# What DNA Analysis Really Means

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## Today's Information

- What is DNA
- DNA Technology
- DNA at DPS
- The cans and cant's of forensic DNA
- Submission of evidence
- A brief overview of forensic serology and DNA analysis
- CODIS
- Analyst Testimony

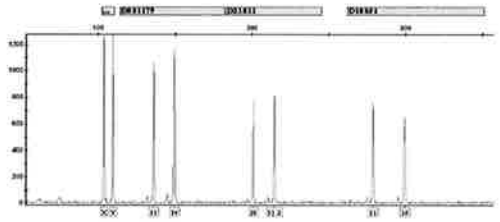
## DNA

## DNA

- What is DNA?
  - Deoxyribonucleic Acid - The genetic instructions inherited from mother and father
  - Found in ALL cells **EXCEPT** red blood cells
  - Only identical twins will share the same DNA pattern
  - Our testing will not determine hair color, eye color, age, etc.

## A DNA Type is....

- Numbers describing a person's DNA type



## Types of DNA Technology

- STR (Short Tandem Repeat) testing
  - What most people think of when talking about "DNA testing"
- YSTR testing - male DNA testing
- mtDNA testing - maternal line testing
  - Typically used for unidentified remains type cases, "last ditch" testing

## Types of DNA Technology

- STR testing - most unique to an individual = most discriminating power
- YSTR testing - paternal line males have the same YSTR type = lower discriminating power
- mtDNA testing - maternal line relatives have the same mtDNA type = lower discriminating power

## AZDPS DNA Unit

- DNA services provided at CRCL, SRCL, and NRCL
- Provides scientific examination of biological evidence to greater than 200 police agencies around Arizona
- Around 3.5 million people served
- Processed over 3000 requests last year
  - Includes nearly 1,000 withdrawals
- Current DNA case backlog across all labs approximately 3500 cases
  - Includes nearly 3,000 property crimes cases

## AZDPS DNA Unit

- Personal Crimes - crimes committed against people
  - Homicide, Sex Assault, Agg Assaults
- Property Crimes - crimes committed against property
  - Armed robbery, burglary, vandalism, auto theft
  - Prioritized by sample type

## AZDPS CRCL- 5 DNA Units

- DNA Violent Crimes Unit
- DNA Sex Assault Unit
- DNA Property Crimes Unit
- DNA Validation Unit
- DNA Database Unit

## AZDPS CRCL- 5 DNA Units

- DNA Violent Crimes, 1 supervisor
  - 3 DNA analysts, 2 serologists
  - Works mtDNA cases as well
- DNA Sex Assault, 1 supervisor
  - 2 DNA analysts, 4 serologists
- DNA Property Crimes, 1 supervisor
  - 2 DNA analysts, 3 serologists
- DNA Validation, 1 supervisor
  - 4 DNA analysts

## AZDPS CRCL - 5 DNA Units

- DNA Database Unit, 1 supervisor
  - CODIS Administrator
  - Assistant CODIS Administrator
  - 4 DNA analysts
  - 3 lab techs

## Proper Use of Forensic DNA Analysis

- Can provide scientific data to support or contradict elements of a crime
  - link suspect to victim or crime scene
  - help identify possible source(s) of DNA
    - suspect or person(s) associated with the crime
- Can exonerate the innocent
- Can corroborate stories

## Legal Value of DNA Evidence

- Biological evidence is more reliable than most eyewitnesses
- Biological evidence is often expected by juries in criminal trials (CSI effect)
- Can provide information that could result in a plea

## What CAN forensic DNA answer?

- Whether a particular DNA profile is present on an item or at a scene
- Familial questions (i.e. criminal paternity)
- Identity of an individual
  - Unidentified human remains
  - Missing person
  - Unknown identity cases

## What CAN'T forensic DNA answer?

- How the DNA got there
- When the DNA got there
- Possession/ownership of an item
- Whether an item was or wasn't handled by an individual

## Example 1

- A gun is found under the seat of a suspect's car. He says he has no idea how it got there and has never seen it before. DNA is requested to show that he handled the gun.
- Will DNA answer the question?

## Example 1

- NOT NECESSARILY
- If his DNA is NOT found on the gun doesn't prove he DIDN'T handle it
  - Brief handling
  - Not a "shedder"
- Finding his DNA on the gun doesn't absolutely prove that he handled it.
  - Sneezing
  - Talking over an item
- Latent print analysis may be more effective/efficient at answering this

## Example 2

- A suspect shoots a victim, killing him. The suspect admits to shooting the victim but claims it was self-defense as the victim rushed him. DNA analysis is requested on the gun.
- Will DNA answer the question?

## Example 2

- MAYBE
- It depends on what the lab is asked to test for:
  - If we are testing for DNA to see who handled the gun, it does NOT answer the question.
  - If we are testing to see if victim DNA on the gun (blood spatter) and find it, it MIGHT answer the question.
  - If we are testing for victim DNA and don't find it, it does NOT answer the question.
    - Lack of blood on the gun doesn't mean it wasn't self defense.

## Example 3

- A woman is sexually assaulted by a stranger. Semen is found on the victim. DNA analysis is requested on the semen to determine who assaulted her.
- Will DNA answer the question?

## Example 3

- YES
- If DNA is found and linked to a suspect, it will establish his presence at the scene.
- NOTE - the DNA, on its own, does NOT establish that he sexually assaulted the victim, only that his semen was found.

## Example 4

- A woman claims her husband sexually assaulted her. They had consensual sex the night before. Semen is found and DNA analysis is requested to determine if he sexually assaulted her.
- Will DNA answer the question?

## Example 4

- NO
- Even if DNA from the semen matches the husband, it will not establish whether the semen was from consensual sex or the alleged sexual assault.

## Example 5

- A body is found and believed to be that of a runaway missing for several months. No known sample exists for the runaway, but there are samples from the mother and father. DNA analysis is requested to determine the identity of the body.
- Will DNA answer the question?

## Example 5

- YES
- Using the DNA profiles of the mother and father, a familial match can be done to determine if the body could be their offspring.

## Example 6

- Swabs are taken from the counter of a McDonald's where the manager says a suspect touched while committing an armed robbery. DNA analysis is requested to find the identity of the suspect.
- Will DNA answer the question?

## Example 6

- NO
- Hundreds of individuals touch the counter of a McDonald's over the course of a day.
- Usable DNA results will not be obtained from this type of sample.

## Submission of Evidence

- Items submitted for analysis:
  - Evidence from crime scene
  - Standards from victim/consensual sex partner
  - Standards from suspect(s), if known
- Information needed for analysis:
  - How items relate to crime scene
    - Allows analyst to determine most viable forensic samples
    - Establishes CODIS eligibility
    - Allows analyst to avoid unnecessary/duplicated work
  - Permission to consume, when necessary

## Submission of Evidence: what happens next?

- Evidence is submitted by investigator to the lab for DNA analysis; what happens next?
  - Analyst contact to investigator/attorney may be needed to establish something important about the case
  - Need communication; if analyst cannot get in touch with someone, the case will be delayed and may even be withdrawn with no work completed

## Submission of Evidence: what happens next?

Evidence moves on for analysis by the lab

## Overview of analysis

- Types of biological samples
- Serology screening
- DNA analysis

## Overview of analysis

- Types of biological samples
  - The "good"
    - Blood
    - Saliva
    - Semen
  - The "bad"
    - Trace ("touch" DNA)
  - The "ugly"
    - Urine, feces, vomit, etc.

## Overview of analysis

- The "good": Blood, saliva and semen
  - Usually very good sources for DNA
  - Usually single source samples
  - Usually need less sample to get results

## Overview of analysis

- The "bad": Trace ("Touch") DNA evidence
  - DNA from items that may be obtained due to someone touching or handling item
  - Dependant upon whether the person touching the item is leaving or "shedding" their DNA
    - Different people tend to leave more or less DNA

## Overview of analysis

- Issues with "touch" DNA evidence
  - Touch DNA samples often result in low-level DNA mixtures, which are **less reliable** for interpretation
  - Touch DNA samples often result in low-level partial DNA types, which are **less reliable** for interpretation
  - These results are **NOT ELIGIBLE** for CODIS entry

## Overview of analysis

- What "touch" DNA evidence **is not:**
  - NOT a reliable source of DNA, especially when only brief contact occurs
  - NOT useful when parties involved in the commission of a crime live together or are often in contact with one another
  - NOT recommended as "a go to" type of evidence to collect

## Overview of analysis

- The absence of "touch DNA" does not mean someone did not touch the item
- The presence of "touch DNA" does not indicate when or how someone came in contact with the item
  - Will usually contain DNA from person who most often touched item
- CONTEXT

## Overview of analysis

- Best "Touch" DNA samples:
  - Items handled/worn over and over again
    - Guns - textured areas
    - Tools - textured areas
    - Clothing
    - Hats/gloves
    - Masks - typically best DNA comes from saliva or phlegm

## Overview of analysis

- Worst "Touch" DNA samples:
  - Public items
    - Doorknobs (including car doors)
    - Cash registers
    - Counter tops

## Overview of analysis

- The "ugly": Urine, feces, vomit, etc.
  - Rarely give usable results
  - Not commonly encountered and not tested routinely for DNA

## DNA - Biological Samples

- STR samples
  - The "good"
  - The "bad"
  - The "ugly"
  - Known standards

## DNA - Biological Samples

- Y-STR samples
  - Used on ↓male/↑female
    - Commonly used for sex assault cases when allegation of "penetration only" (touch DNA)
    - Fingernail samples
    - Sometimes on saliva samples when ↑female is present

## DNA Casework Unit: Serology/DNA

- Serology:
  - Study of blood or biological fluids
  - To identify presence or absence of body fluids
- DNA testing:
  - To associate the DNA profile found on evidence to an individual
  - DNA unique to individuals except identical twins

## General DNA Casework Unit Workflow

- Serological screening of evidence
  - Coordination on dual requests with LP Unit, Firearms Unit, Trace Unit
- Screened positive items retained for DNA analysis
- DNA analysis on retained items
- Known standards (Ks) worked separately from evidence samples (Qs)
- Missing persons

## Overview of analysis

- Serology
  - Testing for biological material that may contain DNA (i.e. blood, semen, etc)
    - Visual examination of evidence
    - Description of physical characteristics of any observed stains
    - Chemical testing for preliminary identification of various types of bodily fluids
  - Collection of samples for future DNA analysis
  - Often involves contact with officer or attorney to determine most probative items from crime scene

## Overview of analysis

- Serology report issued, will list:
  - Items analyzed (or not)
  - Results from evidence screening
  - Any items retained at the lab
  - Statement indicating any further action needed by investigator
    - Other known standards needed for DNA analysis
    - Permission to consume

  OR
  - Statement that DNA analysis will be done

## Overview of analysis

If further action is listed as being needed on the report, those actions MUST be completed before the request for DNA analysis will be entered into the DPS system

## Overview of analysis

- DNA
  - Testing samples for the presence of DNA
  - Comparison of evidence DNA profiles to known DNA profiles
  - Entry of eligible DNA profiles into CODIS
  - Often involves contact with officer or attorney to determine best sample(s) to test for establishing elements of the case

## Overview of analysis

- DNA analysis includes four steps:
  - Extraction
  - Quantitation
  - Amplification a.k.a. PCR
  - Genetic analysis
  - Results in electropherogram that shows the DNA profile for the sample tested
  - Sample profile can be compared to known standard profiles
  - Sample profile entered into CODIS in when eligible

## Overview of analysis

- DNA eligibility for CODIS entry:
  - Must be information a crime was committed
  - Developed from crime scene evidence
  - Believed to contain DNA from perpetrator
  - Not taken from a suspect's person
  - Must meet minimum requirements for quality
  - Other potential DNA sources ruled out
- Violations can result in severe penalties to the crime lab, including fines and loss of access to CODIS

## Overview of analysis

- DNA report issued, will list:
  - Items analyzed
  - If DNA profiles were developed from items
    - match the profiles of any known standards
    - any known standards are excluded
  - Statistics giving significance of match, when probative
  - Which profiles have been entered into CODIS
  - Items retained by the lab, if applicable
  - Statement indicating what further action needed by the officer, if applicable

## Overview of analysis: Limitations of DNA

- Limited or degraded DNA profiles can complicate analysis
- Mixtures of DNA profiles can complicate analysis
- Contamination of samples can complicate analysis
- Known samples not submitted
  - Victim
  - Suspect
  - Individuals that are allowed to be on item

## DNA Database (CODIS)

- CODIS: Combined DNA Index System
  - NDIS - National DNA Index System
  - SDIS - State DNA Index System
  - LDIS - Local DNA Index System
- Database of DNA types of evidence samples from crime scenes
- Database of DNA types from convicted offenders
- CODIS is useful for:
  - Providing leads for unsolved cases
  - Connect two cases together as having the same perpetrator

## CODIS

- Major Indices
  - Offender - sample collected from someone that has committed a felony, is on parole or is required by law to give one - i.e. as a condition of a sentence
  - Forensic - sample attributed to a crime scene; i.e. a blood stain from a burglary, semen from a rape
  - Arrestee - newly added index; sample collected from a person arrested of qualifying crime

## National DNA Database (NDIS)

- DNA Identification Act of 1994
- Implemented October 1998
- All 50 states, D.C, and Puerto Rico participate
- FBI - gatekeeper
- Heavily regulated
  - Thus regulating SDIS and LDIS labs
- >12,000,000 profiles entered to date

## National DNA Database (NDIS)

- Samples must meet minimum quality criteria to be entered into database
  - Known standard must be a full profile
  - Forensic and missing person samples may be partial, but must have minimum # of locations successfully typed in order to be entered
  - Forensic Mixtures cannot be too complex for database to handle
    - 2 person only

## State DNA Database (SDIS)

- Arizona DNA Database
  - Arizona has entered STR profiles since 1999
- Arizona is an Arrestee state
  - One of 27 states entering arrestee samples

## Additional CODIS uses

- Unidentified Human (Remains)
- Missing Person
- Relatives of Missing Persons
  - Only searched against Missing persons

## Arizona SDIS Stats

- As of May 2013
  - > 23,000 arrestee samples
  - > 260,000 convicted offender samples
  - > 13,000 forensic samples
  - Nearly 6,000 Investigations Aided

## CODIS has restrictions

- Victim DNA profiles are not entered
- Suspect standards are not searched
  - Can be entered
  - Can be searched, depends on the jurisdiction
- Elimination standards (consent partner, officer, etc.) are not entered
- Sample not attributed to crime scene
  - Cigarette butts at Circle K

## BIGGEST MYTH: CODIS = Suspect Standard

- Submit a standard for comparison for suspect(s) in cases.
  - "He is a convicted offender (CO) so you have his sample"
    - CO samples are not evidence (no chain of custody)
    - Creates excessive work for DPS -- severely delays that comparative result

## Without Suspect Standard...

- Agency never tells Lab about Known Suspect

1. Case evidence processed for DNA
2. DNA profile from foreign contributor unknown
3. DNA profile from foreign contributor to CODIS
4. Report issued
5. DNA "hit" occurs (investigative lead)
6. Hit report issued
7. Agency needs warrant to get known standard
8. Known standard submitted to Lab
9. DNA testing on known standard and comparison to evidence made
10. New report issued with match to suspect and statistical significance
11. Done

## With Suspect Standard...

- Agency alerts Lab of Known Suspect
  1. Known standard is submitted
  2. Case evidence and all known standards processed for DNA
  3. Comparison between foreign contributor and suspect made
  4. DNA profile from foreign contributor to CODIS
  5. **Report issued with match to suspect and statistical significance**
  6. **Done**

## CODIS

- Does it go into CODIS?
  - During an investigation of a suspect's house a bloody knife is located in the closet. The blood is tested and an unknown DNA profile is obtained.
  - NO
  - Blood is likely from victim and victim profiles are not allowed in CODIS
  - Would be compared to known standard from victim

## CODIS

- Does it go into CODIS?
- During an investigation of a victim's house a knife not belonging to the victim is located. The knife is tested for touch DNA and an unknown DNA profile is obtained.
  - YES
  - Sample is likely to have come from the perpetrator in the case

## CODIS

- Does it go in CODIS?
  - During an investigation of a home burglary, an empty soda can not belonging to the victim is found on the kitchen counter. The can is tested and an unknown DNA profile is obtained.
  - YES
  - Sample is likely to have come from the perpetrator in the case

## CODIS

- Does it go in CODIS?
  - During an investigation of a burglary, an empty soda can is found in a trashcan outside of a business. The can is tested and an unknown DNA profile is obtained.
  - NO
  - Sample cannot be linked directly to the case

## Analyst Testimony

- What can the serologist testify to?
  - Types of testing performed
    - Blood
    - Semen/Sperm
    - Other (i.e. saliva, feces, etc.)
  - Results of analysis
  - Meaning of results
    - Preliminary vs. confirmatory
    - Significance

## Analyst Testimony

- What can the DNA analyst testify to?
  - Types of testing performed
    - Serology
    - STR
    - Y-STR
    - mtDNA
  - Results of analysis
  - Statistics associated with analysis
  - Meaning of results

## Putting It All Together

What can we do to improve what we do?

## Putting It All Together

- Process improvements within the lab
  - Validation of new instrumentation
  - Validation of new methods
  - Reorganization of resources
  - Training to get more analysts online
  - Moving cases throughout the system to reduce backlogs

## Putting It All Together

- Timely Communication
  - Case information/requests from officer to analyst
  - Trial information/requests from attorney to analyst
  - Analysis information/requests from analyst to officer and attorney
  - Addresses "phantom backlogs"
    - Inform lab when analysis no longer needed
  - Single biggest cause of delays for all parties
  - Single biggest cause of frustration for all parties

## Putting It All Together

- Interagency Cooperation
  - Case prioritization
  - Item prioritization
  - Consider time frame for analysis vs. court deadlines
    - Backlogs
    - Other cases in progress with deadlines
  - Consider forensic value of evidence vs. case details
  - Consider possible testimony from analyst vs. needs of the case in court
    - COMPLETE meaning of results
    - Integrity and ethics

## Contact Information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