

Understanding Forensic DNA Analysis: A Program for Lawyers and Judges

# DNA Technology on the Horizon

*Michael Coble (UNTHSC/CHI)*  
*Mindy Montford (Office of the Attorney General)*  
*Lieutenant Trampas Gooding (Texas Rangers)*

Texas State Capitol Auditorium  
November 3, 2023

---

---

---

---

---

---

---

---

## CHAPTER 64 AND WRIT OF HABEAS CORPUS

- SA kit from Medical Examiner's office had a breast swab that was untested.
- The Defendant (Sebastian) was excluded as a possible contributor.
- Right hand fingernail swab – originally tested produced a mixture. The analyst determined that she could not make a determination if Sebastian was a contributor to the mixture.
- New interpretation with STRmix: Sebastian is excluded. Unknown profile is searched in CODIS – no hit.

---

---

---

---

---

---

---

---

## Conventional DNA Testing

- What if – we have no suspect?
- Databases – allow the laboratory to potentially identify a person that matches the evidence profile

---

---

---

---

---

---

---

---

### National Database Search (CODIS)



---

---

---

---

---

---

---

---

### Conventional DNA Testing

- What if – the person of interest is not in the database because he hasn't committed a qualifying crime that would allow his profile to be entered into the database?

---

---

---

---

---

---

---

---

### Familial Searching (CODIS)

HUMAN GENETICS

#### Finding Criminals Through DNA of Their Relatives

Frederick R. Bieber,<sup>1\*</sup> Charles H. Brenner,<sup>2</sup> David Lazer<sup>3</sup>

Science (2006) 312: 1315–1316



---

---

---

---

---

---

---

---

### Why look for relatives?

- Statistics show that (in the US) there is a strong probabilistic dependency between the conviction of a parent and their children.
- Surveys have shown that about 46% of prisoners have indicated that they have a close relative also in prison.

---

---

---

---

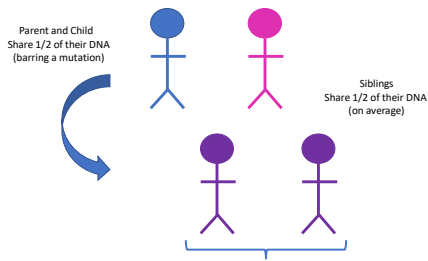
---

---

---

---

### Kinship Review




---

---

---

---

---

---

---

---

The Kinship Index (KI) is a Likelihood Ratio

$$\frac{P(E|H_1)}{P(E|H_2)} = \frac{\text{Probability of genotypes if individuals are related as claimed}}{\text{Probability of genotypes if individuals are unrelated}}$$

---

---

---

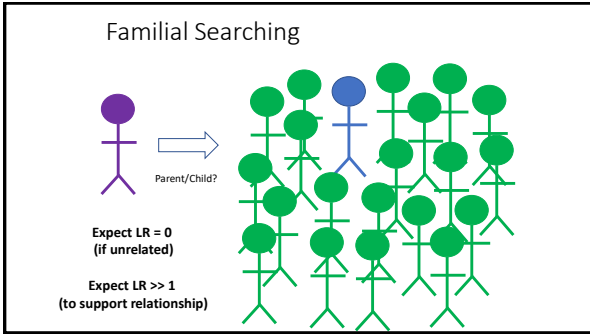
---

---

---

---

---



---

---

---

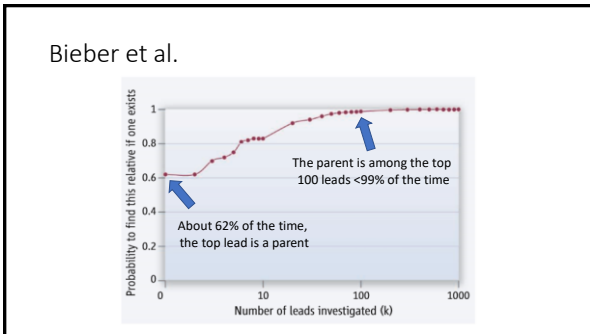
---

---

---

---

---



---

---

---

---

---

---

---

---

### Conclusions

- Cal-DOJ study found that 89-97% of the authentic fathers and 59-74% of the authentic full-siblings detected through their approach.
- This provides confidence that their process will more likely than not detect a true relative should a paternally-related full-sibling, parent, or child be present in the database.
- Similar results to other studies.

Myers et al. 2011, FSI-Genetics

---

---

---

---

---

---

---

---

### Limits of Familial Searching

- Not performed at a national level (only states)
- False positives (allele sharing by chance)
- Y-STR testing – can reduce the number of false positives
- Females in the database – No Y-STR testing!!

---

---

---

---

---

---

---

### What if Familial Searching Fails?

- Continue to wait for the POI or a close family member to be enrolled in the CODIS database...



---

---

---

---

---

---

---

### Familial Searching (FGG)

---

---

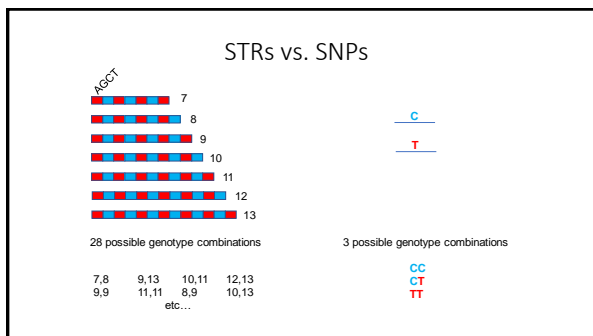
---

---

---

---

---




---

---

---

---

---

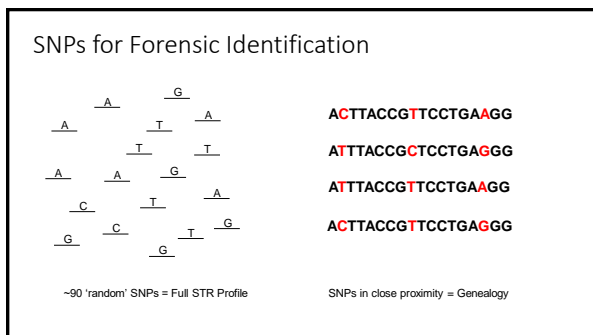
---

---

---

---

---




---

---

---

---

---

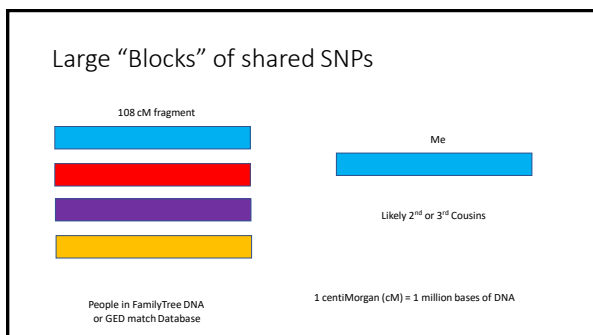
---

---

---

---

---




---

---

---

---

---

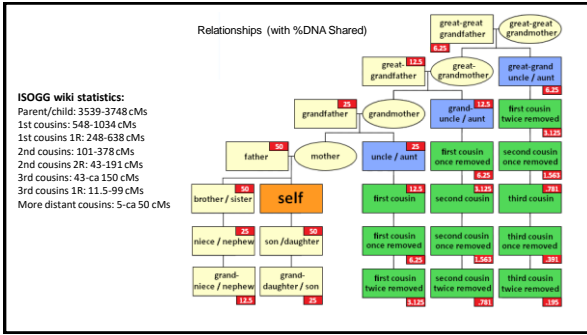
---

---

---

---

---




---

---

---

---

---

---

---

---

---

---

Company	23andMe	Family Tree DNA's Family Finder test	Ancestry.com's AncestryDNA test
Price (as of January 2021)	\$99 for Ancestry and Traits	\$79 for the lifetime of the platform	\$69 in the U.S.
SNP chip used for testing	Customized Illumina GSA chip	Customized Illumina GSA chip	Customized Illumina chip
Number of autosomal SNPs tested	630,122	612,272	617,619
Number of people in the database (as of 13 August 2023)	14,000,000	1,574,253	23,000,000

Over 46 million people have submitted DNA for testing!

23 and Me Family Tree DNA Ancestry.com

[https://isogg.org/wiki/Autosomal\\_DNA\\_testing\\_comparison\\_chart](https://isogg.org/wiki/Autosomal_DNA_testing_comparison_chart)

---

---

---

---

---

---

---

---

---

---

**GEDmatch**

an open-source personal genomics database and genealogy website

Allows people to search for close relatives across the platforms

23 and Me Family Tree DNA Ancestry.com

As of October 2023, the GEDmatch database has over 1.4 million genetic profiles

Note: FamilyTree DNA allows users to opt-in for LE searches

---

---

---

---

---

---

---

---

---

---

How Effective is this process?

Science

RESEARCH

Cite as: Y. Erlich et al., *Science* 10.1126/science.aaa4812 (2018).

**Identity inference of genomic data using long-range familial searches**

Yaniv Erlich<sup>1,2,3,4\*</sup>, Tal Shor<sup>1</sup>, Itzhak Peter<sup>1,5</sup>, Shai Carmi<sup>6</sup>

<sup>1</sup>Herzog, Or Yehuda 607006, Israel; <sup>2</sup>Department of Computer Science, T-1 Foundation School of Engineering, Columbia University, New York, NY, USA; <sup>3</sup>Center for Computational Biology and Bioinformatics (CCBB), Department of Systems Biology, Columbia University, New York, NY, USA; <sup>4</sup>New York Genome Center, New York, NY, USA; <sup>5</sup>Bar Ilan School of Public Health and Community Medicine, The Hebrew University of Jerusalem, Jerusalem, Israel; <sup>6</sup>Corresponding author. Email: erlich@nygenome.com

With ~ 1 million people in GEDmatch, about 60% of the US European population can be identified (using 3<sup>rd</sup> cousins).

---

---

---

---

---

---

---

---

---

---

**APPLYING FIGG TO INVESTIGATIONS**

**STEPS**

- SINGLE SOURCE PROFILES – REVIEW OF CASES WITH THE LEAD AGENCIES
- REVIEW OF DNA EVIDENCE BY DESIGNATED LAB OFFICIAL
- Y-STR TESTING – (IS THERE ENOUGH FOR BOTH TESTS)
- CODIS FAMILIAL SEARCH – IS VICTIM AND DA'S OFFICE WILLING TO PROSECUTE

---

---

---

---

---

---

---

---

---

---

**CODIS FAMILIAL SEARCHES**

**REQUESTS FOR FAMILIAL SEARCHING:**

- DIRECTED TO TEXAS STATE CODIS ADMINISTRATOR
- SUBMITTED BY CODIS FORENSIC LABORATORY
- MUST INCLUDE MEMOS FROM LAW ENFORCEMENT AND DISTRICT ATTORNEY

**LAB PROCESS:**

- 13 - 20 LOCI FOR STR AND A Y-STR PROFILE (PREFERABLY FULL PROFILES BUT CAN PROCEED WITH LESS)
- 60 MANHOURS
- \$13K TO \$14K PER SEARCH (NO COST TO AGENCIES)

**RESULTS:**

- RECEIVE CANDIDATE LIST – 1000 TO 2000 OFFENDERS. TEXAS CODIS DATABASE HAS OVER 1 MILLION OFFENDER PROFILES
- EVALUATE TOP 150 TO 250 OFFENDERS
- IF NO MATCH, THERE ARE STILL OTHERS LOWER ON THE LIST
- CAN COMPLETE ONE FAMILIAL SEARCH PER YEAR (PER CASE)

---

---

---

---

---

---

---

---

---

---

### APPLYING FIGG TO INVESTIGATIONS

#### STEPS

- SNP/WGS TESTING - SINGLE NUCLEOTIDE POLYMORPHISMS/WHOLE GENOME SEQUENCING
- NEED AT LEAST 1NG (NANOGRAM) OF SUSPECT DNA
- A NANOGRAM IS A BILLIONTH OF A GRAM – THE SIZE OF A PAPERCLIP IN A BILLION PIECES

---

---

---

---

---

---

---

---

### APPLYING FIGG TO INVESTIGATIONS

#### STEPS

- NEED TO KNOW THE QUANTITY OF THE EXTRACT
- NEED TO KNOW THE QUALITY OF THE EXTRACT (THE RATIO OF MALE DNA TO FEMALE DNA)
- 65% MALE TO 35% FEMALE OR BETTER DEPENDING ON THE TYPE OF TESTING
- IS THERE DEGRADATION OF THE SAMPLE?

---

---

---

---

---

---

---

---

### APPLYING FIGG TO INVESTIGATIONS

#### STEPS

- SAMPLE IS SENT TO A PRIVATE LAB FOR TESTING
- SAMPLE IS UPLOADED INTO GENEALOGY DATABASES (FAMILY TREE DNA AND GEDMATCH)
- SCREENING REPORT
- PROVIDES AN IDEA OF RELATIONSHIP TO UNKNOWN SAMPLE
- CENTIMORGANS

---

---

---

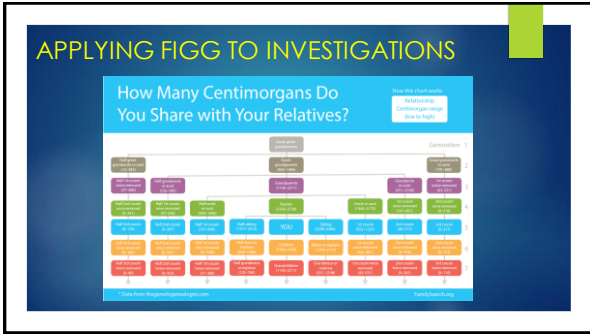
---

---

---

---

---




---

---

---

---

---

---

---

---

### APPLYING FIGG TO INVESTIGATIONS

**STEPS**

- GENEALOGY RESEARCH – GENEALOGIST WILL RESEARCH FAMILY MEMBERS THROUGH PUBLIC DATABASES (OBITUARIES, NEWSPAPERS, SOCIAL MEDIA, ETC.)
- TRYING TO TRIANGULATE FAMILY TREES
- TARGET TEST – VOLUNTARY TESTING OF POSSIBLE FAMILY MEMBERS TO HELP BUILD THE FAMILY TREES (CONSENT)

---

---

---

---

---

---

---

---

### APPLYING FIGG TO INVESTIGATIONS

**STEPS**

- POSSIBLE SUSPECT –  
COVERT SAMPLE – DISCARDED TRASH OR ABANDONED ITEMS WHICH WOULD CONTAIN HIS DNA
- SEND ITEM FOR STR TESTING  
IF MATCHES THEN PROBABLE CAUSE FOR SEARCH WARRANT AND/OR ARREST WARRANT DEPENDING ON DA'S REQUEST

---

---

---

---

---

---

---

---

## APPLYING FIGG TO INVESTIGATIONS

### OTHER OPTIONS

- Y-STR SURNAME SEARCH
- PHENOTYPING – INDIVIDUAL CHARACTERISTICS INCLUDING PROBABILITY OF HAIR, EYE, AND SKIN COLOR – LAST RESORT

---

---

---

---

---

---

---

---

## US DOJ, Bureau of Justice Assistance

NATIONAL SEXUAL ASSAULT KIT INITIATIVE (SAKI)

PURPOSE AREA 4 – INVESTIGATION AND PROSECUTION OF COLD CASE SEXUAL ASSAULTS AND HOMICIDES

---

---

---

---

---

---

---

---

This project was supported by Grant Nos. 2019-AK-BX-0019, which were awarded by the Bureau of Justice Assistance. The Bureau of Justice Assistance is a component of the U.S. Department of Justice's Office of Justice Programs, which also includes the Bureau of Justice Statistics, the National Institute of Justice, the Office of Juvenile Justice and Delinquency Prevention, the Office for Victims of Crime, and the SMART Office. Points of view or opinions in this document are those of the author and do not necessarily represent the official position or policies of the U.S. Department of Justice.




---

---

---

---

---

---

---

---

## PA4 - THE PROBLEM?

- Nonexistent outsourcing for forensic genetic genealogy for DNA samples from unknown offenders linked to unsolved Sexual Assaults and Murders.
- Over 30,000 unknown offender profiles in CODIS with no offense specific data available. We do not know how many unsolved murders vs. Sexual Assault cases are in CODIS.
- The DPS Lab and the TRD originally identified 27 serial offenders in CODIS that are associated with 118 Unsolved Sexual Assaults and Murders.

PURPOSE AREA 4

---

---

---

---

---

---

---

---

## PA4 - THE SOLUTION:

- Purpose area 4 grant provides support for the investigation/prosecution of individuals whose DNA is in CODIS as an unknown profile related to cold case sexual assaults and homicides..
- Funding may be used for outsourcing of DNA testing and Genealogy testing and research.
- Grant will fund outsourcing of existing DNA samples for Y-STR testing for CODIS Familial Searches and also Genealogy testing and research.

PURPOSE AREA 4

---

---

---

---

---

---

---

---

## MORE SOULTIONS:

- Grant will fund CODIS Familial Searches.
- Fund investigators to pursue leads of possible relatives of the offender.
- Fund Genealogy Testing and Research
- Funds the outsourcing of DNA verification tests of suspected offenders for rapid turn around (<72 hrs)

---

---

---

---

---

---

---

---

## PURPOSE AREA 4

DPS LABS – 10

NON DPS LABS – 7

CODIS LAB - 1

---

---

---

---

---

---

---

---

## PURPOSE AREA 4

**49** FORENSIC UNKNOWN SERIAL OFFENDERS RESPONSIBLE FOR **178** SEXUALLY RELATED OFFENSES.

**422** HOMICIDES WITH SINGLE SOURCE FORENSIC PROFILE IN CODIS FROM DPS LABS

**184** FEMALE HOMICIDES WITH SINGLE SOURCE FORENSIC PROFILES IN CODIS.

**38** UNSOLVED FEMALE HOMICIDES WITH A SEXUAL NEXUS

**5,512** SEXUAL ASSAULT CASES WITH SINGLE SOURCE FORENSIC PROFILES IN CODIS DPS LABS

---

---

---

---

---

---

---

---

## PURPOSE AREA 4

**TOTAL SAKI CASES REVIEWED/BEING WORKED:**

**HOMICIDES – 80**

**SEXUAL ASSAULTS – 200**

**UNIDENTIFIED – 5**

---

---

---

---

---

---

---

---

## PURPOSE AREA 4

### CODIS LAB - 1

- 46 FAMILIAL SEARCHES COMPLETED TO DATE
- 9 FAMILIAL SEARCHES PENDING COMPLETION
- 9 LEADS PRODUCED
- 6 SUSPECTS IDENTIFIED AND CONFIRMED THRU DNA
- 3 PENDING SUSPECT IDENTIFICATION

---

---

---

---

---

---

---

---

## PURPOSE AREA 4

### GENEALOGY

- 37 SAMPLES SENT FOR TESTING - 3 SAMPLES DO NOT PROCEED
- 31 CASES PROCEEDED TO GENEALOGY RESEARCH
- 11 CASES SOLVED (1 BY AGENCY WITHOUT GENEALOGY)
- 1 UNIDENTIFIED FEMALE VICTIM IDENTIFIED
- 16 CASES BEING TARGET TESTED FOR FURTHER LEADS OR FURTHER GENEALOGY RESEARCHED
- 2 CASES BEING MONITORED
- 1 CASE PENDING GENEALOGY TESTING

---

---

---

---

---

---

---

---

## PURPOSE AREA 4

- TOTAL SAKI CASES SOLVED TO DATE:**
- HOMICIDES - 15**
- SEXUAL ASSAULTS - 94**
- UNIDENTIFIED VICTIMS IDENTIFIED - 2**

---

---

---

---

---

---

---

---

## PURPOSE AREA 4

SUSPECTS IDENTIFIED FROM SOLVED - 50  
ARRESTS/INDICTMENTS – 30  
OUTSTANDING WARRANTS – 1  
FOUND DECEASED – 8  
PENDING ARREST/INDICTMENT – 6  
DISMISSED BY PROSECUTION – 4  
NO BILLED - 1

---

---

---

---

---

---

---

---

## PURPOSE AREA 4

SUSPECTS IDENTIFIED BY:  
AGENCY REVIEWED CASE/CONFIRMED WITH DNA - 21  
CODIS HITS – 13  
FAMILIAL SEARCH – 6  
GENEALOGY - 10

---

---

---

---

---

---

---

---

### **DNA Technology on the Horizon:**

**Final Thoughts on  
Forensic Investigative Genetic Genealogy  
(FIGG)**

---

---

---

---

---

---

---

---

**Forensic Investigative Genetic Genealogy**

**FIGG**

**IGG**

**FGG**

---

---

---

---

---

---

---

---

**FIGG/IGG/FGG: What It Is Not**

**Not CODIS Familial Searching**

- different from forensic genealogy
- searching **state** CODIS databases to look for close male relatives of an unknown offender (brothers, fathers, uncles, sons); using Y-STR profiles (male profiles)
- only allowed in 13 states (including Texas)

---

---

---

---

---

---

---

---

**STR vs SNP**

**STR uploaded to CODIS**

- STR=Short Tandem Repeats
- Crime scene STR profile is compared to the profiles stored in CODIS to find potential perpetrators
- 40% chance of producing a match (lead)
- Uploaded by LE according to statute

**SNP uploaded to consumer genealogy database**

- SNP=Single Nucleotide Polymorphisms
- Different type of testing (but can take from same extract used from crime scene if enough sample left after STR testing) and profile is uploaded and compared to users in public databases
- 80%-90% chance of producing a lead by matching to a 2<sup>nd</sup> or 3<sup>rd</sup> cousin
- Voluntary upload

---

---

---

---

---

---

---

---

### Genealogy In the News



50

---

---

---

---

---

---

---

---

### The Power of the Tool

-credit to Steve Kramer, Indago Solutions, former FBI and Anne Marie Schubert, former Sacramento District Attorney

#### Before Using FIGG

- Took 43 years to solve the Golden State Killer cases
- 650 investigators over the years and 15 LE agencies
- 8000 persons of interest/300 people swabbed for DNA
- 200k man/woman hours=\$10 million dollars

#### After Using FIGG

- Took 63 days to identify Joseph James DeAngelo as the Golden State Killer
- 6 people to work the family tree
- \$217 (cost of SNP testing back then)

51

---

---

---

---

---

---

---

---

### Facts about FIGG

- ❖ Law enforcement does not have access to medical information when they use genealogy databases. They have information on how families are related within centimorgans "cM" so they can begin building and researching family trees and histories.
- ❖ FIGG only provides law enforcement with a lead. Detectives must still conduct further investigation by obtaining subsequent samples and confirming the lead by using a one-to-one STR test to make sure they have the right individual.

52

---

---

---

---

---

---

---

---

### Facts about FIGG

- ❖ Ancestry.com, 23 and Me, and others do not allow law enforcement to use their databases. Only Family Tree DNA and GEDmatch allow law enforcement to use their databases, and both require their users to “opt-in or out” before allowing law enforcement to find genetic relatives
- ❖ More than 75% of all new GEDmatch users “opt in” for law enforcement to use its databases

53

---

---

---

---

---

---

---

---

### Considerations About Using FIGG

- Art. 38.35 of the Texas Code of Criminal Procedure
  - Be careful if using labs to do SNP testing that are not accredited by the TFSC now that accreditation in this area is possible <https://fsc.txcourts.gov/AccreditedLabPublic>
- Discovery
  - Could be asked to turn over materials used during FIGG research. Some states have successfully fought these requests under Brady, but may not have as good of an argument under Michael Morton Act
- DOJ Guidelines
  - Interim policy on FIGG with specific requirements before FIGG can be used including having an STR profile uploaded into CODIS and getting prosecutorial approval <https://www.justice.gov/olp/page/file/1204386/download>

54

---

---

---

---

---

---

---

---

### Considerations About Using FIGG

- Privacy Challenges
  - Claim that use of genealogy database violates 4<sup>th</sup> Amendment because right to privacy in shared DNA of relatives. Courts so far have found this an unpersuasive argument based upon a lack of standing and no property interest in a 3<sup>rd</sup> party's genetic material voluntarily uploaded
  - Claims invoking Carpenter (comparing genealogy to cell phone location data w/privacy interest)
  - Abandoned property claims (trash runs/discarded items)
- Future Legislation
  - Efforts to regulate vary widely from state to state mainly because of a lack of understanding of databases and information available to law enf.
  - Must use responsibly or will lose this valuable tool
  - Can implicate but can also exonerate

55

---

---

---

---

---

---

---

---

**Resources**

\*Investigative Tools for Solving Cold Cases\*  
Dec. 5-6  
Horseshoe Bay Resort

\*OAG and Texas Rangers BJA Grant Awards\*  
OAG Cold Case and Missing Persons Unit  
[coldcaseunit@oag.texas.gov](mailto:coldcaseunit@oag.texas.gov)  
Texas Rangers SAKI Grant Award  
[Trampas.Gooding@dps.texas.gov](mailto:Trampas.Gooding@dps.texas.gov)

\*Season of Justice\*  
<https://seasonofjustice.org/>

<https://verogen.com/law-enforcement-forensic-investigative-genetic-genealogy/#glossary>

56

---

---

---

---

---

---

---

---