NGS: Possible Applications for Forensic DNA Analysis
What does the Person of Interest Look Like?

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Can NGS Technology Be Used For Next-Generation Human DNA Identification?

When the person of interest is not in the DNA database, can we take advantage of advances in genetic analysis to provide investigative leads on the person of interest?

What do they look like?

The FBI is not conducting human genomic sequencing on reference or crime scene samples.
Evolution Of DNA Identification

**PAST**
- RFLP (≈ 6-8 Weeks)

**PRESENT**
- 13 core STRs (≈ 1 day-1wk)
- RAPID DNA (≈ 1 hr)

**FUTURE**
- NGI
- Sequencing
  - STR, mtDNA
  - Y-STR, SNP

Legend:
- Ladder
- Control
- Suspect 1
- Suspect 2
- Suspect 3
- Case #1
- Boy Friend
Combined DNA Index System

Mission

CODIS blends forensic science and computer technology into an effective tool for solving violent crimes. CODIS enables Federal, State, and local crime laboratories to exchange and compare STR DNA profiles electronically.
Brief Chronology

- **CODIS** - pilot project 1990 - 14 state and local labs

- **DNA Identification Act of 1994** - FBI’s authority to establish a National DNA Index System (NDIS). **Required FBI to establish National Standards for Forensic and Database DNA Analysis.** Samples in NDIS must meet FBI QAS. FBI establishes NDIS Custodian.

- *October 1998* - FBI’s NDIS became operational with 9 states participating

- **DNA Analysis Backlog Elimination Act of 2000** – Authorizes collection of DNA samples from Federal convicted offenders (FCO)

- **Justice for All Act of 2004** – Indicted Persons at NDIS, One-Time Search Capability, Accreditation & Audit, All Felonies for FCO

- **DNA Fingerprint Act of 2005** – Arrestees & Legally Collected Samples at NDIS, Elimination of One-Time Search, Arrestees and Detainees for FCO
CODIS Participants

CODIS/NDIS Laboratories
190 in 50 states, FBI, US Army Crime Laboratory, Puerto Rico and Washington, DC.

Users
Over 2,000 authorized users

International
73 Labs in 37 countries
Database Connectivity

Clarksburg, WV

Secure network connecting all public DNA laboratories in the USA - allows searches and match messaging.
NDIS Indexes

Convicted Offender

Forensic

Missing Persons

Arrestee

Legal

Unidentified Human (Remains)

Relatives of Missing Person
Compare the Target Profile to the Candidate Profile - They match at the 13 CORE CODIS loci
POPSTATS- used to calculate the random match probability.
CODIS Investigations Aided
Through April 30, 2012

171,052 Offender /Arrestee Hits
28,515 Forensic Hits

The Investigations Aided metric tracks the number of criminal investigations where CODIS has added value to the investigative process.
# NDIS Statistics

As of April 30, 2012

<table>
<thead>
<tr>
<th>Category</th>
<th>Total Number of Profiles</th>
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<tbody>
<tr>
<td>Offender Profiles</td>
<td>9,629,475</td>
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<tr>
<td>Arrestee</td>
<td>1,077,436</td>
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<tr>
<td>Detainee, Legal</td>
<td>4,127 &amp; 7,681</td>
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<tr>
<td>Forensic Profiles</td>
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<tr>
<td>Missing Person</td>
<td>1,025</td>
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<tr>
<td>Rel. of Missing Person</td>
<td>5,779</td>
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<tr>
<td>UnID’ d Human Remains</td>
<td>4,101</td>
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<tr>
<td>Pedigree Trees</td>
<td>2,832</td>
</tr>
</tbody>
</table>
NGS and Human Forensic Analysis

- **Sensitivity (200-300 pg CODIS STRs)**
  Forensic Samples: degradation, mixtures, inhibitors

- **mtDNA**: Missing Person (bone/teeth) – hair

- **Y-STR**: male-female mix., male missing per.

- **SNPs**
  - BioGeographic Ancestry
  - Phenotype
  - Lineage/Clan
  - Identity By Decent
NGS and Human Forensic Analysis

Issues

- Technology/Chemistry
- Assembly/Alignment
- Standards for Data Exchange - (NAS)
- BioInformatic Hard/Software and Expertise
- Sample Prep – Labor, dedicated space
When the person of interest is not in the DNA database, can we take advantage of advances in genetic analysis to provide investigative leads on the person of interest?

**CODIS STR, mtDNA, Y-STR, X-STR**

What do they look like?

**SNPs**
Baton Rouge Serial Killer: Derrick Todd Lee
- Linked to at least 7 homicides in Louisiana
- Many arrests over 20 years
- No felony convictions
- Composite sketch
- AIM SNPs analysis
- Louisiana passes arrestee DNA law
Before the FBI would apply NGS to crime scene sample analysis, it would have to gain approval from FBI and DOJ executive management and establish well thought out rules and policies in order to maintain public trust in forensic DNA analysis.
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