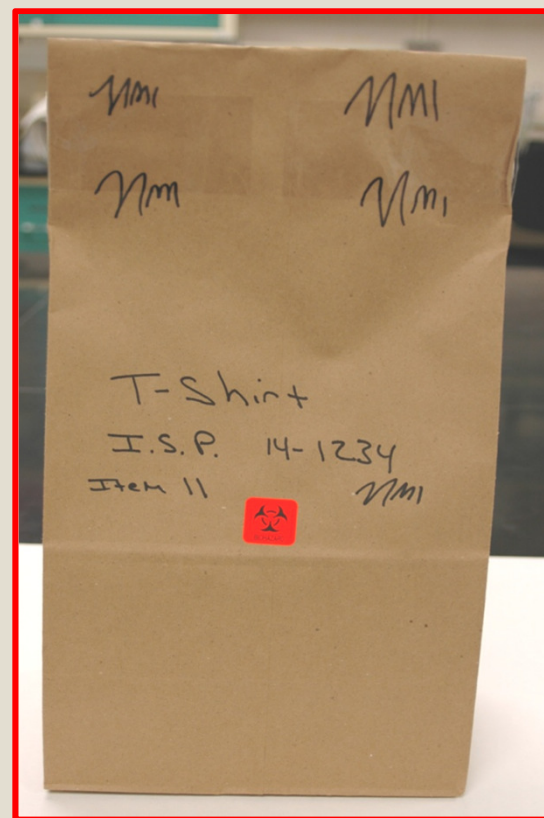


Poorly Packaged



"Mummy Wrapping"

Properly Packaged



Two stages of the DNA request



- 1. Forensic Serology** – Examine evidence for the presence and identification of body fluid stains such as blood. Locate potential sources of DNA.
- 2. DNA Analysis** – Develop DNA profiles from questioned samples and known standards for comparison purposes.

Forensic Serology

Detection/ID of Body Fluids and Other Sources of DNA



Serology Tool Box



- Screening tools assist in locating stains
 - Layout rooms
 - Light/ALS
 - Microscopes
- Chemical tests help identify body fluids
 - Blood
 - Semen
 - Saliva



Alternate Light Source (ALS)



- Exposes stains to various wavelengths of light causing them to be reflect or absorb light.
 - Urine
 - Semen
 - Saliva
 - Vaginal Secretions
 - Sweat



Blood Tests



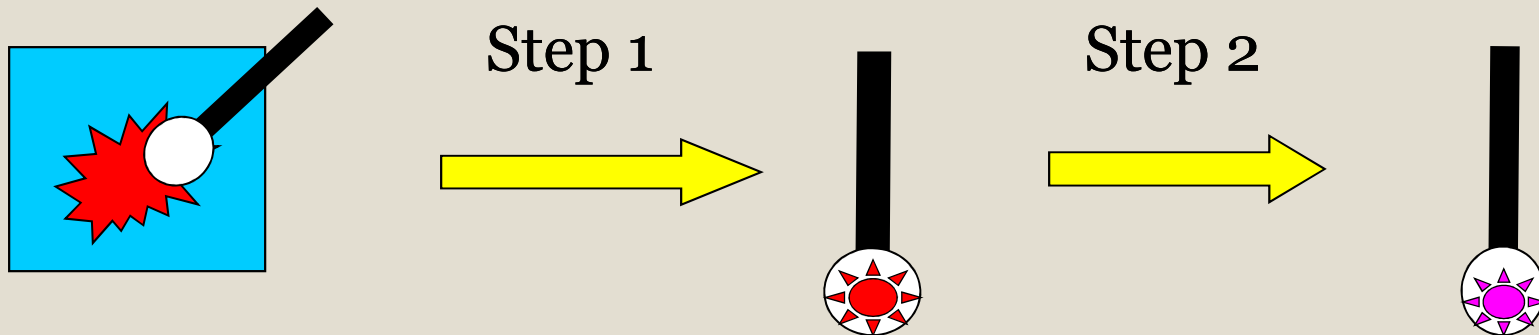
- **Presumptive:**
 - Phenolphthalein
 - Luminol
- **Confirmatory:**
 - Takayama
 - HemDirect



Blood Tests: Phenolphthalein



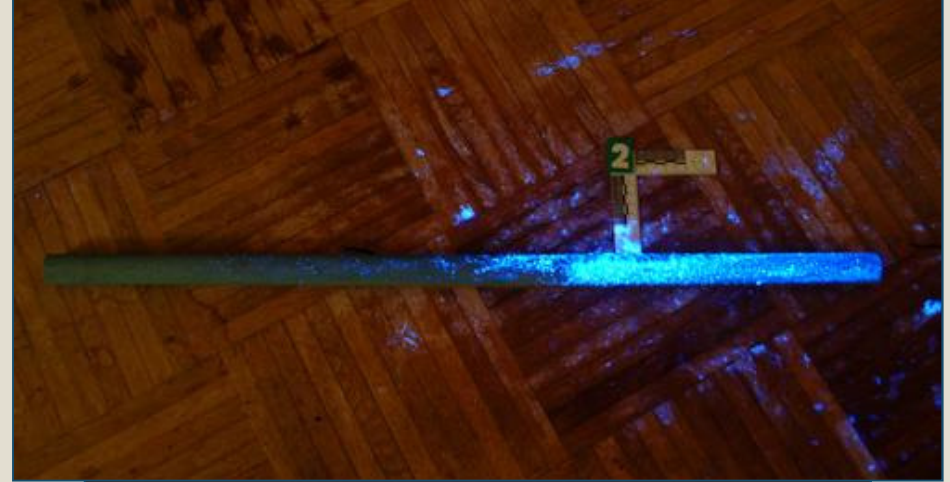
- Presumptive test for blood
- Two-step reaction develops a bright pink/purple color in the presence of **possible** blood



Blood Tests: Luminol



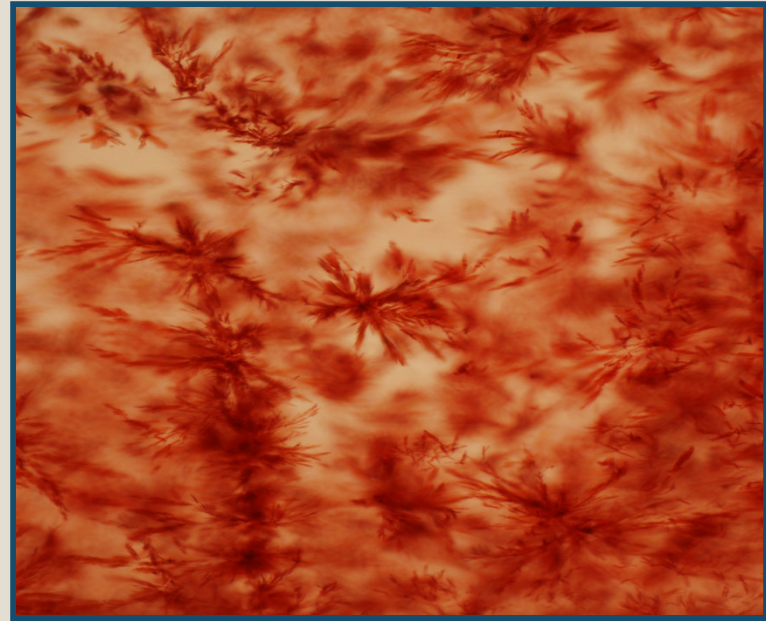
- Presumptive test for blood
 - Screening tool
 - Works best in darkness
- Reacts with hemoglobin
- Bluish-green glow
- Lots of false positives
 - e.g., metals, cleaning supplies, cigarette smoke



Blood Tests: Takayama



- Confirmatory test for blood
- Positive results form deep red, feathery crystals



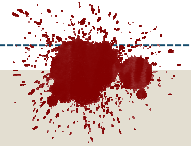
Blood Tests: HemDirect



- HemDirect tests for human blood
- Human blood reacts with an antibody, which forms a red line in the “test” region of the HemDirect cassette.



Semen Tests



- **Presumptive:**
 - Acid Phosphatase
- **Confirmatory:**
 - Microscopic Search



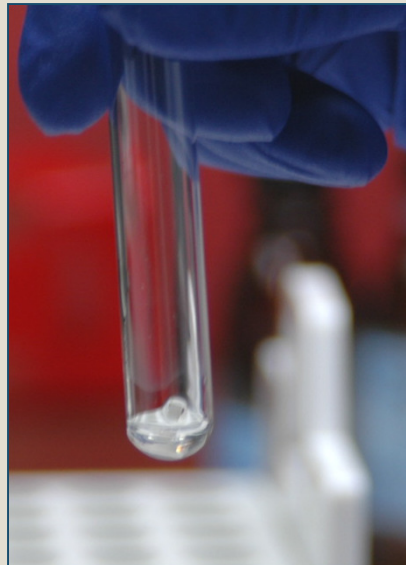
Semen Tests: Acid Phosphatase Test



- Presumptive test for semen
- Detects acid phosphatase, an enzyme found in large amounts in semen
- Two-step reaction develops a deep purple color in the presence of semen

Sample

Step 1



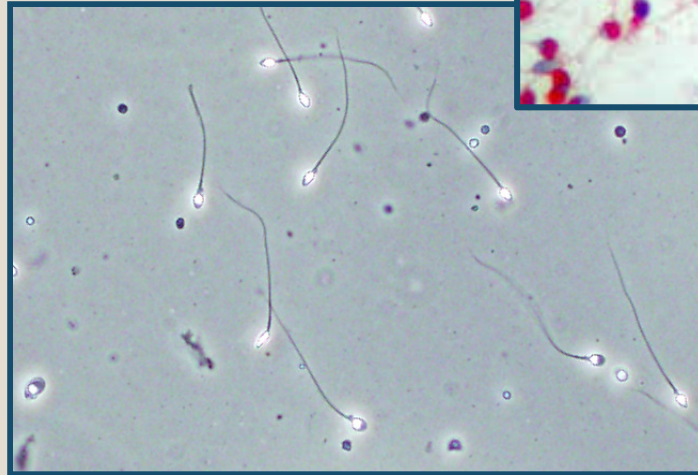
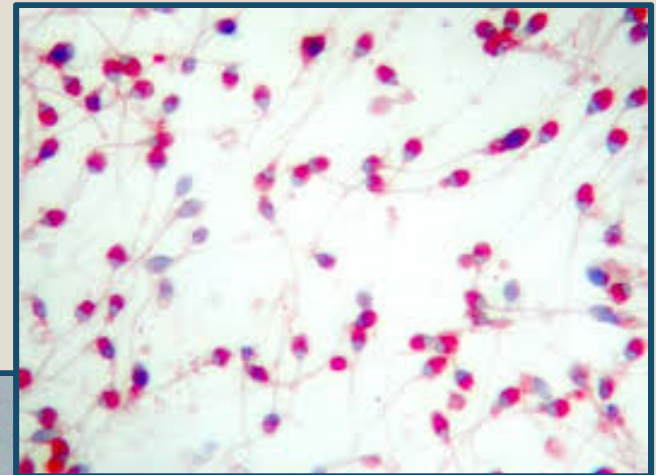
Step 2



Semen Tests: Microscopic Exam



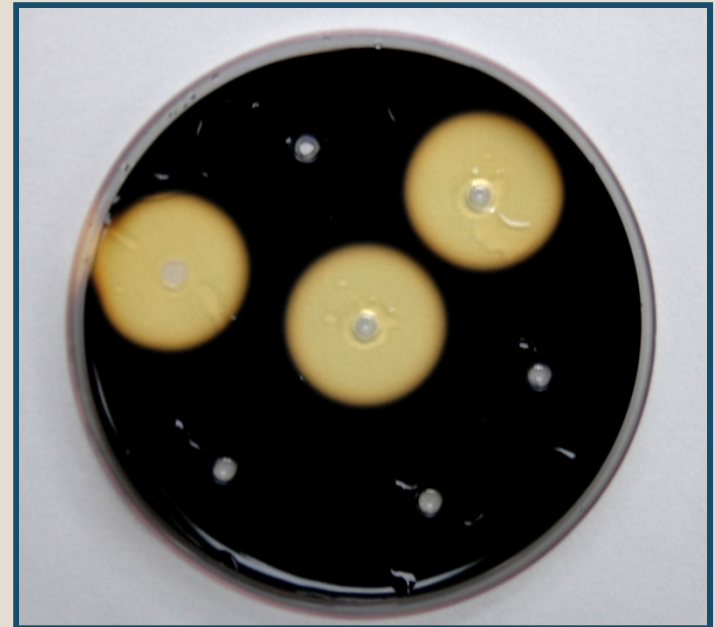
- Human sperm at 400x magnification
 - Size
 - Head
 - Mid-piece
 - Tail
 - Acrosomal cap
 - Profile pear shape



Saliva Tests



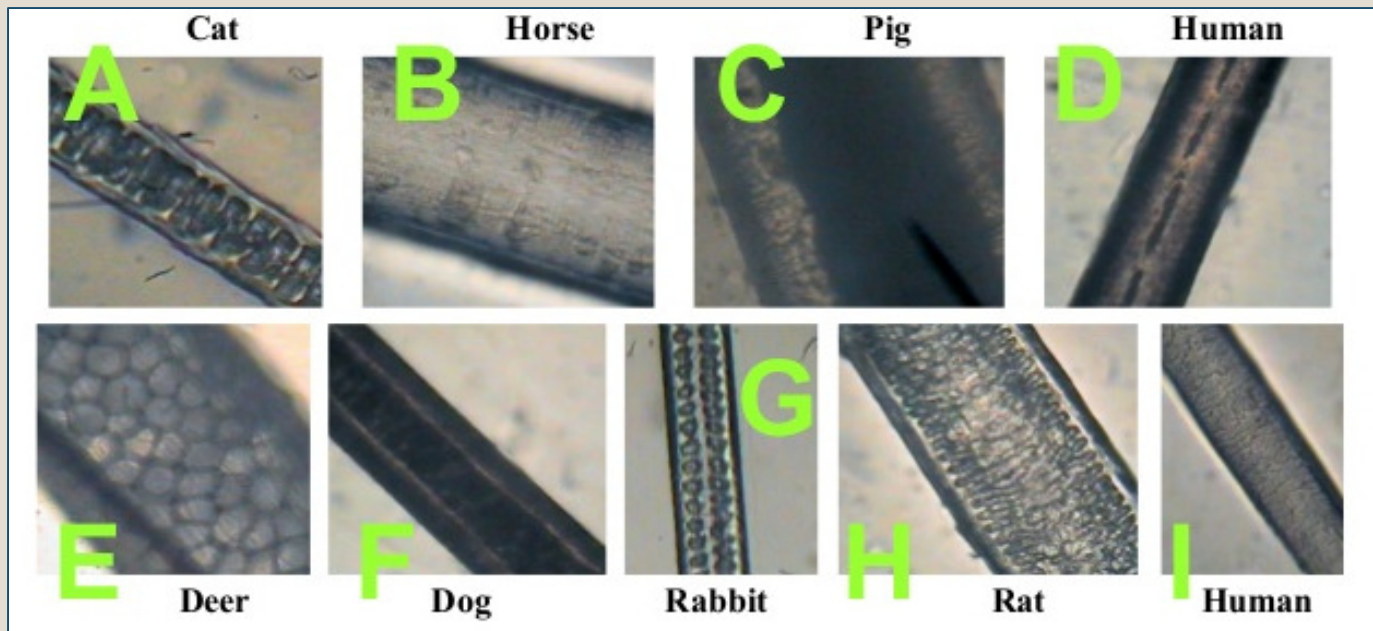
- Amylase Radial Diffusion Assay
 - Presumptive test for Saliva
 - ✦ Agar plate (looks like Jell-O) containing starch
 - ✦ Amylase, an enzyme in saliva, breaks down starch
 - ✦ Measured with iodine staining
 - As of yet, no confirmatory test



Hair Microscopic Examination



- Hair vs. fiber
- Human vs. animal
- DNA located in root



Epithelial/Skin Cell/Touch DNA



- Fingernail scrapings
- Penile Swabs
- Condoms
- Earrings
- Hat bands
- Gloves
- Eye glasses
- Weapons (handler)
- Ligatures/ropes
- Door handles
- Gear shift selector
- Steering wheel
- Cigarette lighter
- Pens/pencils
- Tape
- Telephones
- Clothing
(determine wearer)

Evidence of Limited Value (That We Get Anyway)

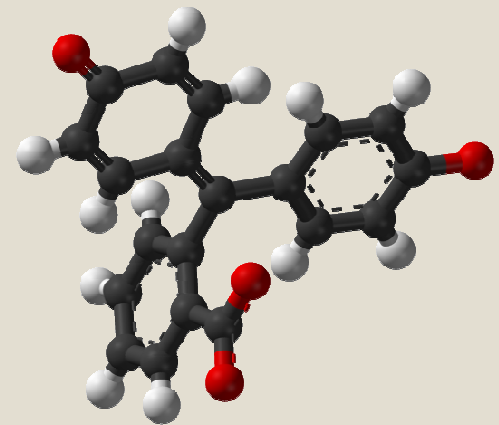


- Drain traps
- Swabs of toilets
- Swabs of commonly used areas (e.g., door knobs)
- Swabs of money for handler
- Vacuum sweepings
- Entire garbage can contents
- Sample of pooled blood under victim

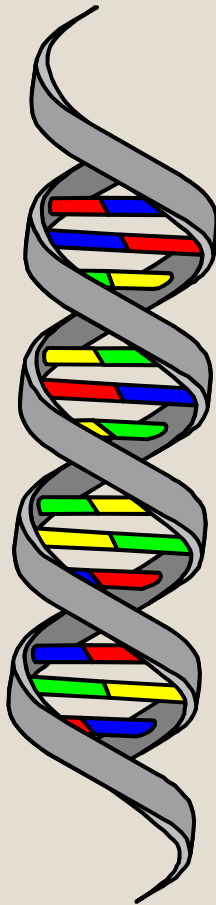
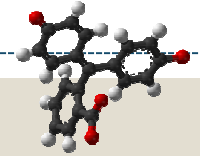


DNA Testing

Developing DNA profiles to Compare Evidence to Individuals

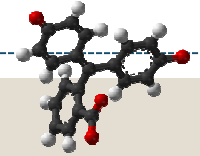


What is DNA?



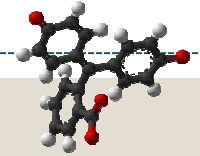
- DNA = Deoxyribonucleic Acid
 - Located in most cells in human body
- Basis for human heredity
 - Contains a person's genetic blueprint
 - Half inherited from each parent

Why use DNA in forensics?



- It is highly polymorphic (lots of variation)
- DNA profiles are unique for each person (except for identical siblings!)
- It is the same throughout the body (mostly)
- It is the same throughout the lifetime (mostly)

STR = Short Tandem Repeats



- STRs are repetitive short segments of DNA (~2-7 base pairs in length).



5 repeat units

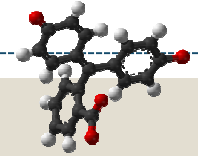


4 repeat units

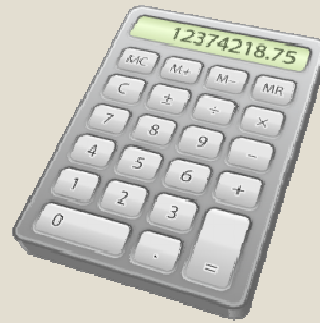


3 repeat units

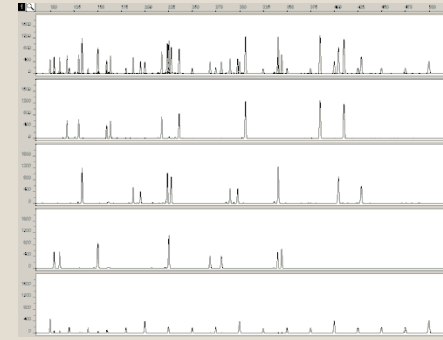
DNA Analysis: Overview



Starting Sample



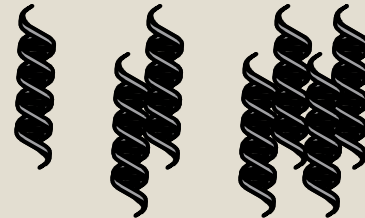
Quantitate



Visualize (Electrophoresis)



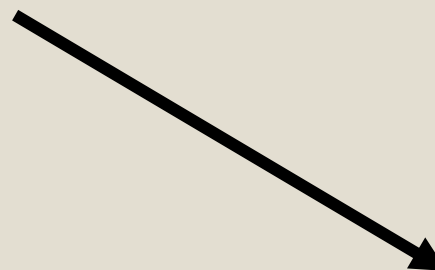
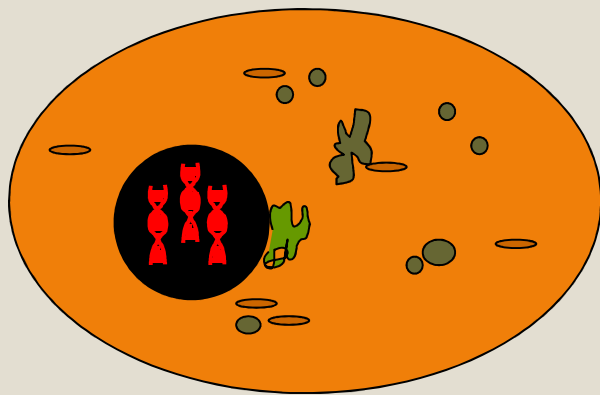
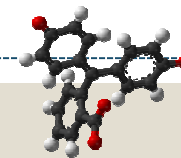
Extract DNA



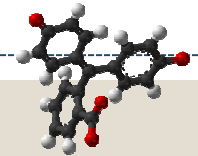
Amplify (PCR)



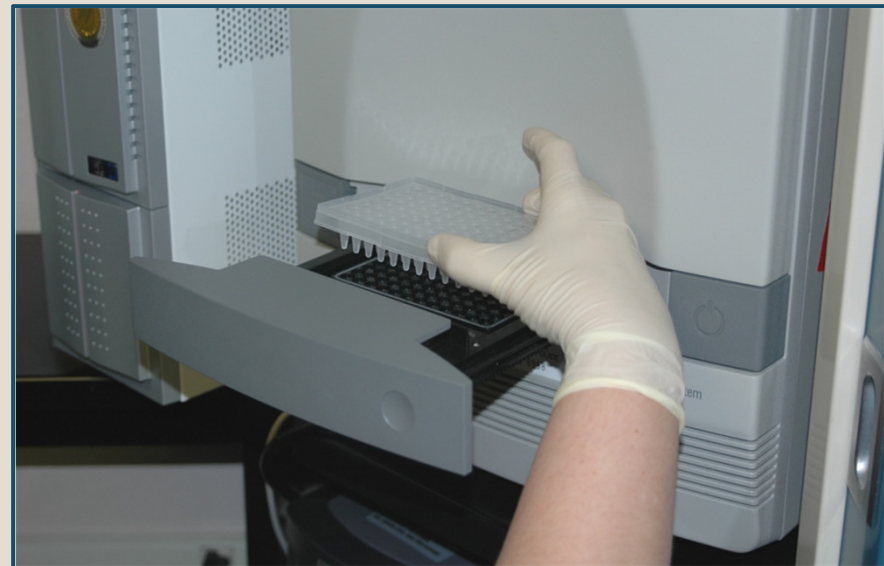
Extraction



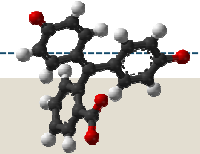
Quantitation (qPCR)



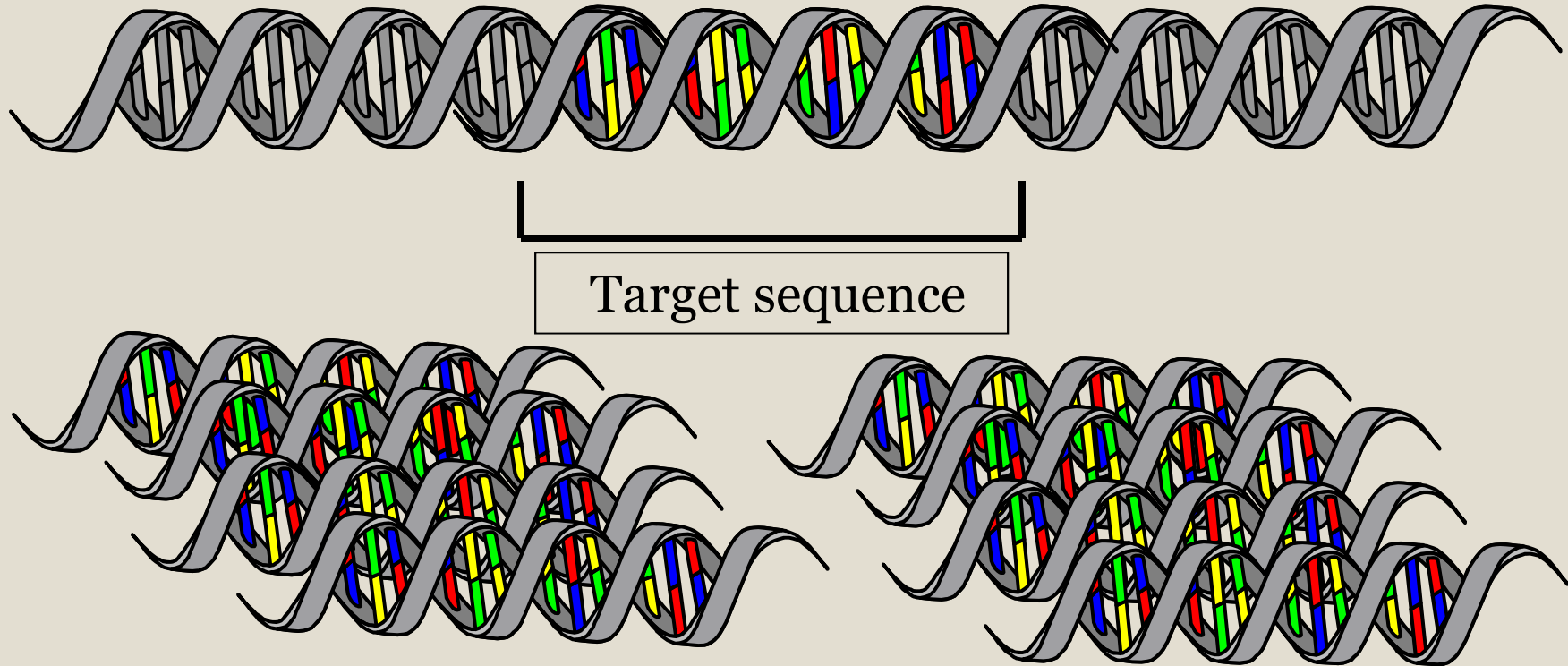
- Purpose:
 - Human DNA quantity
 - Male DNA quantity
 - Sample quality
- ~50–100 cells needed for further testing



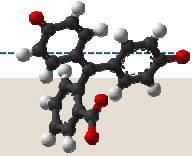
Amplification (PCR)



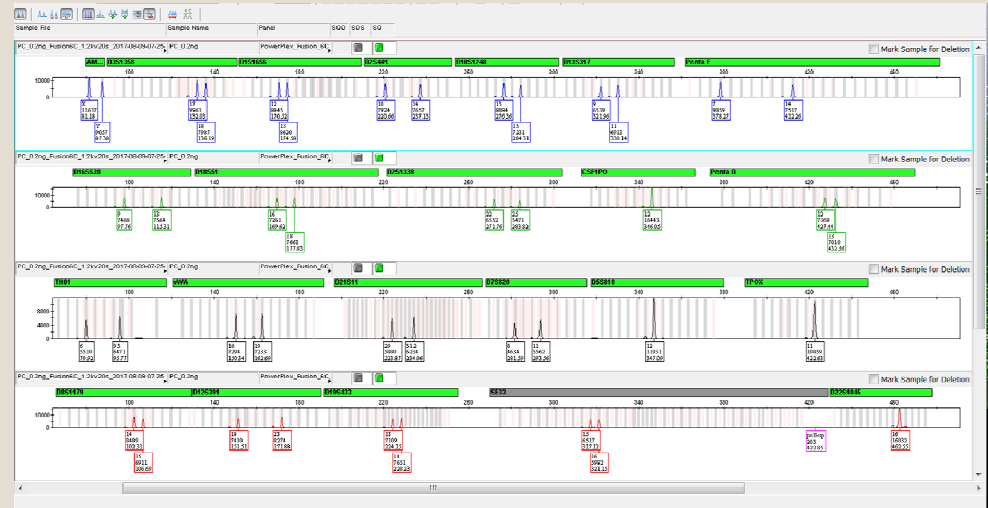
A technique used to make billions of exact copies of specific sequences of DNA.



Electrophoresis



ABI 3500 Genetic Analyzer



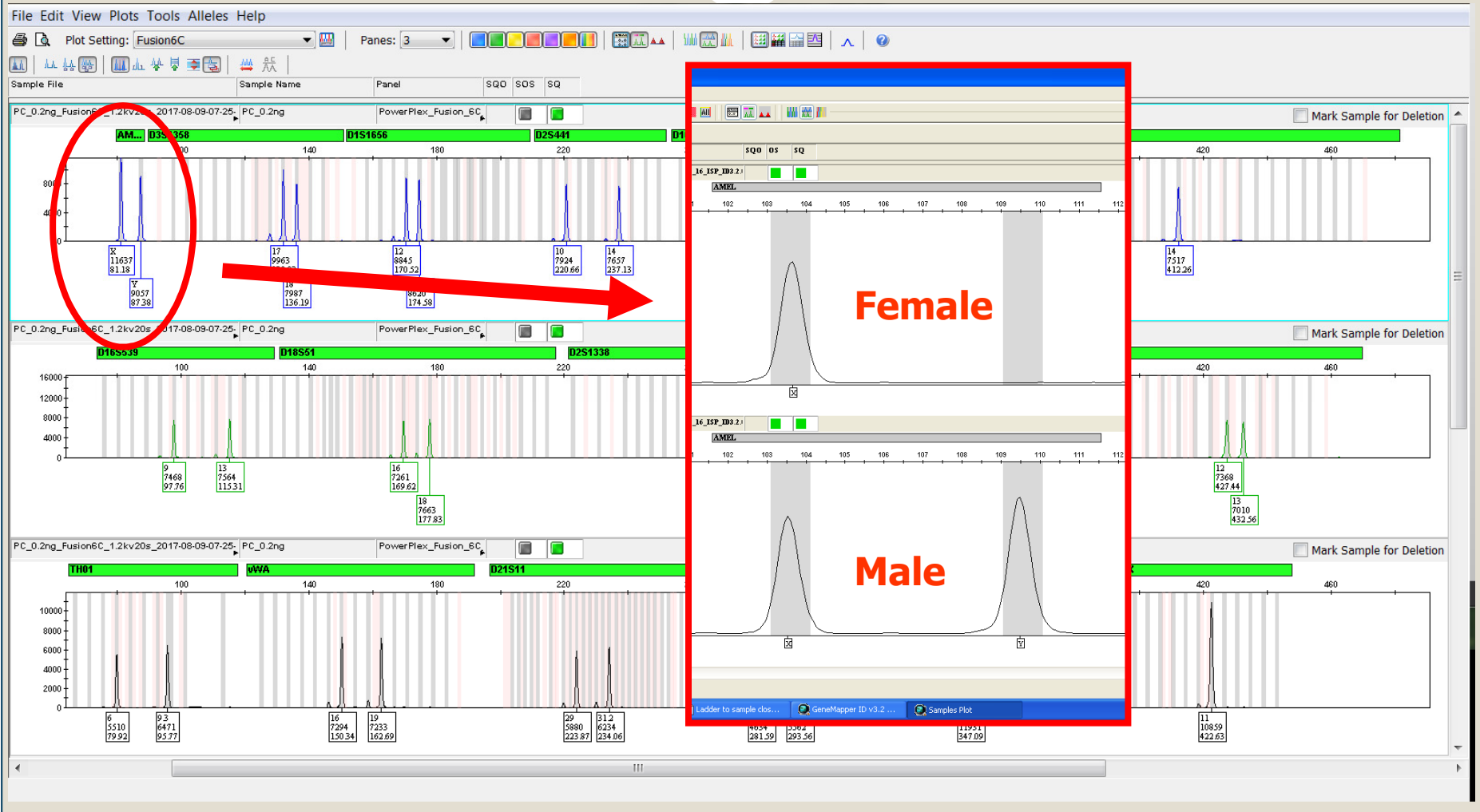
Electropherogram

- Separates and detects DNA fragments.
- Data is provided in electronic format.

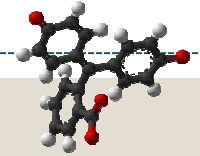
Electropherogram



Amelogenin Marker (Shows Gender)



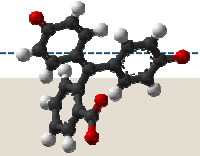
Example DNA Profile



FGA	23, 27
TPOX	8, 10
D8	10, 15
vWA	15, 17
Amel	XY
Penta E	5, 9
D18	15, 19
D21	30.2, 31.2

THO1	6, 9.3
D3	14, 15
Penta D	9, 12
CSF	10, 13
D16	11, 13
D7	10, 11
D13	10, 12
D5	11, 14

DNA Standards



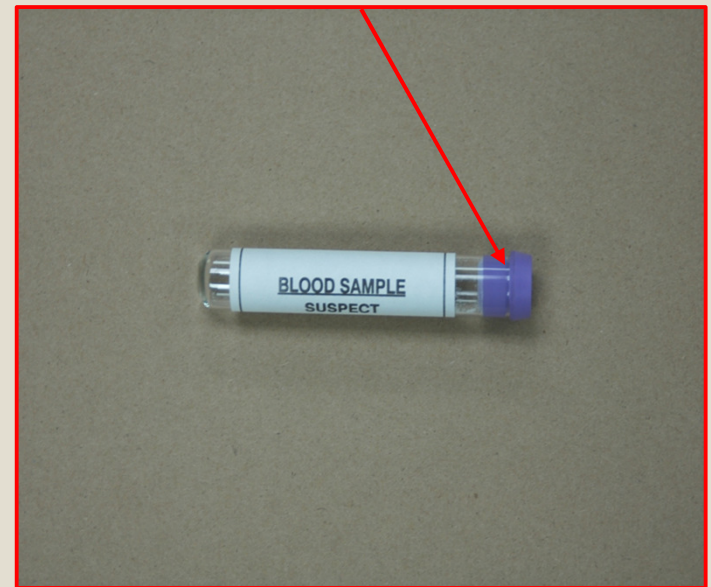
- What is a standard?
 - A known sample from a person so we can determine their DNA profile.
- Why do we need them?
 - To compare to the profiles obtained from evidentiary samples.

Collection of standards

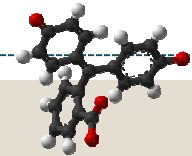


- **Blood**
 - PURPLE top vacutainer
 - Stain card
- **Saliva/Buccal swabs**
 - On swabs
- **Hairs**
 - Must be PULLED
- **Tissue/Teeth/Bone**
 - Molars, femur, ribs

Purple top tube



Profiles Consistent



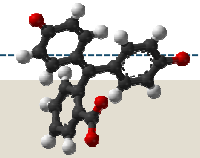
DNA Std. – John Doe

FGA	23, 27
TPOX	8, 10
D8	10, 15
vWA	15, 17
Penta E	5, 9
D18	15, 19
D21	30.2, 31.2
TH01	6, 9.3

Blood from scene

FGA	23, 27
TPOX	8, 10
D8	10, 15
vWA	15, 17
Penta E	5, 9
D18	15, 19
D21	30.2, 31.2
TH01	6, 9.3

Profiles Consistent



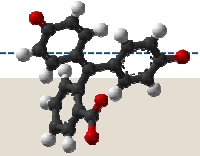
DNA Std. – John Doe

FGA	23, 27
TPOX	8, 10
D8	10, 15
vWA	15, 17
Penta E	5, 9
D18	15, 19
D21	30.2, 31.2
TH01	6, 9.3

Cigarette from scene

FGA	23, 27
TPOX	no result
D8	10, 15
vWA	15, 17
Penta E	no result
D18	15, 19
D21	30.2, 31.2
TH01	6

Profiles Not Consistent



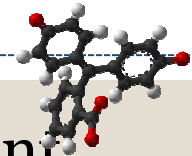
DNA Std. – John Doe

FGA	23, 27
TPOX	8, 10
D8	10, 15
vWA	15, 17
Penta E	5, 9
D18	15, 19
D21	30.2, 31.2
TH01	6, 9.3

Tissue from scene

FGA	23, 25
TPOX	6, 9
D8	10, 15
vWA	15, 17
Penta E	10, 15
D18	15, 17
D21	30.2
TH01	9, 9.3

Statistics



- Statistics give weight to the evidence given two different explanations

- Example:

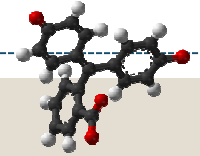
The probability of the evidence has been calculated by considering the following propositions:

H1: The profile originated from John Doe (item 003A).

H2: The profile originated from an unknown, unrelated individual.

The DNA profile is at least 1 trillion times more likely if it originated from John Doe than if it originated from an unknown individual. This analysis provides strong support for the proposition that John Doe is a contributor to the DNA profile.

Technical and Administrative Review



- All work is reviewed by another qualified analyst and a unit supervisor (or designee)
 - Ensures accuracy of the results and report
- Once analysis is complete and reviewed, a Certificate of Analysis (report) is generated
 - Lists evidence examined
 - Serology and DNA results
 - Statistics (if appropriate)
 - Disposition of the evidence

iResults



Web based way to obtain laboratory results

iResults questions should be directed to:

iResults @ isp.in.gov

(Questions should be answered within 3 business days)

To access iResults for reports or status, go to:

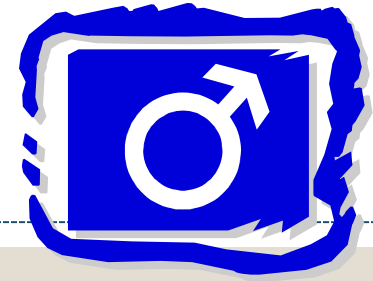
[https:// myweb.in.gov/ ISP/iresults](https://myweb.in.gov/ISP/iresults)

Specialty Analysis Methods



- **YSTRS**
- **MISSING PERSONS**
- **PATERNITY**

Y-STR DNA Analysis



- This only amplifies the male DNA in a sample that may not be detected using conventional DNA testing methods
- Useful for child molests, gang rapes
- It is paternally inherited so it is not unique to each individual
- Done by ISP Indianapolis Laboratory

Missing Persons



- DNA profiles from unidentified human remains can be searched in CODIS
- Biological relatives of missing persons can be submitted for comparison or entry into the database to search against unidentified humans
- If you have a case that could benefit from this analysis contact the lab for guidance or see PEB #21

Paternity



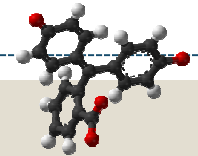
- Establishes criminal paternity
 - Examples: child molest, rape or incest
- Typical evidence type include buccal swab standards from mother, child, and alleged father and products of conception
- Same relationship comparisons performed as Missing Persons

CODIS

COMBINED DNA INDEX SYSTEM

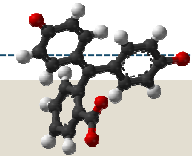


CODIS: Combined DNA Index System



- Criminals are recidivists
 - 50% chance suspect will commit another crime
 - 70% chance offender will commit another sex crime
- Created database of DNA profiles from various sources
 - Maintained across country at local, state, and national levels
- Saved profiles from one case will benefit others
 - Creates leads for law enforcement
 - Links serial crimes early
 - Links to crimes in other states

CODIS 101



- Contains DNA profiles from individuals and crime scene evidence
 - Individuals include:
 - ✦ Convicted Offenders and Arrestees (not suspects)
 - ✦ Missing Persons
 - ✦ Relatives of Missing Persons
 - Crime Scene Evidence
 - ✦ Eligibility Guidelines from FBI
 - Also, Unidentified Human Remains
 - ✦ To be searched against Missing Persons, Relatives and Offenders to identify



CODIS



- The lab makes final determination of what is eligible for CODIS.
- Anything eligible will *automatically* be entered and searched on a routine basis.
- All profiles that are eligible for National Level are uploaded each week.
- All profiles are searched against each other at the state and national level each week.
 - ✦ This means old cases are searched against any new offenders added each week.

It's A Hit!



- **Two common types of hits**
 - Offender – case to person
 - Forensic – case to case
- **Must Confirm**
 - Re-test offender sample
 - Double check case profile
 - Fingerprint match
- **Memo Released (could be only a month after initial report)**
- **One year extension of statute of limitations on most felonies (IC 35-41-4-2b)**

Offender Sample v. DNA Standard



- Not interchangeable
 - CODIS samples are not evidentiary
 - Lower security standards, No Chain of Custody
 - Likewise, suspect standards cannot be searched
- **Evidentiary standard must still be submitted**
- Lead not invalidated if offender was placed in database by mistake: IC 10-13-6-10 (c)

Questions

