



2022 SPRING SYMPOSIUM

This certifies that

Searchin Girl

has completed a 5-hour webinar entitled:

*"Can New Forensic Technology
Solve the JonBenet Ramsey Case?"*

April 26, 2022



Henry Lee

Dr. Henry C. Lee

Founder and Distinguished Professor

DNA evidence in the JonBenét Ramsey cold case

Overview, considerations, & recent advancements in DNA technology



THE HENRY C. LEE
INSTITUTE OF
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at the University of New Haven

Dr. Angie Ambers, Forensic Geneticist
Assistant Director - Henry C. Lee Institute of Forensic Science
Associate Professor - Henry C. Lee College of Criminal Justice & Forensic Sciences
University of New Haven, West Haven, Connecticut 06492

University of
New Haven

Can recent advancements in DNA technology solve the JonBenét Ramsey cold case???



"Timing is everything for DNA"
Year of death: 1996

Contamination prevention measures for DNA testing were not as stringent in 1996. Today's "increased sensitivity methods" allow us to detect very small amounts of DNA – but this is a bit of a "double-edged sword" because it also enables us to detect exogenous DNA (from DNA transfer) that is potentially unrelated to the crime. Also, DNA degrades over time....

Forensic DNA methods: Changes & improvements over time

The size of the blood sample necessary for RFLP

The size of the blood sample necessary for PCR

Primary differences between early DNA methods vs. current technologies:

- Better DNA markers (higher discriminatory power)
- FBI-mandated **13** core CODIS loci (1997-2016)
- FBI-mandated **20** core CODIS loci (2017-present)
- More DNA markers available for testing
- Speed-of-analysis has increased
- **Higher sensitivity**

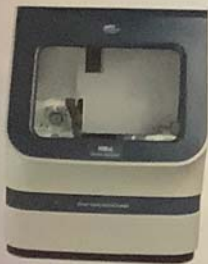
Higher sensitivity and improved/better technology translates into more DNA data. Is **“more”** always **better in older cases and/or cold cases??**

- Potential DNA transfer issues (mishandling)
- Increased chance of detection of DNA contamination

Traditional Forensic DNA Testing – FBI-mandated markers

Autosomal Short Tandem Repeats (Autosomal STRs)

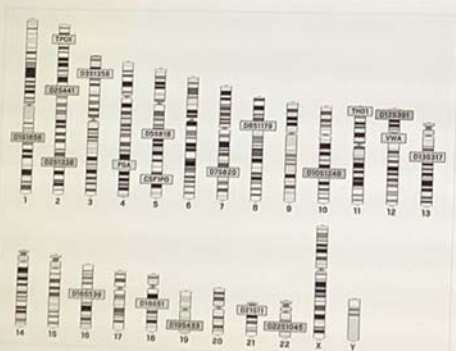
- Autosomal short tandem repeats (STRs)
- Current mainstay for human identity testing
- High discrimination power (20 CODIS loci)
- Fragment analysis (length polymorphism)
- No context without exemplars for comparison
- No context without DNA database hit
- Additional tests needed for investigational leads



Capillary electrophoresis (CE)
3500xl Genetic Analyzer



STR profile (electropherogram)



Locus
CSF1PO
D3S1358
D5S818
D7S820
D8S1179
D12S317
D16S539
D18S51
D21S11
FGA
TH01
TPOX
vWA
D1S1656
D2S441
D2S1338
D10S1248
D12S391
D19S433
D22S1045

Original 13 core
CODIS loci
(1997-2016)

Expanded set
Implemented
January 2017

Traditional DNA Casework (STR Genotyping) vs. Next Generation Sequencing (NGS)

A Paradigm Shift in Forensic Genetics



Next Generation Sequencing (NGS) Verogen's ForenSeq DNA Signature Prep Kit

ForenSeq DNA Signature Prep Kit

First NGS-based STR sequencing chemistry approved for upload to the National DNA Index System (NDIS) for casework



Simultaneous analysis of ~ 200 DNA markers

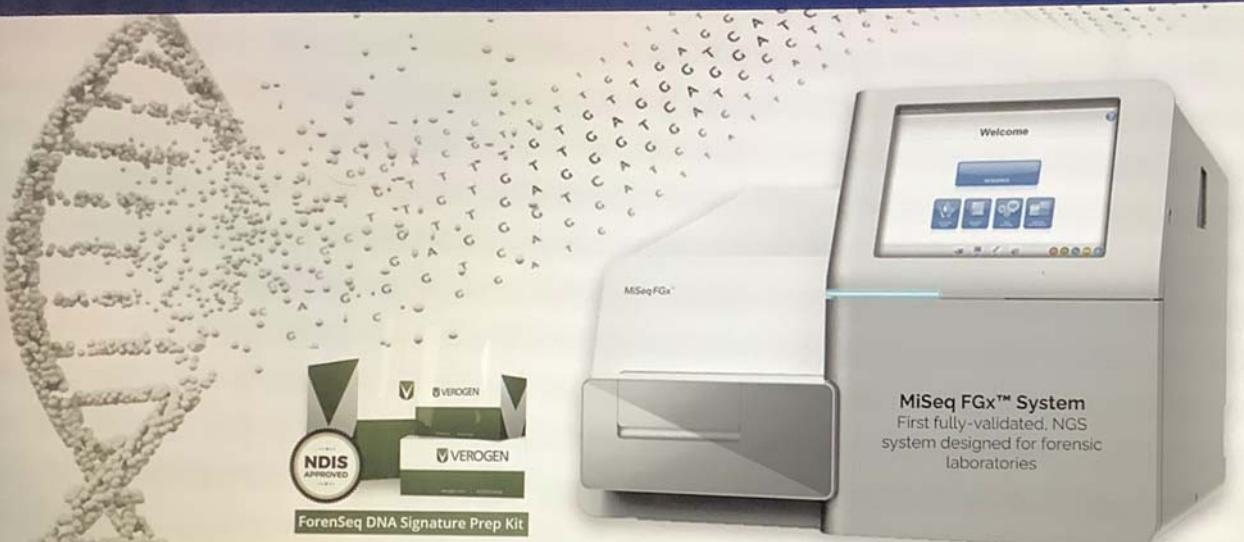
Table 1: ForenSeq DNA Signature Prep Kit—Forensic LocI

Feature	Number of Markers*	Amplicon Size Range (bp)	Included in DNA Primer Mix A	Included in DNA Primer Mix B [†]
Global Autosomal STRs	27	61–467	Yes	Yes
Y-STRs	24	119–390	Yes	Yes
X-STRs	7	167–462	Yes	Yes
Identity SNPs	94	63–231	Yes	Yes
Phenotypic SNPs	22	73–227	No	Yes
Biogeographical Ancestry SNPs	66	67–200	No	Yes

High concentration of amplicon sizes < 200bp
**Greater success with challenging, degraded samples

ForenSeq DNA Signature Prep Kit & MiSeq FGx™ System

First fully-validated NGS system designed for forensic laboratories



MISeq FGx™

Welcome

MISeq FGx™ System
First fully-validated, NGS
system designed for forensic
laboratories

VEROGEN

VEROGEN

NDIS APPROVED

ForenSeq DNA Signature Prep Kit

Forensic examination of hair evidence



- Microscopic comparison between hair evidence & reference samples
- DNA testing if "foreign" hairs are present

1. mtDNA testing (hairs without roots) → low discriminatory power (maternal inheritance)

2. nuclear DNA testing (hairs with root or follicular tissue) → high discriminatory power (CODIS STRs)

**New technology → nuclear DNA testing (CODIS STRs) on rootless hairs

Nuclear DNA testing of rootless hairs



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[DNA Forensic Services](#)

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[About Bode Technology](#)

DNA from Rootless Hairs

[DNA from Shell Casings](#)

[DNA from Rootless Hairs](#)

[Sampling and Serology](#)

[Automation](#)

[STRs and Y-STRs](#)

[STRmix](#)

[Rapid DNA](#)

[Massively Parallel Sequencing](#)

[COVID-19 Testing](#)

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[Bode Technology](#)

NEW: Bode X-traction™ Technology: DNA from Rootless Hairs

[Learn More: Click Here for On Demand Webinar](#)

Bode Technology introduces a NEW proprietary, advanced DNA extraction from spent shell casings and rootless hairs. Kristen Naughton will present about how Bode's solution can be applied to sampling methods and how using Bode X-traction we may now be able to obtain ~10 X more DNA from the thousands of shell casings and obtain useable nuclear DNA profiles from challenging cases containing as little as a single hair.

Presenter: Kristen Naughton, Director of Validation and Training, Bode Technology

**BODE
X-TRACTION™**
MORE DNA FROM SHELL
CASINGS & ROOTLESS HAIRS



DNA from Rootless Hairs

Bode Technology introduces a NEW proprietary, advanced DNA extraction process that can be applied to rootless hair shafts.

Use **Bode X-traction™** to solve your rootless hair cases.

Bode X-traction - Detect **Nuclear** DNA from a Single, Rootless Hair

DNA from rootless hairs may be fragmented or severely degraded. **Bode X-traction technology can be used to obtain useable DNA profiles from challenging cases containing as little as a single hair.**

Bode X-traction is a proprietary technique for DNA recovery that can be used to obtain CODIS eligible profiles from nuclear DNA recovered from rootless hair shafts.



<https://www.bodetech.com/dna-rootless-hairs>

Nuclear DNA testing of rootless hairs



DNA LABS
INTERNATIONAL
EXPERIENCE · TECHNOLOGY · RESULTS

DNA Labs International
700 W. Hillsboro Boulevard (Building 3)
Deerfield Beach, Florida 33441
Phone: (954) 426-5163
www.dnalabsinternational.com

STR DNA Results From Rootless Hair Shafts

New! Hair Shaft Testing

We implemented a new specialized DNA extraction method and amplification kits with increased sensitivity that have allowed for DNA Labs International to obtain an STR DNA profile from the hair shaft.

- Only 1-3 cm piece of hair required
- NEW Technology (Kits) & NEW DNA Analysis Software

Prior to this technology, only Mitochondrial DNA (mtDNA) could be obtained from hair shafts, and mtDNA only links an individual to a maternal line. Additionally, some mtDNA profiles are very common among the general population. STRs are unique to each individual.

<https://dnalabsinternational.com/services/#dna>



Microscopic Hair Comparisons (PCAST - FBI study)

REPORT TO THE PRESIDENT
Forensic Science in Criminal Courts:
Ensuring Scientific Validity
of Feature-Comparison Methods

Executive Office of the President
President's Council of Advisors on
Science and Technology

September 2016



President's Council of Advisors on Science
and Technology (Obama Administration)
2016

The DOJ's supporting document also cites a 2002 FBI study that used mitochondrial DNA analysis to re-examine 170 samples from previous cases in which the FBI Laboratory had performed microscopic hair examination. But that study's key conclusion does *not* support the conclusion that hair analysis is a "valid and reliable scientific methodology." The FBI authors actually found that, in 9 of 80 cases (11 percent) the FBI Laboratory had found the hairs to be microscopically indistinguishable, the DNA analysis showed that the hairs actually came from *different* individuals.

In 9-of-80 cases (11%) → hair samples found to be microscopically indistinguishable were proved to have actually originated from different individuals through DNA testing

Colorado police reexamine DNA evidence in JonBenet Ramsey case

Dec. 20, 2021 at 4:25 pm | Updated Dec. 20, 2021 at 9:16 pm

December 20, 2021

25-year anniversary

**Unknown DNA (underwear)
"Touch" DNA (long johns)**

Boulder Police announced that nearly 1000 DNA samples have been analyzed, including 750 reference samples, through the Colorado Bureau of Investigation.

Unidentified (foreign) DNA does not match any of the suspects or persons-of-interest in the case



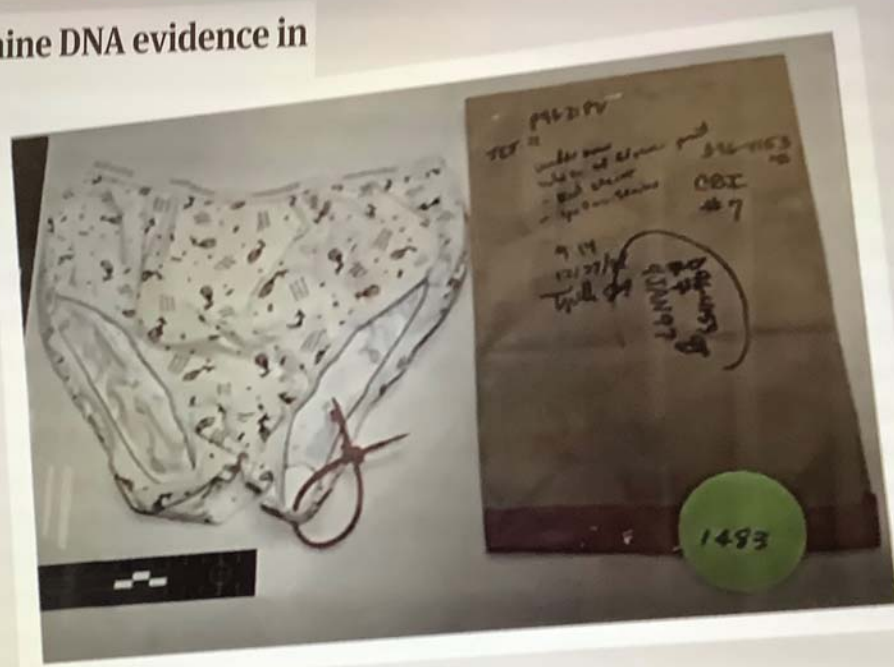
<https://www.seattletimes.com/nation-world/colorado-police-reexamine-dna-evidence-in-jonbenet-ramsey-case/>

Colorado police reexamine DNA evidence in JonBenet Ramsey case

Dec. 20, 2021 at 4:25 pm | Updated Dec. 20, 2021 at 9:16 pm
December 20, 2021
25-year anniversary

Unidentified (unknown) male DNA in underwear (not derived from semen) **does not match** any of the suspects or persons-of-interest in the Ramsey case

No "hits" in FBI's CODIS database (which includes genetic profiles from more than 20 million known offenders and arrestees)



Colorado police reexamine DNA evidence in JonBenet Ramsey case

Dec. 20, 2021 at 4:25 pm | Updated Dec. 20, 2021 at 9:16 pm

December 20, 2021

25-year anniversary



Unidentified (unknown) "touch DNA" recovered from waistband of long johns **does not match** any of the suspects or persons-of-interest in the Ramsey case

No "hits" in FBI's CODIS database (which includes genetic profiles from more than 20 million known offenders and arrestees)



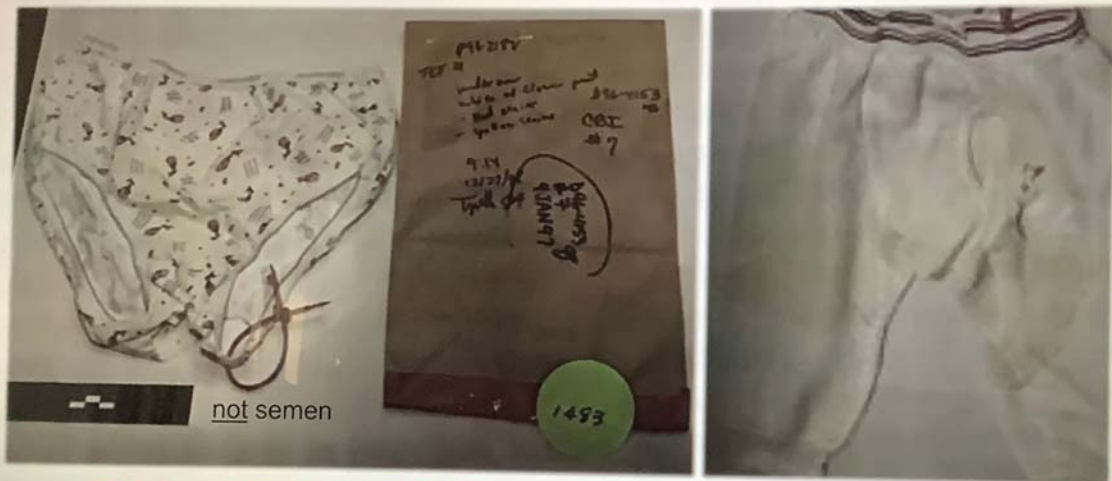
Unidentified DNA in JonBenét Ramsey's underwear (Bloomies)
& "touch DNA" on waistband of long johns



Theory #1 → this DNA originated from the perpetrator

Theory #2 → this DNA is exogenous (unrelated to the crime)

Unidentified DNA in JonBenét Ramsey's underwear (Bloomies) & "touch DNA" on waistband of long johns



Theory #1 → this DNA originated from the perpetrator

No "hits" in FBI's CODIS database (includes DNA profiles from more than 20 million known offenders and arrestees)



- Offender Index
 - convicted criminal offenders
- Forensic Index
 - crime scene evidence (no suspects)
 - crime scene evidence (no matches)
- Arrestee Index
 - certain states & certain offenses only
- Missing Persons Index
 - unidentified human remains
 - biological relatives of missing persons

The FBI's DNA database --- called CODIS (Combined DNA Indexing System) --- is vastly "incomplete"

Contains DNA profiles of those who have been caught ("convicted offenders") and, in some states, arrestees

- 1) What if a DNA profile is obtained from an item of evidence, uploaded into CODIS for comparison, and does not result in a "hit"? (i.e., a match to a known profile in the database)
- 2) What if the DNA profile obtained from an item of evidence does not match any of the suspects or persons-of-interest?
- 3) What if the perpetrator dies before getting caught?

COLD CASE

Solving Crimes using Relatives' DNA: Forensic Genetic Genealogy (FGG) and Familial DNA Searching (FDS) Applications for Casework



Keynote speakers:



Dr. Henry Lee
Emeritus Professor
Forensic Science Dept
Founder/Director
Henry C. Lee Institute
Cold Case Consultant



Dr. Colleen Fitzpatrick
Founder, Identifinders International
Pioneer/Founder, Forensic Genealogy
Member, The Vidocq Society
Cold Case Consultant



Rockne Harmon, JD
Sr. Deputy District Attorney (Ret.)
Prosecutor, O.J. Simpson case
Int'l Homicide Investigators Assoc.
Cold Case Consultant



Dr. Angie Ambers
Associate Professor
Forensic Science Dept
Assistant Director
Henry C. Lee Institute
Cold Case Consultant

Identifinders
INTERNATIONAL



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DNArock@aol.com



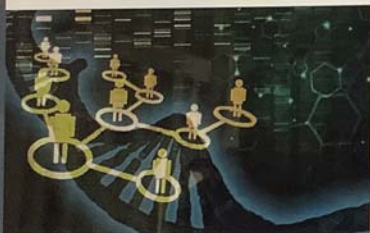
Familial DNA Searching (FDS) & Forensic Genetic Genealogy (FGG)

- Forensic investigative techniques to identify relatives of a perpetrator in DNA databases
- CODIS “high-stringency” database search = exact match only
- FDS CODIS database search = can identify relatives of the perpetrator *Searching for similarities in DNA that indicate relatedness (not looking for an “exact match”)
- FGG involves comparisons to public (direct-to-consumer, DTC) genealogy/ancestry databases (e.g., GEDmatch)



Familial DNA Searching: Current Approaches

FINAL REPORT



Report Date: January 2015



National Institute of Justice
Office of Investigative and Forensic Sciences
810 Seventh Street, N.W.
Washington, D.C. 20531
Award #2011-DN-BX-K564



Project Team

Dr. Bruce Budowle – UNTHSC
Mr. Rockne Harmon – former prosecutor (retired)
Dr. Angie Ambers – UNTHSC
Dr. Patricia Melton – RTI International
Mr. Shane Hamstra – RTI International

<https://forensiccoe.org/report-familial-dna-searching/>
<https://rti.connectsolutions.com/p49ix1rzbp/>

U.S. state	Year FDS adopted
Colorado	2007
California	2008
Texas	2010
Virginia	2011
Wyoming	2011
Florida	2012
Michigan	2012
Pennsylvania	2012
Minnesota	2013
Utah	2014
Wisconsin	2014
New York	2017

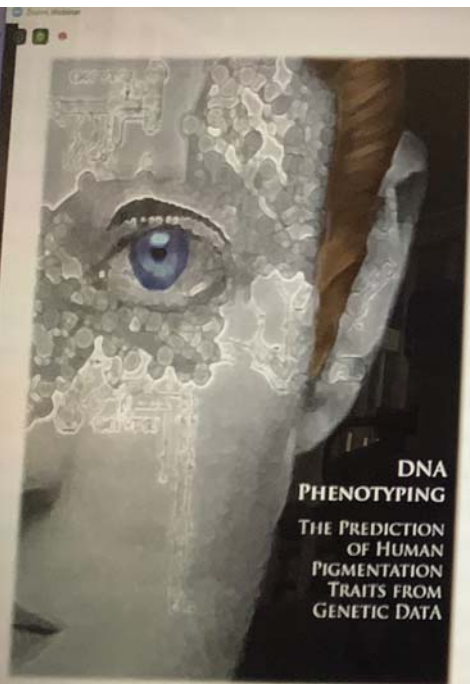
Familial DNA Searching: Success Stories

Snapshot of successes in solving violent crimes and cold cases with the use of Familial DNA Searching (FDS). Three cases resulted in the exoneration of wrongfully convicted individuals who had been imprisoned for numerous years...
(Reference: 2015 FTCOE/NIJ Report, Appendix)



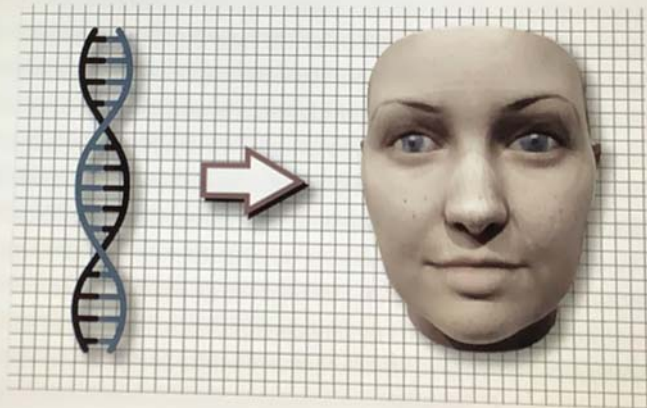
Recent Successes Using Familial DNA Searching to Solve Violent Crimes and Cold Cases

Year	Jurisdiction	Case/Defendant	Offense/Date
2002	U.K.	"Saturday Night Strangler" (Joseph Kappen)	serial rape/homicide (3 victims) (1973)
2003	U.K.	Jason Thomas Ward	rape/homicide (2002)
2003	U.K.	Jeffrey Guboor	homicide (1988)
2004	U.K.	Daniel Aderson	rape (1992-1997)
2004	U.K.	Craig Harman	manslaughter (2003)
2004	North Carolina	Willard Brown*	rape/homicide (1984)
2005	Kansas	"BTK Killer" (Dennis Rader)	serial homicide (10 victims) (1974-1991)
2006	U.K.	"The Shoe Rapist" (James Lloyd)	serial rape (1980s)
2006	U.K.	Christopher Downes	rape (1984-1985)
2006	U.K.	Graham Darbyshire	rape (2 victims) (1993-1995)
2006	U.K.	Tahir Mahmood	rape (1993)
2006	U.K.	Ian O'Callaghan	rape/homicide (1994)
2007	U.K.	Ronald Gostree**	rape/homicide (1975)
2007	U.K.	Geoffrey Godfrey	rape (1993)
2008	U.K.	Russell Bradbury	rape (1986)
2008	U.K.	Dale Burrows	rape (1989)
2008	New Zealand	Wayne Jarden	rape (2 victims) (1988-1996)
2008	U.K.	Derek Young	serial rape (3 victims) (1990-1994)
2008	U.K.	James Ben Davies	serial rape (3 victims) (1998-2000)
2008	U.K.	David Newton	serial rape (3 victims) (1997-2006)
2009	U.K.	David Lacey***	homicide (1979)
2009	U.K.	Robert Morley	homicide (1985)
2009	U.K.	Harry Musson	rape (1990)
2009	New Zealand	Joseph Reekers	homicide (2001)
2009	Denver, Colorado	Luis James-Tinajero	automobile thefts
2010	U.K.	Paul Stewart Hutchinson	homicide (1983)
2010	U.K.	Phil Collins	rape (1990)
2010	U.K.	"Isle of Wight Rapist" (Keith Davison)	rape (1990)
2010	California	"The Grim Sleeper" (Lomnie David Franklin Jr.)	serial homicide (10 victims) (1985-2010)
2011	U.K.	Robert Sains	rape (1989)
2011	California	Elvis Lorenzo Garcia	rape (2008)
2011	U.K.	Kevin Holmes	rape (2010)
2012	California	James Brown	rape/homicide (1978)
2012	U.K.	"Pot-bellied Rapist" (Michael Acey)	rape (1984)
2012	U.K.	David Bryant	kidnapping/rape (4 victims) (1982-1995)
2012	Texas	Jack Wesley Melton	homicide (1994)
2012	U.K.	Jon Molt	rape (1997)
2012	U.K.	Keith Henderson	rape (2001)
2012	California	"Roaming Rapist of Sacramento" (Dereck Sanders)	serial rape (10 victims) (1998-2003)
2013	U.K.	Barry Howell	rape (1989)
2013	U.K.	Salvador Orozco	rape (1990)
2013	U.K.	Ian Phipps	rape (2 victims) (1986-1991)
2013	U.K.	Hillard Matthews	rape (1992)
2014	Virginia	Tyrone Lamont Holloway	rape (2001)
2014	Wisconsin	Michael L. Dixon	serial rape (2002-2012)
2014	Wisconsin	Antoine Devon Pettis	rape (2014)



Forensic DNA Phenotyping

- Prediction of the externally visible characteristics (EVCs) of a perpetrator using DNA left behind at a crime scene
- Can provide “investigational leads” in cold cases, or cases in which there are no suspects and/or no match in the FBI’s CODIS database



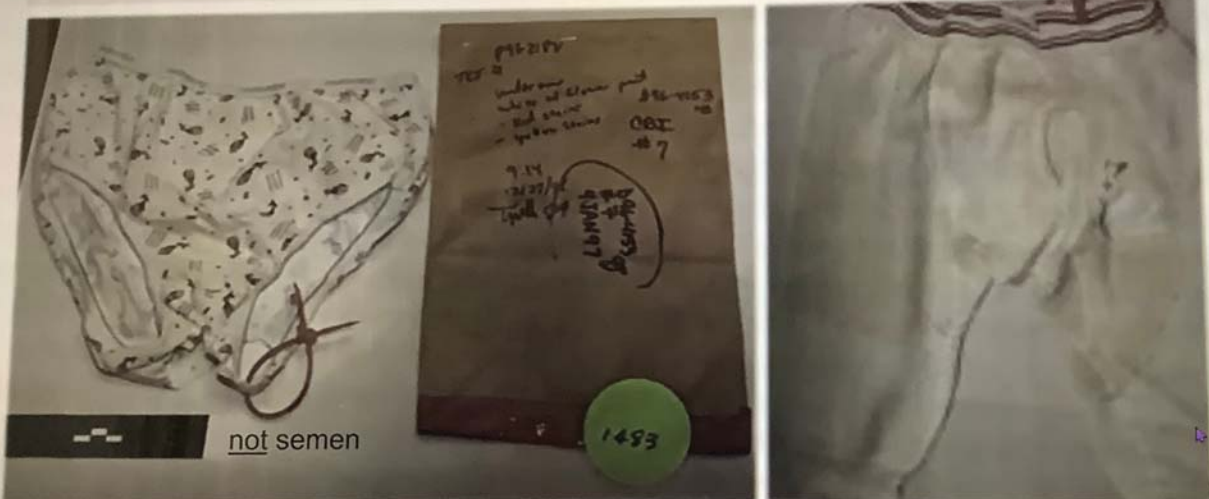
What can DNA phenotyping currently predict?

- **Eye color** – 77 genes identified
- **Hair color** – 32 genes identified
- **Skin color** – 31 genes identified

- **Biogeographic ancestry (ethnicity)**
Currently accurate for broad categories, such as European, African, Asian, Hispanic

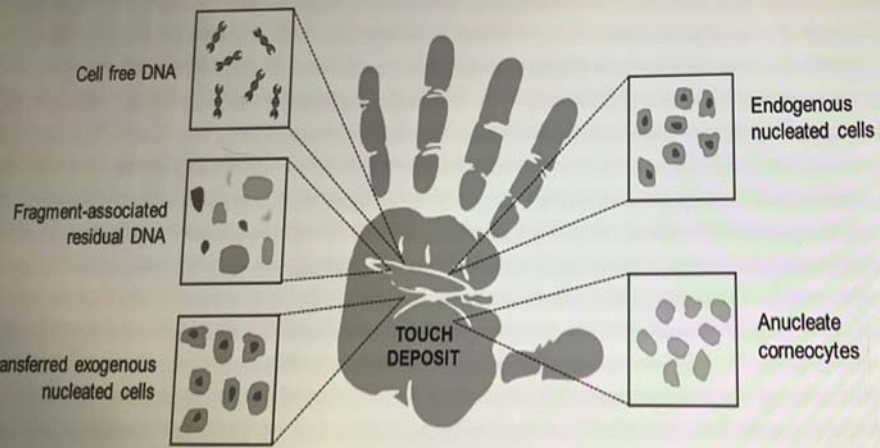


Unidentified DNA in JonBenét Ramsey's underwear (Bloomies) & "touch DNA" on waistband of long johns



Theory #2 → this DNA is exogenous (unrelated to crime)
Possible DNA transfer or contamination?

Increased sensitivity is a “double-edged sword” “Touch DNA” and DNA transfer



New methods offer improved ability to detect low quantities of DNA...but it also increases our chances of detecting contaminant and/or exogenous DNA unrelated to the crime

Direct DNA transfer
Secondary DNA transfer

RE: Unidentified DNA in JonBenét Ramsey's underwear (Bloomies)
Exploratory testing by Henry C. Lee Institute of Forensic Science



DNA testing was performed on brand new (unopened, packaged) underwear from the same manufacturer. Purchased specifically for this exploratory testing.

DNA profiles were recovered despite the underwear having never been worn by anyone.

Likely DNA transfer from handling during manufacturing & packaging

RE: Unidentified DNA in JonBenét Ramsey's underwear (Bloomies)
"Forensic DNA Grade" implementation & DNA transfer considerations

ISO 18385

Forensic DNA Grade

Due to "increased sensitivity" DNA methods, laboratories have had to implement the use of **Forensic DNA Grade (ISO 18385)** products for human identification testing (and to consider the potential for presence of exogenous DNA on evidentiary items).



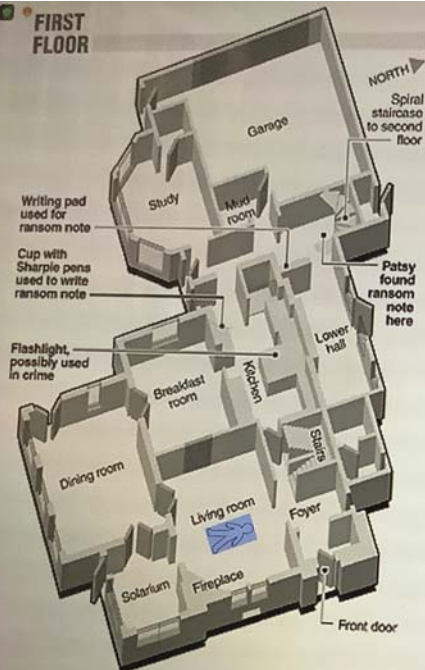
Why implementation of ISO 18385 Forensic DNA Grade Products???

- Exogenous DNA previously detected on products used for forensic DNA testing (tied to manufacturer)

Considerations for unwashed (new) items

- Plastic or other types of packaging of new items (e.g., clothing) seemingly implies sterility and cleanliness, although such items have been shown to contain exogenous human DNA (likely deposited during handling, packaging, manufacturing)

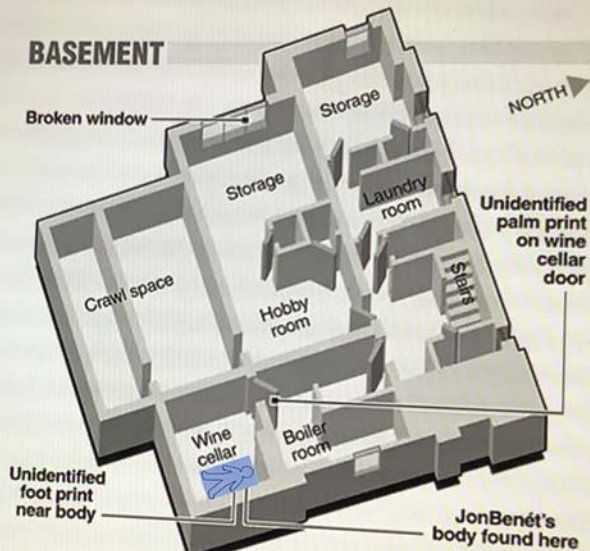
FIRST FLOOR



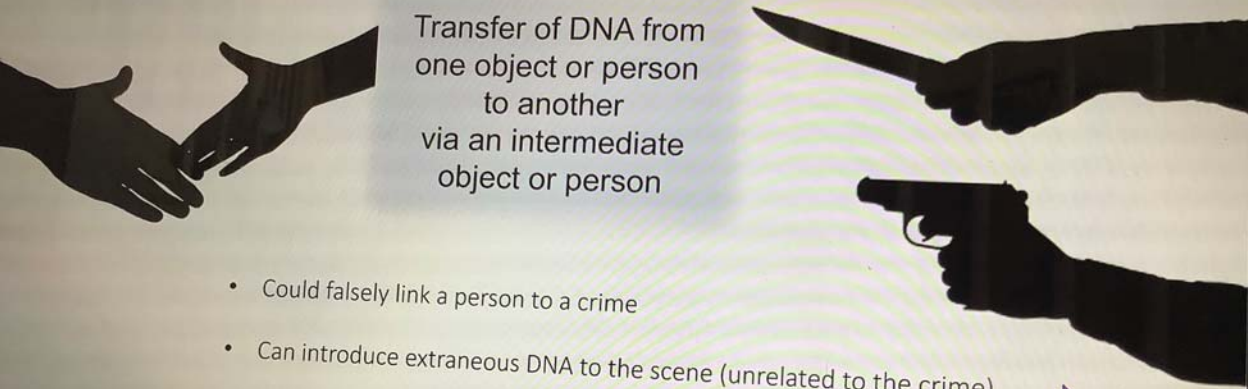
Crime scene was compromised

Multiple DNA transfer events likely

BASEMENT



Secondary DNA Transfer

The slide features two sets of black silhouettes. On the left, two hands are shown in a shaking gesture. On the right, one hand holds a knife pointing towards the center, and another hand below it holds a handgun pointing towards the center. A central text box is overlaid on the background.

Transfer of DNA from
one object or person
to another
via an intermediate
object or person

- Could falsely link a person to a crime
- Can introduce extraneous DNA to the scene (unrelated to the crime)
- Could lead analysts to falsely conclude that DNA left on an item of evidence is due to direct contact (or that it is even related to commission of the crime)

TECHNICAL NOTE
CRIMINALISTICS

Cynthia M. Cale,^{1,2} B.S.; Madison E. Earll,² M.S.; Krista E. Latham,² Ph.D.; and Gay L. Bush,¹ Ph.D.

Could Secondary DNA Transfer Falsely Place Someone at the Scene of a Crime?*,†



ABSTRACT: The occurrence of secondary DNA transfer has been previously established. However, the transfer of DNA through an intermediary has not been revisited with more sensitive current technologies implemented to increase the likelihood of obtaining results from low-template/low-quality samples. This study evaluated whether this increased sensitivity could lead to the detection of interpretable secondary DNA transfer profiles. After two minutes of hand to hand contact, participants immediately handled assigned knives. Swabbings of the knives with detectable amounts of DNA were amplified with the Identifiler® Plus Amplification Kit and injected on a 3130xl. DNA typing results indicated that secondary DNA transfer was detected in 85% of the samples. In five samples, the secondary contributor was either the only contributor or the major contributor identified despite never coming into direct contact with the knife. This study demonstrates the risk of assuming that DNA recovered from an object resulted from direct contact.

KEYWORDS: forensic science, criminalistics, DNA analysis, secondary transfer, forensic casework, Identifiler® Plus

Demonstrates risk of assuming that DNA recovered from an object resulted from direct contact

Secondary DNA Transfer via Shaking Hands

Simulated stabbing study

Experimental Group #1:
"Secondary contributors"

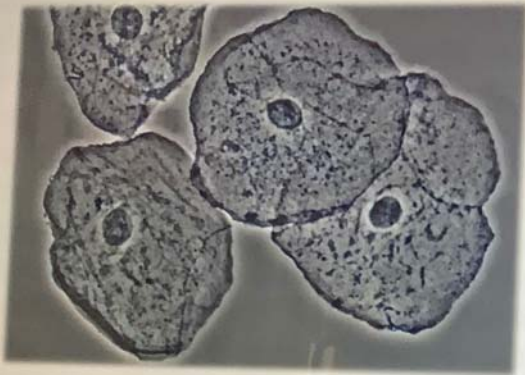


Experimental Group #2:
"Primary handlers"



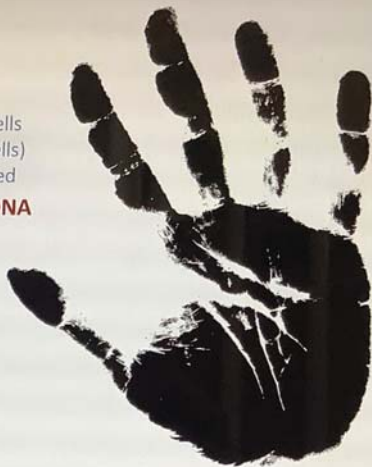
- "Secondary contributors" – shook hands w/primary handler
- "Primary handlers" – handled knives directly
- DNA typing results obtained from 20-out-of-24 knife handles
- 2 single-source DNA profiles; 18 DNA mixtures
- 5 knife handles – "secondary contributor" identified as the only contributor or the major contributor, despite never touching the knife

Epithelial (skin) cell
"Shedder Status"



Dead skin cells
(epithelial cells)
are nucleated

Nucleus = DNA



- Every contact by a person's hand is a potential opportunity to deposit (leave behind) skin cells or pick them up for transfer to another object, surface, or person
- Some people are classified as "high DNA shedders;" others are "low DNA shedders" (differences do exist)
- Several studies now have demonstrated a significant difference amongst individuals in tendency to shed skin cells and therefore deposit DNA on touched objects

“Shedder Status”
(differs between individuals)

Low shedders

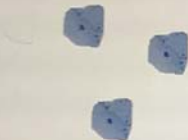


High shedders

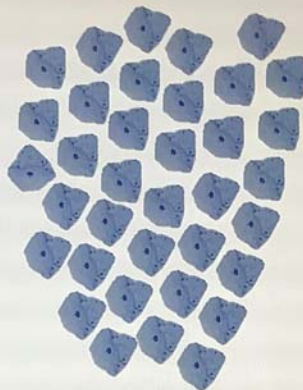


“Shedder Status” (differs between individuals)

Low shedders



High shedders



Note on the
“Intruder Theory”

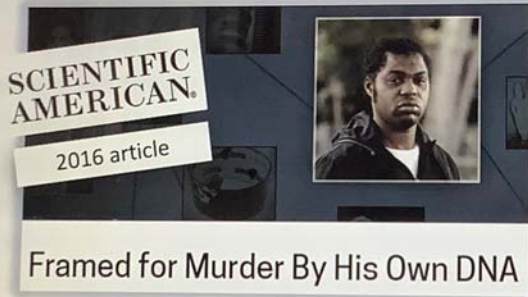
“Absence of
evidence is not
evidence of
absence”

Low shedder
Gloves/mask
Other precautions
Testing (detection)
limitations

BIOLOGY

When DNA Implicates the Innocent

The criminal justice system's reliance on DNA evidence, often treated as infallible, carries significant risks



https://www.pbs.org/wgbh/frontline/article/framed-for-murder-by-his-own-dna/?utm_source=TWITTER&utm_medium=social&utm_term=20180730&utm_content=1694490706&utm_campaign=Frontline%20Season%2036&linkId=54918856

<https://www.scientificamerican.com/article/when-dna-implicates-the-innocent/?print=true>

Lukis Anderson's DNA was found on the victim's fingernails



Anderson's DNA was found on fingernail clippings from Ravesh Kumra's right hand. (San Mateo County Crime Laboratory)

7:54pm

A 7-Eleven store clerk calls local police to report Lukis Anderson drunk in front of store. A few hours later, Anderson stumbles into another local convenience store & collapses in aisle. Store clerk calls 911

10:45pm

Anderson admitted to hospital for severe intoxication. Official medical records stated "patient inebriated to point of unconsciousness" (stayed overnight in hospital)

Alibi

"blackout drunk" (blood alcohol content was five times the legal limit)

Time of Kumra's homicide → between 11:30pm – 1:30am



How Innocent Man's DNA Was Found at Horrific California Murder Scene

Same paramedics and ambulance that transported Lukis Anderson to hospital for severe intoxication responded to the scene of Kumra's murder & transported his body to the morgue



<https://abcnews.go.com/US/innocent-mans-dna-found-horrific-california-murder-scene/story?id=44098772>

6 months in jail (charges dropped)

Most probative DNA evidence in the JonBenét Ramsey cold case

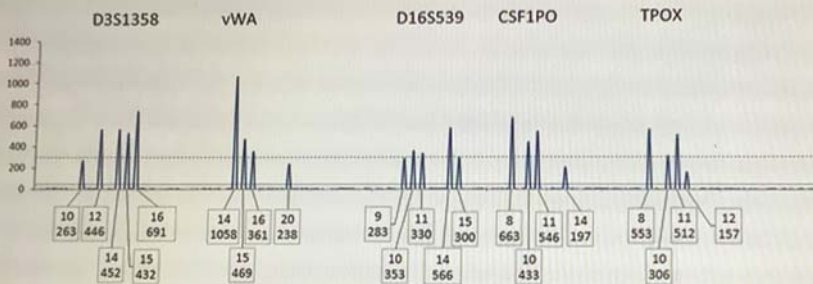
The GARROTE & the duct tape



CONTEXT – CONTEXT – CONTEXT
DNA transfer (shedding) from hands of perpetrator tying the knot
Shed skin cells on adhesive of duct tape

“Increased sensitivity” methods contribute to increased detection of complex DNA mixtures

DNA Mixture Interpretation



Mixed DNA (STR) Profile


(a mixture of DNA from more than one person)




Multiple alleles (more than 2) at each DNA marker tested

Artificial intelligence → STRmix™ & TrueAllele®

Software programs used to interpret complex DNA mixtures



**STRmix™
Probabilistic
Genotyping**



Cybergenetics

TrueAllele® Technology

Computer interpretation of DNA evidence

- “Probabilistic genotyping” software programs
- Computer interpretation vs. human interpretation
- Computers (artificial intelligence) = more objective analysis
- Computers eliminate “confirmation bias” issues

Can recent advancements in DNA technology solve the JonBenét Ramsey homicide cold case???



- Improved “sensitivity” methods (detect & profile low DNA quantities)
 - CAUTION for potential DNA transfer events
- Better DNA markers → higher discriminatory power (stronger stats!)
- Greater # of DNA markers tested → better discriminatory power
 - FBI-mandated **13** core CODIS loci (1997-2016)
 - FBI-mandated **20** cored CODIS loci (2017-present)
 - Phenotype SNP markers (hair & eye color prediction)
 - Biogeographic ancestry SNP markers (race/ethnicity)
- Massively Parallel Sequencing (MPS) → “more bang for the buck”
 - Over 200 DNA markers tested in a single reaction/test
 - Excellent for degraded and/or low quantity evidence
 - Prediction of **externally visible characteristics** (hair/eye color)
 - Prediction of **biogeographic ancestry** (race/ethnicity)
- Familial DNA Searching (FDS) approaches (12 U.S. states)
- Forensic Genetic Genealogy (FGG) investigations
- Artificial intelligence to interpret complex DNA mixtures
 - “Probabilistic genotyping” software (STRmix, TrueAllele)
- Nuclear DNA profiling of rootless hairs

Overview of Verogen NGS tests available for limited quantity and/or degraded DNA evidence

ForenSeq DNA Signature Prep Kit



- 27 Global autosomal STRs
- 24 Y-chromosome STRs (Y-STRs)
- 7 X-chromosome STRs (X-STRs)
- 94 Human Identity SNPs
- 22 Phenotypic SNPs
- 56 Biogeographic ancestry SNPs

"More bang for the buck"

A photograph of a hand in a white lab coat holding a glowing DNA double helix structure. The background is a blurred laboratory setting.

VEROGEN

From DNA to Identification

Multi-application sequencing solutions from Verogen

ForenSeq MainstAY Kit

- 27 Global autosomal STRs
- 25 Y-chromosome STRs (Y-STRs)

ForenSeq mtDNA Control Region Kit

- 1200-bp mtDNA control region
- Overlapping amplicons (tilted primer design)
- Prevents sequence gaps (data loss)

ForenSeq mtDNA Whole Genome Kit

- Whole mitochondrial genome (mtGenome)
- Targets entire 16,569 bp
- Overlapping amplicons (tilted primer design)

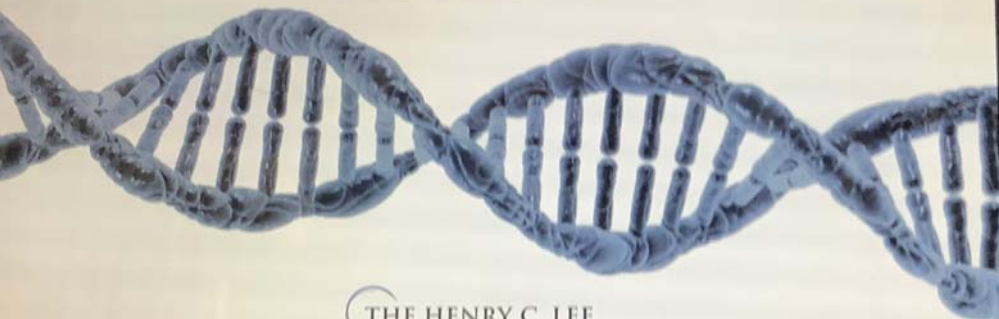
ForenSeq Kintelligence Kit

- 10,230 SNPs explicitly curated for forensic kinship
- Only sequence-based assay designed for Forensic Genetic Genealogy (FGG)
- GEDmatch-compatible reports for investigational lead generation

Thank you

Questions/Inquiries:

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