DNA

The Good, the Bad, and the Ugly

Embracing / Attacking DNA

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Putting it all into Perspective

What does it Mean??

STR testing is extremely sensitive….

- Approximately 30 diploid cells (200 pg) will be detected at reportable levels by most labs (150 RFU)
- How did the evidence get there?? Transfer?? Contamination?? Duration???

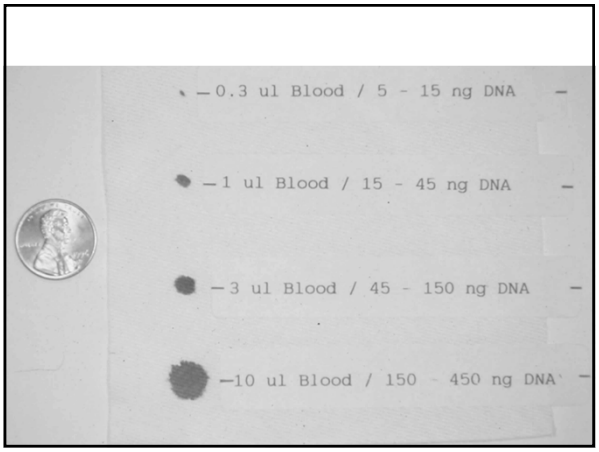
Special Precautions:

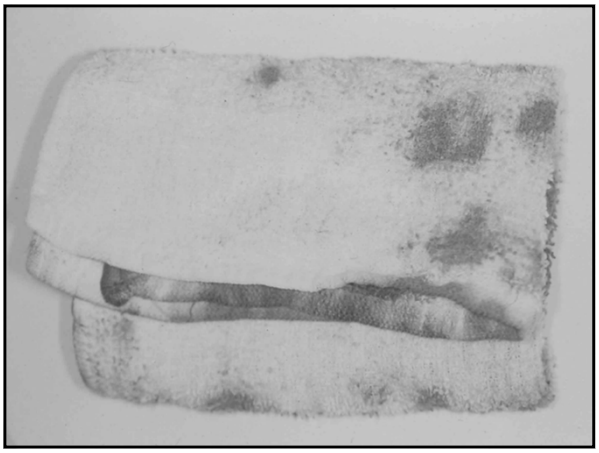
It is important that the DNA extraction and PCR setup of evidence samples be performed at a separate time from the DNA extraction and PCR setup of reference samples. This precaution will help to prevent potential cross-contamination between evidence samples and reference samples.

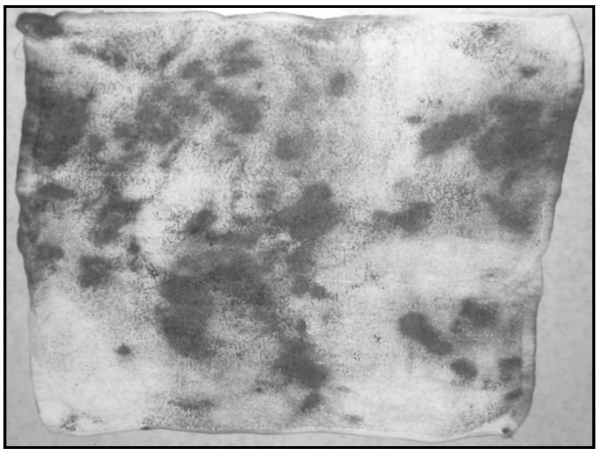
Perform DNA extraction from samples containing high levels of DNA (for example, whole blood) separately from samples containing a low level of DNA (single hairs, small bloodstains, etc.) to minimize the potential for sample-to-sample contamination.

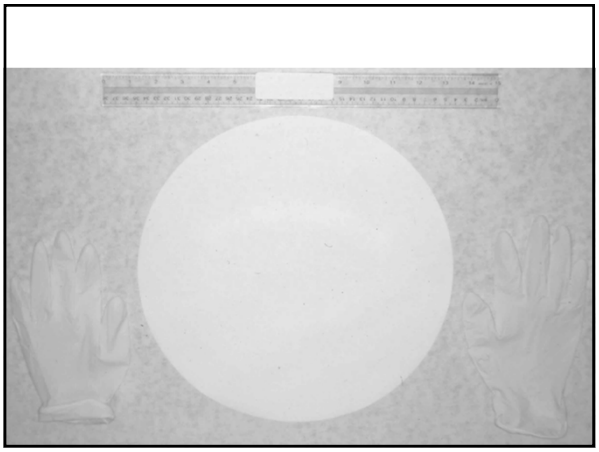
Use disposable gloves at all times. Change gloves frequently to avoid sample-to-sample contamination. Change them whenever they might have been contaminated with DNA and whenever exiting the work area.

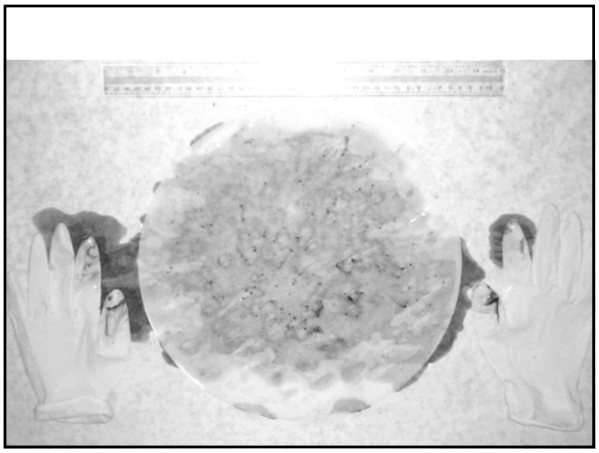
Clean scissors thoroughly with ethanol and water or use fresh scalpel blades after cutting each evidence sample.











What does it Mean??

- Seminal fluid contains 60-150 million sperm/ml
- A typical ejaculate contains 2-5 ml of semen
- A drop of seminal fluid will contain at least 1 million sperm cells

DNA Transfer

- Primary Transfer – same as a direct deposit to the "target"
- Secondary Transfer – biological material goes through one intermediary before being deposited onto the "target"
- Tertiary Transfer – biological material goes through two intermediaries before reaching the "target"

Primary Transfer

Example:

Blood drips from a stabbing victim directly onto the perpetrator's shoe.

victim - shoe

Secondary Transfer

Example:

The detective touches the victim and gets blood on his gloves, then touches the suspect's shoe and transfers some blood to it (blood goes through one step to get to the shoe).

victim – glove - shoe

Tertiary Transfer

Example:

The detective unwittingly transfers blood from the victim to a desktop, then the CSI guy unwittingly lays the suspect's shoes on top of the bloodstain on the desktop, thus transferring victim's blood to the defendant's shoe.

victim - glove - desk - shoe

DNA from Touched Objects

- Shell casings
- Weapons – gun grips, knife handles
- Gloves – inside and outside surfaces
- Steering wheels
- Writing pens
- Door handles
- Ligatures
- Explosive devices and many more

Things to Remember

- A person may or may not leave behind their cells (thus, DNA) when they touch an object.
- The strongest DNA profile does not always originate from the last person to touch an object.
- No one can place the time, order, or method of deposit (direct v. transfer) from a DNA profile.

Spotting problems in Forensic Biology / DNA Testing

NEBRASKA

CSI official found guilty

A judge convicted a top crime scene investigator of evidence tampering after prosecutors argued that the investigator had planted blood from a slaying victim in a car linked to two innocent suspects.

Cass County District Judge Randall Rehmeier said he didn't believe Douglas County CSI director David Kofoed's excuse that the victim's blood ended up in the car because of a sloppy mistake. Rehmeier said there was enough evidence to show that Kofoed planted fake evidence.

Kofoed, 53, faces up to five years in prison and a $10,000 fine at his May sentencing. He remains free on bond.

— ASSOCIATED PRESS

How to spot the problems?

- Get the notes, data, photos, and error logs!!
- Do your own exam or retest… sometimes the notes just don't reveal the problems

Most successful challenges to DNA

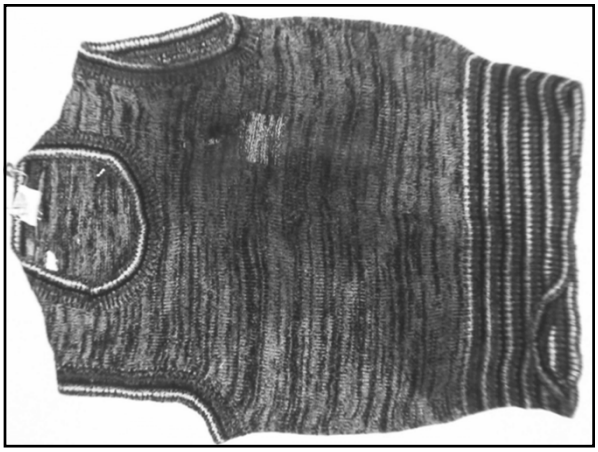
Are not in challenging the DNA result obtained by the State's lab, but involve:

- Finding evidence missed by their lab***
- Challenge the interpretation of the profiles (especially mixtures)
- Relate to the significance of the presence (or absence) of biological evidence
- Expose erroneous testimony

Is the evidence collected and stored properly to avoid cross contamination?

Possible Contamination in Storage

Sample ID	*D3S1358*	*VWA*	*FGA*	*AMEL*	*D8S1179*	*D21S11*	*D18S51*	*D5S818*	*D13S317*	*D7S820*
Sweater	16,17, [o1]	14,17	21,25	X,X	13,15, [9]	29,29	13,14	12,13	8,8	8,9
Left shoe	16,17	[14], [17]		X,X	13,15	[29]		12,13	[8]	
Control	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA



Is there improper batching of samples that could increase contamination risk?

Improper sample batching-contamination risk

- Reference and evidence samples extracted together
- Samples from the victim extracted with samples from the defendant (vaginal and penile swabs processed together, murder weapon with the defendant's clothes, etc.)

Possible Contamination in the Lab

Sample ID	*D3S1358*	*VWA*	*FGA*	*AMEL*	*D8S1179*	*D21S11*	*D18S51*	*D5S818*	*D13S317*	*D7S820*
Victim's Standard	16,18	16,19	22,23	X,Y	12,15	28,30	13,16	10,12	11,12	10,11
Blood – hammer	16,18	16,19	22,23	X,Y	12,15	28,30	13,16	10,12	11,12	10,11
Blood stn Q8 jacket	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Blood stn Q15 jacket	16,18	16,19	22,23	X,Y	12,15	28,30	13,16	10,12	11,12	10,11

SAMPLE AMPLIFICATION WORKSHEET: PROFILER PLUS

Sample	Resolub. Volume (µL)	Yield Gel (ng/µL)	Slot Blot (ng/µL)	Dil'n for Amp.	Amount of DNA (µL)	Amount of H_2O (µL)
19A1	100	(1/10) 2	(1/100) ~~0.37~~ ~~4.00~~	1/100	3	17
24A1	100	(1/10) 0.25	(1/10) 0.31	1/10	4	16
25A1	100	(1/10) 1	(1/10) 0.9	1/10	1.5	18.5
1A	100	0.5	~1.0	—	1	19
16Q8	36	ND	0.025 ~~0.039~~	—	* 20	0
16Q15	55	ND	0.015	—	* 20	0
22L	100	(1/10) 0.5	(1/10) 0.42	1/10	3	17
22R	100	(1/10) 0.25	(1/10) 0.2	1/10	6	14
Positive Control	—	—	—	—	20	0
Negative Control	—	—	—	—	0	20

Victim

Hammer

Jacket

Sample Name	Extract Volume (ul)
1_RB1_Q	~30
2_POS_Q	
3_08P2031_#10AT1_shirt_Milam_B	
4_08P2031_#10FT1_jeans_Milam_B	
5_08P2031_#13DT1_shirt_Carson_J	
6_08P2031_#13ET1_pants_Carson_J	
7_08P2031_#14AT1_shirt_Milam_D	
8_08P2031_#14AT2_shirt_Milam_D	
9_08P2031_#14AT3_shirt_Milam_D	
10_08P2031_#20I_left_elbow_swab	
11_08P2031_#20J_left_knee_swab	
12_08P2031_#31AT1_baby_wipe	
13_08P2031_#38T1_jeans	
14_08P2031_#39T1_steel_bar	
15_08P2031_#39T2_steel_bar	
16_08P2031_#40BT1_pipe ~~wrench~~ wrench	

Does the lab have a history of sloppy handling/errors?

Get the contamination or unexpected results logs!!

Contamination at WSP

Contamination/Extraneous DNA Log

Case Number: AB-001555 Date: 08/15/03

Source of Extraneous DNA (if known): Felon sample (used for training)

Circumstances:

A reagent blank (non-sperm.) sample had DNA present. The samples were re-prepared for the 310, and the contamination was still present. A keyboard search was done on the partial profile - a match occurred. The felon was only a child when the crime occurred. It was determined that the felons' sample was being used as a training sample by another analyst.

2005 - CORRECTIVE ACTION (DNA)

CAR#	Date Initiated	Date Completed	Unit	Analyst Involved	Issue
05-001	1-21-05	4-25-05	DNA	[redacted]	Evidence control sample contaminated with analyst's profile [redacted]
05-002	3-22-05	4-21-05	DNA	[redacted]	Extraction control contaminated with another analyst's profile [redacted]
05-004	4-4-05	4-25-05	DNA	[redacted]	Two extraction controls contaminated with another staff member's profile [redacted]
05-005	5-12-05	5-18-05	DNA	[redacted]	One evidence sample contaminated with analyst profile [redacted]
05-006	5-16-05	6-22-05	DNA	[redacted]	Evidence samples and extraction controls contaminated with another staff member's profile [redacted]
05-007	5-5-05	6-29-05	DNA	[redacted]	Sample extract contaminated with unknown profile [redacted]
05-010	11-6-05	11-8-05	DNA	[redacted]	Evidence sample contaminated with another staff member's partial profile [redacted]

N/A = no corrective action needed

Year	Reason for corrective action	Number of occurrences	Total number of DNA cases completed
2003	Staff to sample contamination	3	
2003	Unknown contaminant detected	1	559
2004	Case-to-case contamination	2	
2004	Staff to sample contamination	2	
2004	Casework sample switch	1	
2004	Training sample switch	1	579
2005	Analyst to sample contamination	2	
2005	Staff to sample contamination	4	
2005	Unknown contaminant detected	1	557
2006	Staff to sample contamination	1	
2006	Case-to-case contamination	3	
2006	Unknown contaminant detected	1	
2006	Training sample switch	1	
2006	Reporting error	1	620
2007	Staff to sample contamination	2	
2007	Case-to-case contamination	1	
2007	Statistics calculation error	2	819

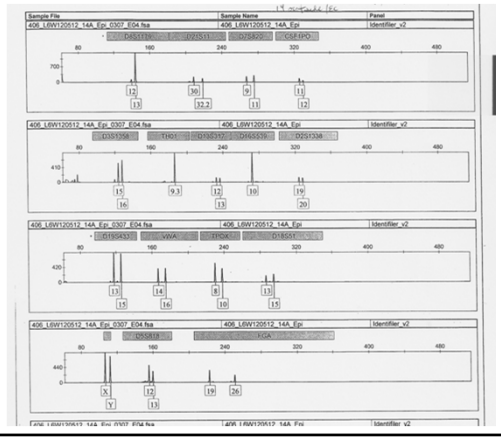
DNA Analytical Discrepancy Log

Date	Analyst	Description	
10/23/2001	Kalafut	Transfer contamination between test samples during extraction; detected during routine QC	Rean in cas
11/6/2001	Allen	Transfer contamination between test samples during extraction; detected during routine QC	Rean in cas
1/14/2002	Sweetland	Ssample switch between cases; detected following a CODIS match at state	Rean place CODI
2/6/2002	Sweetland	Transfer contamination of an expected blank sample during extraction; detection during routine QC	Rean in cas
6/13/2002	Sliter	Transfer contamination of a reagent blank during extraction; detected during routine QC	Rean in cas
10/23/2002	Ridgley	Transfer contamination between test samples during extraction; detected during routine QC	Rean in cas
5/6/2003	Allen	310 sample set-up discrepancy during rerun; detected during routine QC	Rean place
7/28/2003	Allen	Transfer contamination of a reagent blank during extraction; detected during routine QC	Rean in cas
11/26/2003	Ferreira	Unconfirmed discrepancy during 310 sample set-up; detected during routine QC	Possi shoot place

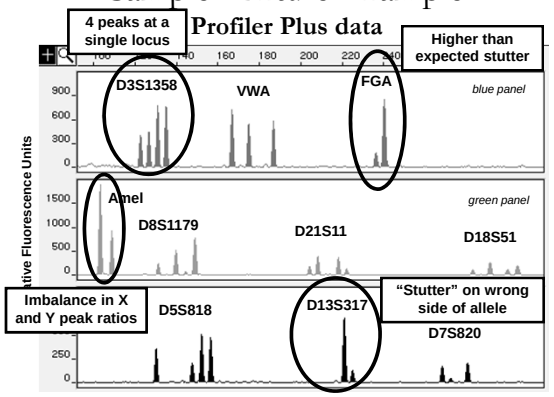
Mixture Interpretation

It's all in the punctuation:

- PLEASE DON'T STOP
- PLEASE, DON'T STOP!
- PLEASE DON'T. STOP!



Sample Mixture Example



Mixture Interpretation

- How does one interpret a mixture, that is, which bands or peaks are alleles and which are artifacts or errors?
- How should one estimate the weight of mixture evidence given that all alleles are determined accurately?
- SWGDAM issues mixture interpretation guidelines in 2010.

Are the statistics OK?

- Did the lab correctly report AND interpret a mixture profile?
- Was the statistic correct? Or did the lab:
  - "Fish" the defendant's profile out of a mixture and report it as single source?
  - Ignore the data at loci where expected alleles are missing?
  - Fail to enter data correctly for CODIS searches?

DNA

WHAT CAN GO WRONG?

Pitfalls and Mistakes….

Is accreditation a guarantee of quality???

Problems in accredited labs….

Problems we've seen while monitoring other labs

Cross Contamination Risks:

- Extracting references and unknowns at the same time (but on different lab benches, so it's ok??)
- Extracting /testing evidence taken from the victim and defendant together
- Opening tubes with fingertips, touching inside of tube caps with glove

Problems we've seen while monitoring other labs

- Touching pipet tips to surfaces, analyst raking the pipet tip through his hair
- Having all tubes open at once
- Inefficient extraction, waste of sample
- Storing wet samples at room temperature - bacterial growth/degradation of DNA

Problems we've seen while monitoring other labs

- Careless movement between pre- and post-amplification areas
- Failing to change gloves, washing off the gloves
- Losing hairs
- Spilling of DNA extract onto the analyst's lap

Problems we've seen while monitoring other labs

They Forgot the "R"!!

- Major errors in the protocols – error gets spread throughout a state lab system or to other labs - FBI, WSP, TXDPS, more???

EVIDENCE SHAPING

The twisting of facts or opinions to favor a particular viewpoint

Evidence Shaping

Takes many forms and may include:

- Selected testing – some key samples may have been omitted from testing
- Selected reporting – omission of key facts from final reports that may or may not be gleaned from the bench notes
- Selected testimony – omission of key details or addition of speculative statements

Examples we've seen (by review, testimony, evidence re-exam)

- "Fishing" a profile out of a close mixture and reporting statistics as a single source
- Ignoring other combinations of alleles in a mixture to search CODIS
- Re-analyzing the data multiple times to get noise to label as an allele with genotyper

Examples we've seen (by review, testimony, evidence re-exam)

- Reporting a result as inconclusive but testifying that it includes the defendant
- Ignoring all other mechanisms (besides the prosecution's theory) for DNA to be on an item of evidence
- And….completely missing or not testing biological stains

Duke Lacrosse

- DA Mike Nifong hires a private NC lab to perform Y-STR testing on evidence collected from the accuser and the scene and compare to reference samples from 46 lacrosse players
- DNA Securities issues a report - no DNA from any team member is found on the accuser
- They FAIL to report results that DNA from other men is found on the accuser

Duke Lacrosse

- Evidence of other male DNA is found on discovery review - lab director says this was omitted from the report at the DA's request
- DA Nifong recuses himself from the case, resigns as Durham Co DA, and ultimately is disbarred

Duke Lacrosse

The Outcome:

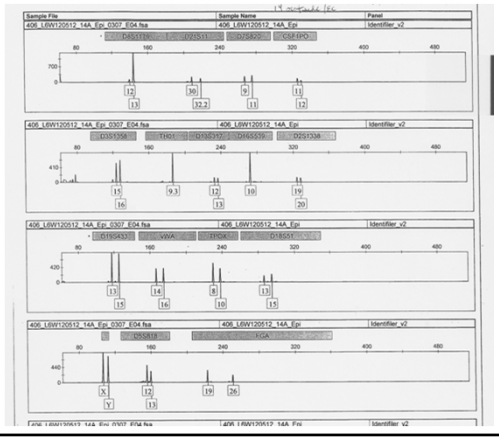
CASE DISMISSED

TX. v. Rodolfo Rodriguez

Conclusions

The DNA profile from item 2N1, the sperm fraction from the outside of item 14, and the swabbing from the inside of item 14 is from an unknown male.

The DNA profile from item 2N2 and the epithelial fraction from the outside of item 14 is consistent with a mixture of the same unknown male and Deborah [redacted]. Deborah [redacted] cannot be excluded as a contributor to the stain at the loci: D8S1179 and D19S433. At these loci, the probability of selecting an unrelated person at random who could be a contributor to this stain is approximately 1 in 25 for Caucasians, 1 in 78 for Blacks, and 1 in 59 for Hispanics. The approximate world population is 6.5 billion.



TX. v. Rodriguez - Defense report excerpted

a contributor to the stain at the loci: D8S1179 and D19S433". This characterization that Deborah [redacted] is a donor to the DNA in the epithelial fraction of DNA from this sample is patently false. The epithelial fraction of DNA from the outside of item 14 is consistent with a single source male donor. Deborah [redacted] should be excluded as a contributor to this DNA sample because at the 15 genetic locations tested, and for which results were developed on the evidence, she has alleles (genetic markers) in her known reference DNA that are clearly missing at 13 of the 15 loci. At the two loci referenced in the report, the lab has used an apparent stutter artifact to include Ms. Faries at D8S1179, and at D19S433 she coincidentally shares an allele with the male DNA donor.

It is my opinion that the TXDPS lab has willfully engaged in selective reporting and mischaracterization of the laboratory results in order to falsely associate Ms. [redacted] with condom 14 through DNA testing when she clearly is not associated with this item through the DNA

TX. v. Rodolfo Rodriguez

The Outcome:

CASE DISMISSED

Even if the testing and report are correct and came from an accredited lab, can you trust the testimony??

WA v. Charles Jackson

- Victim and defendant were together all night having sex and doing drugs…cause of death undetermined due to decomposition, maybe OD
- Swabs of the victim's fingernails show a mix of DNA – approx. 80% victim, 20% defendant
- WSP analyst testifies on direct to the DNA mix but not that the defendant is a very minor donor

WA v. Charles Jackson

- WSP analyst testifies that the cells from the defendant would have to get under the nails by some forceful act such as "a back scratch or neck rub", (implying a struggle) and…..
- That the victim likely did not have a chance to wash her hands after the cells were deposited

WA v. Charles Jackson

Defense expert points out that, by the way…..

- The defendant's DNA is present at a very low level and is no more than 20% of the mixture
- That very few cells of his are present, as few as 30 cells can be detected
- That if you simply lick your finger to turn a page you've placed 100s-1000s of cells on your finger
- That 1000s of his cells could have gotten on her nails during sex

MD v. Tonto Corbin

- Victim was a prostitute; crime lab found only the defendant's sperm on her vaginal swabs
- Crime lab found semen from three other men (not defendant) on her underwear and clothes
- Therefore, State's theory is the victim never stood up after having sex with the defendant

MD v. Tonto Corbin

Defense expert points out that, by the way…..

- The number of sperm on the vaginal swab was far too low to be consistent with a full ejaculate inside the victim (2 sperm on the entire slide)
- A small amount of drainage of defendant's semen/sperm could be lost in the large number of sperm present in the panties from the other man

MD v. Tonto Corbin

Defense expert points out that, by the way…..

- Not all of the stains on the clothing were tested
- Drainage is not a constant process….it varies widely between women and for the same woman with different partners
- There are no, and cannot be, controlled studies on drainage because of these variables
- The victim may have changed panties

MD v. Tonto Corbin

The outcome:

The judge encourages the DA to offer a great plea deal, Corbin is released in less than 1 year

Revised SWGDAM Guidelines

- January 2010 SWGDAM publishes revised guidelines for autosomal STR interpretation including mixtures.
- http://www.fbi.gov/hq/lab/html/codis_swgdam.htm
- This does not include Y-STR or Low Copy