Forensic DNA and Serology Evidence:
Science, Justice, and the Gaps in Between

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Founder and President
The Institute for Advanced Career Development
3/19/2015
Crime Scene: Biological Evidence Processing

Evidence Collection and Preservation

Field Testing  Laboratory Testing

Identification

What is it?  Who is it from?

Serology  DNA

CODIS Database

Suspect (s)

Cold Hit
What is it? Forensic Serology

Blood

Saliva

Semen

Others??
Crime Scene: Biological Evidence Processing

Possible Semen Stain

Ex: 450nm Orange filter
Forensic Serology

**Presumptive Tests:**
- Used for preliminary screening
- Prone to false positive and false negative
- Test is mostly chemical in nature
- Look for a color change or luminescence (usually a catalyzed oxidation reaction)

**Confirmatory Tests:**
- Used for confirmation / validation (alone or in conjunction with a presumptive test)
- False positive is rare, but false negative can happen
- Test is chemical, biological, or physical in nature
- Identify/detect UNIQUE characteristics using various technologies
Case 7

Greg Taylor: Convicted in Jacquetta Thomas’ murder in 1993
exonerated in 2010
Forensic Serology

Phenolphthalin

Phenolphthalein

**Colorless**

**Pink**

**Iron**

Oxidation of Phenolphthalin

The Kastle-Meyer Test
Forensic Serology

Confirmatory Blood Test

Hemachromagen Crystal Assay (Takayama Assay)
Lab’s final conclusions:

“Semen was found on the external genitalia swabs”.

However! The Lab’s report (detailed section) also states:

The acid phosphatase test was Inconclusive. (P)

The P30 (or PSA) was weak positive. (P?)

Microscopic exam for the presence of sperm was negative. (C)

And, DNA analyses were “negative” for male DNA !!!
Forensic Serology

The Prostate gland

- sigmoid colon
- rectum
- seminal vesicle
- ejaculatory duct
- prostate gland
- cowper’s gland
- anus
- vas deferens
- epididymis
- testis
- scrotum
- bladder
- pubic bone
- penis
- corpus cavernosum
- penis glans
- foreskin
- urethral opening
Forensic Serology

The Skene's glands (aka the lesser vestibular glands, periurethral glands)
Forensic Serology

Sperm Identification
Christmas Tree Test

- **Acrosomal cap**: clear to pink
- **Acrosome**: dark pink to red
- **Midpiece**: green to blue
- **Tail**: green to blue
Blood Typing and Identification

<table>
<thead>
<tr>
<th>Population</th>
<th>O</th>
<th>A</th>
<th>B</th>
<th>AB</th>
</tr>
</thead>
<tbody>
<tr>
<td>US Whites</td>
<td>45.3%</td>
<td>41.3%</td>
<td>9.9%</td>
<td>3.5%</td>
</tr>
<tr>
<td>US Blacks</td>
<td>49.1%</td>
<td>26.5%</td>
<td>20.1%</td>
<td>4.3%</td>
</tr>
<tr>
<td>Chinese</td>
<td>43.9%</td>
<td>27.0%</td>
<td>23.3%</td>
<td>5.8%</td>
</tr>
<tr>
<td>Bolivian</td>
<td>93.1%</td>
<td>5.3%</td>
<td>1.6%</td>
<td>0.1%</td>
</tr>
</tbody>
</table>
DNA Exonerations by Year in the U.S.

Source: Innocence Project
Genetic Principles and DNA as a Forensic Tool
Deoxyribonucleic Acid (DNA)
DNA Discovery

Johann Friedrich Miescher
1870

Rosalind Franklin

Avery and Griffin
1944

1953

1962

Francis Crick
James Watson

DNA in Living Things
DNA is packed inside a compartment called “The Nucleus”
Human DNA: Chromosomes

23 Pairs of chromosomes in every human cell (with few exceptions):
One copy from Mom, one copy from Dad
Chromosomes in Living Organisms

# of Chr in:
- Fruit Fly: 8
- Broccoli: 18
- Cat: 38
- Dog: 78
- Goldfish: 94
- Ferns: 1200+
Cell Division Requires DNA Replication

1 cell

2 cells

DNA

DNA

46 chromosomes

23 chromosomes in sperm

23 chromosomes in egg

Fertilization
Every Chromosome is a continuous double strand of DNA...Think of it as a long string of the 4 DNA molecules: (A, G, C, and T)!
DNA in the Cell

A switch

A gene
Chromosome 15

106 million bases

- Hypertension, essential, susceptibility to
- CLL/lymphoma, B-cell
- Lymphoma, diffuse large cell
- Necdin
- Prader-Willi syndrome
- Angelman syndrome
- Hair color, brown
- Spastic paraplegia
- Limb deformity
- Schizophrenia, neurophysiologic defect in
- Isovalericacidemia
- Spherocytosis, hereditary, Japanese type
- Bartter syndrome
- Amyotrophic lateral sclerosis, juvenile recessive
- Dyserythropoietic anemia, congenital, type III
- Griscelli syndrome
- Deafness, autosomal recessive
- Hepatic lipase deficiency
- Marfan syndrome
- Shprintzen-Goldberg syndrome
- Ectopia lentis, familial
- Leukemia, acute promyelocytic, PML/RARA type
- Cardiomyopathy, familial hypertrophic
- Enhanced S-cone syndrome
- Glutaricaciduria, type IIA
- Epilepsy, nocturnal frontal lobe, type 2
- PAPA syndrome
- Diabetes mellitus, insulin-dependent

Eye color, brown

Prader-Willi/Angelman syndrome (paternally imprinted)
Human coronavirus sensitivity
Albinism, oculocutaneous, type II and ocular
Andermann syndrome
Cardiomyopathy, dilated and familial hypertrophic
Epilepsy, juvenile myoclonic
Spinocerebellar ataxia
Microcephaly, primary autosomal recessive
Dyserythropoietic anemia, congenital, type I
Muscular dystrophy, limb-girdle, type 2A
Dyslexia
Amyloidosis, hemodialysis-related
Ceroid-lipofuscinosis, neuronal, late infantile
Gynecomastia, familial
Virilization, maternal and fetal
Colorectal cancer
Carbohydrate-deficient glycoprotein syndrome, type Ib
Bardet-Biedi syndrome
Tay-Sachs disease
GM2-gangliosidosis
Tyrosinemia, type I
Mental retardation, severe
Hypercholesterolemia, familial, autosomal recessive
Retinitis pigmentosa, autosomal recessive
Otosclerosis
Bloom syndrome

Source: PD
What is a Locus or Loci?
A region or sequence on a chromosome that is responsible for a trait or a genetic characteristic (e.g. a specific location of a gene for hair color).

What is an Allele?
An allele is a variant of a gene or genetic sequence at a given genetic locus.
Allele Inheritance for Locus “Cat Allergy1”

Chromosome 15

Mike

a
b

Judy

a
b

Anna

Paul

Tony

Phil

a
b
a

b
c
b
a

a
a

a
a

a
a

The Whiskers Family
Forensic DNA Analysis
Locus (Loci): Location on a Chromosome

Locus = Marker

Chromosome 16

Remember:
one copy from mom
one copy from dad

Marker D16S10
Short Tandem Repeats (STRs) in DNA

...AAGTTTCA

TGTAGTCCCAGTCCAGTCAGCC

ATTTGACA

AGTTTCA

GATA GATA GATA GATA

GATA

CCCTCTTC...

5 Repeats of “GATA”

...AAGTTTCA

TGTAGTCCCAGTCCAGTCAGCC

ATTTGACA

AGTTTCA

GATA GATA GATA GATA

GATA GATA GATA GATA GATA

CCCTCTTC...

8 Repeats of “GATA”

Chromosome 16 Marker D16S539
Short Tandem Repeats

Number of STRs Provides **Uniqueness**

Example: a locus on Chromosome 10
Short Tandem Repeats (STRs) in DNA

<table>
<thead>
<tr>
<th>Chromosome #</th>
<th>Chr 8</th>
<th>Chr 21</th>
<th>Chr 7</th>
<th>Chr 13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marker Name</td>
<td>(D8S1179)</td>
<td>(D21S11)</td>
<td>(D7S820)</td>
<td>(D13S317)</td>
</tr>
<tr>
<td>Genotype</td>
<td>4, 4</td>
<td>2, 3</td>
<td>1, 4</td>
<td>5, 3</td>
</tr>
<tr>
<td>Or “Profile”:</td>
<td>4, 4</td>
<td>2, 3</td>
<td>1, 4</td>
<td>5, 3</td>
</tr>
</tbody>
</table>

or “4”
Restriction Fragment Length Polymorphism

Allele1

```
GAATT GAATT
```

2 repeats

Allele2

```
GAATT GAATT GAATT GAATT GAATT
```

5 repeats
Gel Electrophoresis

- Each white band is a DNA fragment
- Each column or “lane” is a DNA sample from an individual

DNA fragment migration through a gel
Who is the possible Biological Child?

<table>
<thead>
<tr>
<th>TH01 alleles</th>
<th>Allele ladder</th>
<th>Mother</th>
<th>Father</th>
<th>C1</th>
<th>C2</th>
<th>C3</th>
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</thead>
<tbody>
<tr>
<td>(14)</td>
<td></td>
<td>(12)</td>
<td>(13)</td>
<td></td>
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<tr>
<td>(11)</td>
<td></td>
<td>(10)</td>
<td>(10)</td>
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<td>(10)</td>
<td>(10)</td>
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</tr>
<tr>
<td>(9)</td>
<td></td>
<td>(10)</td>
<td>(10)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>(8)</td>
<td></td>
<td>(10)</td>
<td>(10)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(7)</td>
<td></td>
<td>(6)</td>
<td>(6)</td>
<td></td>
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<tr>
<td>(6)</td>
<td></td>
<td>(3)</td>
<td>(6)</td>
<td></td>
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<td></td>
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<tr>
<td>(5)</td>
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<tr>
<td>(4)</td>
<td></td>
<td>(3)</td>
<td>(3)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>(3)</td>
<td></td>
<td>(3)</td>
<td>(3)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Sir Alec Jeffreys, a professor of genetics at the University of Leicester, developed DNA fingerprinting. Used as a criminal tool for the first time in 1988 to convict Colin Pitchfork in the rape/murder of Lynda Mann and Dawn Ashworth in Narborough, England.

- Requires lots of cells (5,000-30,000 cells)
- Requires intact DNA
- Requires a way to distinguish size differences
- Requires the use of radioactive material
Modern Forensic DNA Analysis
Polymerase Chain Reaction (PCR)

Components:

- Water
- Template DNA
- Nucleotides (A, T, G, C)
- Magnesium Chloride/Buffer
- A set of primers per locus
- Taq Polymerase

Assemble in a reaction tube/plate
Place in Thermocycler

95°C … 30 sec
62°C … 30 sec
72°C … 1 min
25-40 cycles

http://www.youtube.com/watch?v=2KoLnIwoZKU

Polymerase Chain Reaction (PCR)

After just 20 PCR cycles
You will have:

1,048,555
carbon copies of the DNA from that specific area in the genome

Source: J. Butler
Highly sensitive

Need between 0.1 to 2.5 ng of DNA to get a full profile with a PCR-based DNA test

1 GRAM (~ 1/25th of an ounce)

= 1,000 mg (miligrams)
= 1,000,000 μg (micrograms)
= 1,000,000,000 ng (nanograms)
= 1,000,000,000,000 pg (picograms)

Each cell has about 6.5 picograms of DNA on average
Polymerase Chain Reaction (PCR)

Chr 8 (D8S1179)

Chr 21 (D21S11)

Chr 7 (D7S820)
Capillary Electrophoresis (CE)

PCR Tube or 96-well plate

Data Acquisition

Detector

Capillary

Modified with permission from: Butler, J; NIST
Capillary Electrophoresis (CE)

Old style Gels

New World electropherograms

CE Instrument: 310, 3100, 3130
Markers

Suspect 1

Suspect II

Suspect 2

Evidence

<table>
<thead>
<tr>
<th></th>
<th>D3</th>
<th>vWA</th>
<th>FGA</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>14,15</td>
<td>17,18</td>
<td>23,24</td>
</tr>
<tr>
<td>S2</td>
<td>15,18</td>
<td>17,19</td>
<td>23.2,24</td>
</tr>
<tr>
<td>E</td>
<td>15,18</td>
<td>17,19</td>
<td>23.2,24</td>
</tr>
</tbody>
</table>
There are more than 100,000 STR markers in the human genome
Electropherograms or “e-grams”
## Modern DNA Profiling

### DNA Profile of “Jane Doe”

<table>
<thead>
<tr>
<th>Locus</th>
<th>allele1</th>
<th>allele2</th>
</tr>
</thead>
<tbody>
<tr>
<td>D18S1179</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>D21S11</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>D7S820</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>CSF1PO</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>D3S1358</td>
<td>14</td>
<td>15</td>
</tr>
<tr>
<td>TH01</td>
<td>8</td>
<td>9.3</td>
</tr>
<tr>
<td>D13S317</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>D16S539</td>
<td>11</td>
<td>12</td>
</tr>
<tr>
<td>D2S1338</td>
<td>19</td>
<td>23</td>
</tr>
<tr>
<td>D19S433</td>
<td>14</td>
<td>15</td>
</tr>
<tr>
<td>VWA</td>
<td>17</td>
<td>18</td>
</tr>
<tr>
<td>TPOX</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>D18S51</td>
<td>15</td>
<td>19</td>
</tr>
<tr>
<td>Amelogenic</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>D5S818</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>FGA</td>
<td>23</td>
<td>24</td>
</tr>
</tbody>
</table>

### Identifiler DNA Testing Kit from ABI/Life Technologies

- Markers not always included in statistical calculations
RFU=Relative Fluorescence Units

Allele Calls for Marker TH01 (8, 9.3)

Balance

RFU or Peak Height (1336)
Artifacts / Anomalies / Challenges

**Technically Induced**
- Dye Blobs
- Pull-Ups
- Spikes

**Biologically Induced**
- Stutter
- Split Peaks
- Microvariants
- Tri-alleles

**Sample Induced**
- Contamination
- Mixtures
- Inhibition
- Low Copy Number DNA (LCN)

- Allele Drop In / Out
- Allele Peak Imbalance
- Complex Mixtures
- Stutters

Wrong Conclusions

Increased Complexity
Allele 8

Dye Blobs

Dye Molecule

The Institute for Advanced Career Development
Pull-Up Peaks

Data on panel 1

Pull-up

Data on panel 2
Spike Peaks

Panel 1

Panel 2

Panel 3

Panel 4

Spikes
Stutter

Most Copies are of Allele 7

-1 Stutter ("allele 6")

+1 Stutter ("allele 8")
Stutter

Allele 11

<15% 10 11 12 <5%

D5S818

150

11 2899
Evidence Sample
Evidence Sample

[Image of a GeneMapper ID v3.2 chart showing genetic markers and peak analysis.]
“Dropouts”
Is allele 12 a stutter peak?
DNA Analysis: Steps

- Sample Collection
- DNA Extraction
- Quantitation
- Amplification
- Electrophoresis
- Data Interpretation
Sample Types

Positive Controls

Negative Controls

Evidence Samples (Qs)

Reference Samples (Ks)
DNA Analysis: Steps

Sample Collection → DNA Extraction → DNA Quantitation → Amplify w/ PCR → Capillary Electrophoresis → Results → Interpretations / Statistics

Re-PCR
Re-inject
Increase Injection time

Contamination?
Optimum amount is 1 nanogram of DNA
Outcomes of Forensic DNA Analysis

- **Match** – Peaks between the compared STR profiles have the same genotypes and no unexplainable differences exist between the samples. Statistical evaluation of the significance of the match is usually reported with the match report.

- **Exclusion (Non-match)** – The genotype comparison shows profile differences that can only be explained by the two samples originating from different sources.

- **Inconclusive** – The data does not support a conclusion as to whether the profiles match. This finding might be reported if two analysts remain in disagreement after review and discussion of the data and it is felt that insufficient information exists to support any conclusion.
Allele Frequency in the Population

<table>
<thead>
<tr>
<th></th>
<th>Frank</th>
<th>Liz</th>
<th>Michelle</th>
<th>Judy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alleles</td>
<td>8 4</td>
<td>8 12</td>
<td>8 12</td>
<td>8 7</td>
</tr>
<tr>
<td>Numbers</td>
<td>14 14</td>
<td>13 12</td>
<td>6 13</td>
<td>8 7</td>
</tr>
</tbody>
</table>
# Allele Frequency in the Population

<table>
<thead>
<tr>
<th>Allele Name</th>
<th>Size of “Population” Surveyed</th>
<th># Chrom. Detected in Population</th>
<th>Allele Frequency</th>
<th>Approx %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allele 4</td>
<td>16</td>
<td>1</td>
<td>0.0625</td>
<td>6%</td>
</tr>
<tr>
<td>Allele 6</td>
<td>16</td>
<td>1</td>
<td>0.0625</td>
<td>6%</td>
</tr>
<tr>
<td>Allele 7</td>
<td>16</td>
<td>2</td>
<td>0.125</td>
<td>12%</td>
</tr>
<tr>
<td>Allele 8</td>
<td>16</td>
<td>5</td>
<td>0.3125</td>
<td>31%</td>
</tr>
<tr>
<td>Allele 12</td>
<td>16</td>
<td>3</td>
<td>0.1875</td>
<td>18%</td>
</tr>
<tr>
<td>Allele 13</td>
<td>16</td>
<td>2</td>
<td>0.125</td>
<td>12%</td>
</tr>
<tr>
<td>Allele 14</td>
<td>16</td>
<td>2</td>
<td>0.125</td>
<td>12%</td>
</tr>
</tbody>
</table>

**Total = 1 or 100%**
Where do these Astronomical Numbers come from?

<table>
<thead>
<tr>
<th>Locus</th>
<th>allele</th>
<th>value</th>
<th>allele</th>
<th>value</th>
<th>1 in</th>
<th>Combined</th>
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<tbody>
<tr>
<td>D3S1358</td>
<td>16</td>
<td>0.2533</td>
<td>17</td>
<td>0.2152</td>
<td>9.17</td>
<td>9.17</td>
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<td>VWA</td>
<td>17</td>
<td>0.2815</td>
<td>18</td>
<td>0.2003</td>
<td>8.87</td>
<td>81</td>
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<tr>
<td>FGA</td>
<td>21</td>
<td>0.1854</td>
<td>22</td>
<td>0.2185</td>
<td>12.35</td>
<td>1005</td>
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<td>D8S1179</td>
<td>12</td>
<td>0.1854</td>
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<td>0.1656</td>
<td>16.29</td>
<td>16,364</td>
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<td>D21S11</td>
<td>28</td>
<td>0.1589</td>
<td>30</td>
<td>0.2782</td>
<td>11.31</td>
<td>185,073</td>
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<tr>
<td>D18S51</td>
<td>14</td>
<td>0.1374</td>
<td>16</td>
<td>0.1391</td>
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<td>D5S818</td>
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<td>0.3394</td>
<td>14</td>
<td>0.0480</td>
<td>30.69</td>
<td>1.38 x 10^9</td>
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<td>D7S820</td>
<td>9</td>
<td>0.1772</td>
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<td>31.85</td>
<td>4.38 x 10^{10}</td>
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<td>9</td>
<td>0.1126</td>
<td>11</td>
<td>0.3212</td>
<td>13.8</td>
<td>6.05 x 10^{11}</td>
</tr>
<tr>
<td>THO1</td>
<td>6</td>
<td>0.2318</td>
<td></td>
<td></td>
<td>18.62</td>
<td>1.13 x 10^{13}</td>
</tr>
<tr>
<td>TPOX</td>
<td>8</td>
<td>0.5348</td>
<td></td>
<td></td>
<td>3.50</td>
<td>3.94 x 10^{13}</td>
</tr>
<tr>
<td>CSF1PO</td>
<td>10</td>
<td>0.2169</td>
<td></td>
<td></td>
<td>21.28</td>
<td>8.37 x 10^{14}</td>
</tr>
</tbody>
</table>

The Random Match Probability for this profile in the U.S. Caucasian population is 1 in 837 trillion ($10^{12}$)
What is it? Forensic Serology

Blood

Saliva

Semen

Urine....& others

**Presumptive Tests:**

**Confirmatory Tests:**

DNA
“Touch” DNA

What is “touch” DNA?

-DNA from potential contact with human skin.
  -Skin cells, Sweat, and oil from skin glands (cell-free DNA).

-Term is used to describe the nature of sample being analyzed.

-Typically:
  -Swabs from surfaces or items like weapons, stolen goods, etc.
    -Samples usually contain small amounts of DNA.
    -Analysis can yield partial DNA profiles.

-The word “touch” can be misleading.

-Analysis cannot prove whether contact was direct or indirect.
Keep in Mind:

DNA evidence is very powerful. It is the best forensic tool available so far to identify a potential perpetrator.

Forensic DNA evidence cannot tell you how, when, and under what circumstances a DNA sample was left at the crime scene.

DNA evidence cannot reveal the source of DNA (blood, semen, etc). DNA from blood will look exactly like DNA from skin.

DNA evidence can be weak and misleading, and the interpretation of that evidence can be highly subjective.
Future Webinar Topics:

- Forensic Serology: Bodily Fluids Identification
- Statistics: Understanding the Weight of DNA Evidence
- The Forensic Laboratory and Quality Assurance Standards (QAS)
- Advanced Topics in Forensic DNA Testing:
  - Mixture Interpretations
  - Mitochondrial DNA Analysis
  - Y-STR DNA Analysis
“Touch” DNA

Where is this “touch” DNA coming from??

Things to Keep in Mind:

Cells
Keratinization
Free DNA

Physiology
Body Secretions
Surface
Secondary Transfer

SWAB
The Forensic Laboratory and Quality Assurance Standards (QAS)
Quality Assurance Standards

- Laboratory Accreditation / Audits
- Laboratory Management / Case Management
- Staff Proficiency / Education
- Validation of instruments, test kits, protocols
- Quality Control, sample prep, processing, integrity
- Results and Interpretations Standards

*The Laboratory “Should” establish most standards*
Quality Assurance Standards

Organization of Scientific Area Committees (OSAC)

Forensic Science Standards Board (FSSB)

Legal Resource Committee (LRC)

Quality Infrastructure Committee (QIC)

Human Factors Committee (HFC)

SAC Biology/DNA
- DNA Analysis Sub 1
- DNA Analysis Sub 2
- Wildlife Forensics Sub

SAC Chemistry/Instrumental Analysis
- Controlled Substances Sub
- Fire Debris and Explosives Sub (lab)
- Geological Materials Sub
- Gunshot Residue Sub
- Materials (Trace) Sub
- Toxicology Sub

SAC Crime Scene/Death Investigation
- Anthropology Sub
- Disaster Victim Identification Sub
- Dogs and Sensors Sub
- Fire Scene and Explosives Sub
- Medical/Legal Death Invest Sub
- Odontology Sub

SAC IT/Multimedia
- Facial Identification Sub
- Imaging Technologies Sub
- Speaker Recognition Sub

SAC Physics/Pattern
- Blood Stain Pattern Analysis Sub
- Friction Ridge Sub
- Firearms & Toolmarks Sub
- Footwear & Tire Tread Sub
- Questioned Documents Sub

SAC = Scientific Area Committee
Sub = Subcommittee

Source: www.nist.gov

March 15, 2014
Lab Discovery

Full Case File (will vary slightly based on the laboratory)

Evidence Submission Forms

Lab reports: Final as well as any/all rescinded / cancelled reports

Evidence Packaging / Analyst Notes

Serology Analysis / Analyst Notes

DNA Work Sheets / Analyst Notes:
- DNA Extraction
- Quantitation
- Amplification
- Electrophoresis (e-grams and raw data if needed)
- Allele calls/Data tables
- Statistical analyses
- Controls
Lab Discovery—cont.

Technical and Administrative reviews
Chain of Custody documents
Case-related e-mails and communication
CODIS submission documents
Photographs of evidence (if any)
Analyst CV
Contemporaneous and recent revision of
SOPs and protocols for analysis and interpretation

Quality Assurance Records:
- QA Manual
- Lab accreditation and audits
- Non conformity records
- Corrective Action records
Preservation of Evidence
Questions
Thank you:

For Questions or Comments:

Please send an e-mail to Dr. Max Noureddine:

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