

## **Twenty-three and Who?**

A Summary of Dr. Allison Jablonski's Presentation  
to the Sphex Club  
September 21, 2023

Dr. Jablonski introduced her topic by relating the story of the first use of DNA testing in policing to identify the perpetrator of two sexual assaults and murders in England in 1986, and to exonerate the leading suspect. She then reviewed the structure of DNA, the process of extraction, amplification and analysis of samples, and the types of DNA analysis, including VNTR (variable number of tandem repeats), STR (short tandem repeats), mitochondrial DNA and Y chromosome analysis. She discussed the limitations of DNA testing, including privacy considerations, contamination, chain-of-custody issues, as well as obvious limitations such as cost, identical twins, and the fact that presence at the crime scene does not equal guilt. She listed good sources of DNA in criminal work, which include, aside from the obvious, hair and toothbrush and relatives. She discussed the use of commercial DNA databases, such as those created by [ancestry.com](http://ancestry.com), [familytreedna.com](http://familytreedna.com), and [23andme.com](http://23andme.com). She described how the degree of relatedness between individuals in the same family can be used to construct probabilities and referenced the Shared cM Project. The [gedmatch.com](http://gedmatch.com) open-source database contains over 1.8 million DNA profiles. While this database might not identify a specific perpetrator, it might place the perpetrator within a family and close to relatives in the database. She then reviewed the case of the Golden State Killer, the first person identified using this database. Finally, Dr. Jablonski addressed the question of whether individuals such as Sphex members should have their DNA analyzed. Considerations include who should have their DNA analyzed and who will have access to that information.



# Twenty-three and who?

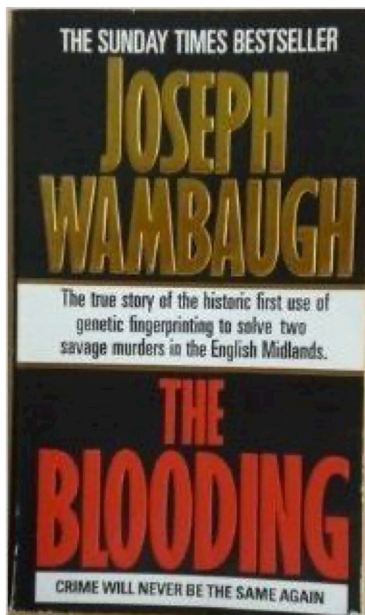
## DNA profiling in the modern age

Allison Jablonski  
University of Lynchburg



## DNA Profiling

- Background on DNA structure
- Types of DNA testing
- Reliability of DNA testing



## First Use of DNA Testing in Policing

- After going missing, Lynda Mann, a 15-year-old schoolgirl, was raped and murdered on the grounds of the Carlton Hayes psychiatric hospital in Narborough, Leicestershire, in November 1983.
- Forensic examination of a semen sample on Lynda's body showed that it was a type found in only 10% of men, and was from someone with type A blood. However, the police did not identify a suspect.
- <http://www.exploreforensics.co.uk>



## First Use of DNA Testing in Policing

- Richard Buckland, a local 17-year-old who worked at the Carlton Hayes psychiatric hospital, had been spotted near Dawn Ashworth's murder scene and knew unreleased details about the body. In 1986, he confessed to Dawn Ashworth's murder but not Lynda Mann's.
- <http://www.exploreforensics.co.uk>



## First Use of DNA Testing in Policing

- Using Sir Alec Jeffreys' new technique, scientists compared the semen samples with a blood sample from Richard Buckland. This proved that both girls were murdered by the same man, and also proved that this man was not Richard Buckland – the first person to be exonerated using DNA.
- <http://www.exploreforensics.co.uk>

## First Use of DNA Testing in Policing

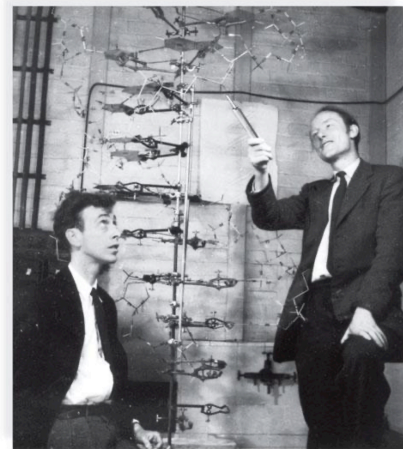
- In 1987, in the first ever mass DNA screen, the police and forensic scientists screened blood and saliva samples from 4,000 men aged between 17 and 34 who lived in the villages of Enderby, Narborough and nearby Littlethorpe and did not have an alibi for murders. The turn-out rate was 98%, but the screen did not find any matches to the semen samples. The police and scientists expanded the screen to men with an alibi, but still did not find a match.
- <http://www.exploreforensics.co.uk>

## First Use of DNA Testing in Policing

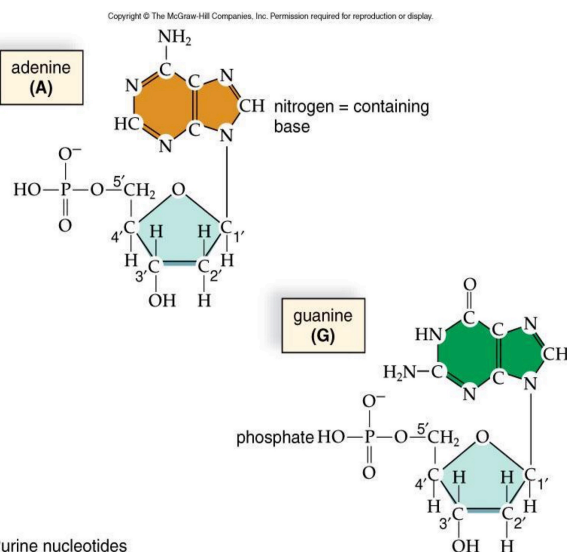
- In August 1987, a woman overheard a colleague, Ian Kelly, boasting that he had given a sample posing as a friend of his, Colin Pitchfork. Pitchfork had persuaded Kelly to take the test as he claimed he had already given a sample for a friend who had a flashing conviction. The police arrested Colin Pitchfork in September 1987, and scientists found that his DNA profile matched that of the murderer.
- <http://www.exploreforensics.co.uk>



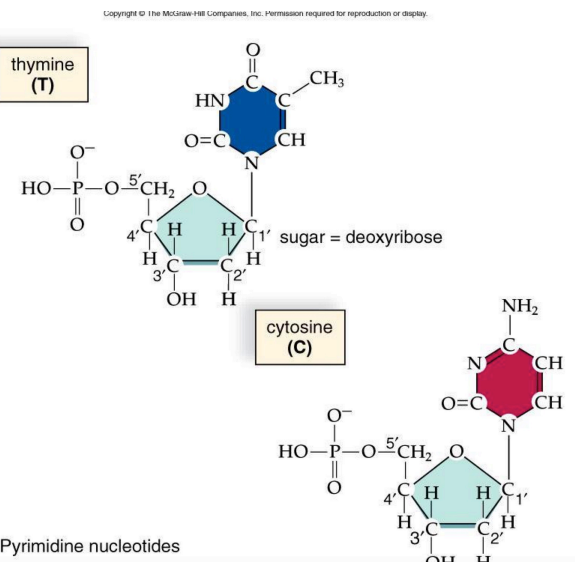
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d.

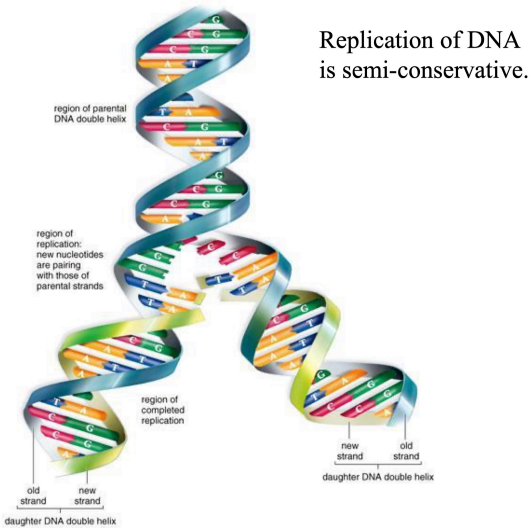


a. Purine nucleotides

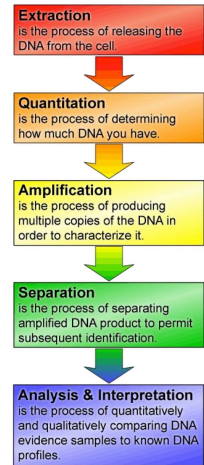


b. Pyrimidine nucleotides

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## DNA Analysis



## Types of DNA Analysis

- Polymerase Chain Reaction (PCR)—amplifies DNA from very small samples to generate enough to analyze.
  - VNTR: Variable Number of Tandem Repeats
  - STR: Short Tandem Repeats
- Mitochondrial DNA (mtDNA) analysis
- Y analysis

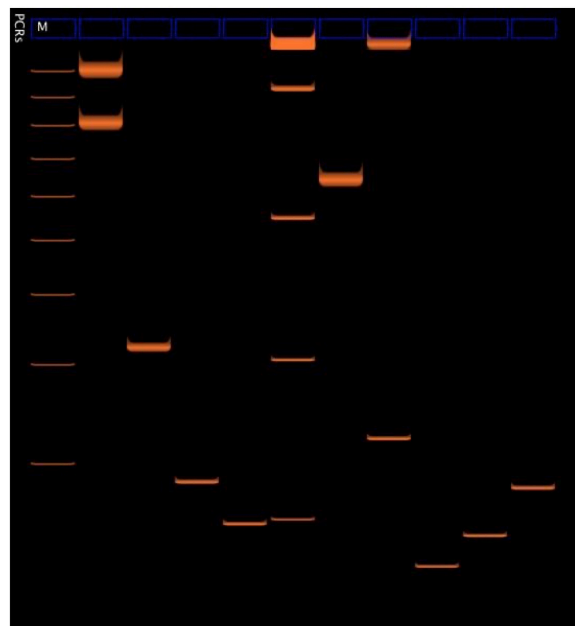
## PCR Analysis

- <https://www.youtube.com/watch?v=2KoLnlwoZKU>

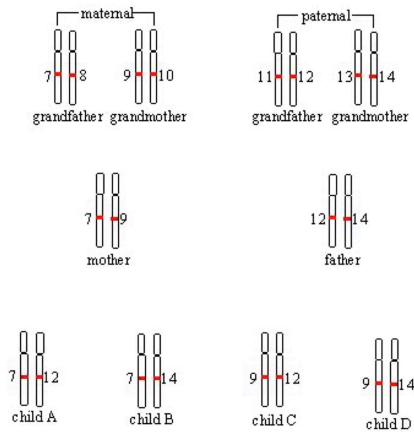
## Types of DNA Analysis: Small Tandem Repeat (STR) Analysis

- Several regions in the human genome that exhibit small tandem repetitive sequences (2-, 4-, 6-bp sequences, AKA microsatellites)
- Highly variable number of repeats in each person; inheritable from parents
- Can determine number of repeats via PCR and gel electrophoresis

Example of STR PCR analysis gel



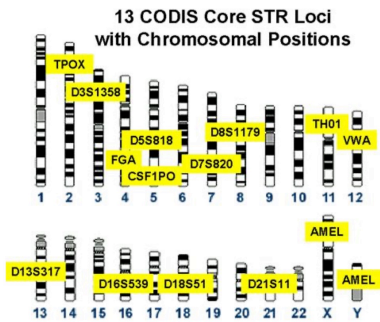
## Simplified Example of STR Analysis



## STR Analysis

- In a given population, one can determine the frequency of individuals with a given number of repeats. This can be expressed as a probability.
- Assaying STRs at several different loci in the genome will combine probabilities via the [Product Rule](#).
- In the Commonwealth of Virginia, STR testing involves examination of 13 different loci, giving the testing great power in determining an individual.
- CODIS (COMbined DNA Index System) is the large database of DNA samples available to law enforcement.

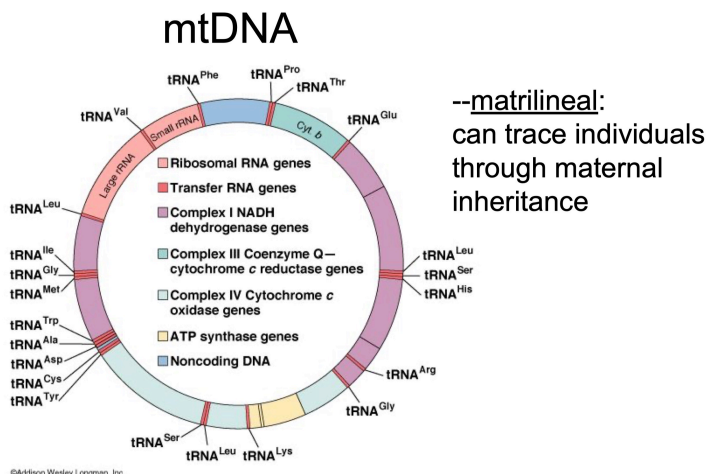
## CODIS Loci



## STR Y Chromosome Analysis

- Same as STR analysis for any other chromosome, but strictly looking for Y chromosome regions

## STR Mitochondrial DNA Analysis



## What are some limitations of DNA testing?

- Cost
- mtDNA could mutate
- Twins (evil and otherwise)
- Crime scene presence doesn't equal guilt.
- Breach of privacy
- DNA doesn't tell us everything.
- People are fallible in their interpretation.



## Limitations of DNA Testing

- Contamination
  - at the crime scene
  - in the laboratory
- Small Sample Sizes
- Chain of Custody failure
- Decay due to environmental conditions or poor handling
- Not easy to explain in court



## Limitations of DNA Testing

- Interpretation of unclear results
- Context of the crime
- Accusations of planted evidence



## What are good sources of DNA?

- Hair: follicle, root
- Contacts (corneal cells)
- Blood: WBC
- Urine
- Semen
- Mucus
- Saliva



## What are good sources of DNA?

- Hairbrush/toothbrush
- Skin/tissue
- Bone marrow
- Relatives: genetic testing sites such as 23andme

How does genetic testing work to identify individuals?

Is genetic testing always accurate?

## The Key to Cold Cases?

Often, cold cases are cold because original biological samples are too degraded, have been disposed or because there are no matches in CODIS.

Without doing broad DNA sampling, it may be impossible to make a match until a perpetrator leaves a sample at another crime scene.

The problem or challenge

How can we use commercial genomic DNA databases to solve these crimes?

### Current commercial DNA databases

- [www.ancestry.com](http://www.ancestry.com) \$99
- [www.myheritage.com](http://www.myheritage.com) \$89
- [example](#)
- [www.familytreedna.com](http://www.familytreedna.com) \$79
- [www.23andme.com](http://www.23andme.com) \$119
- [Example, example](#)

### Current commercial DNA databases

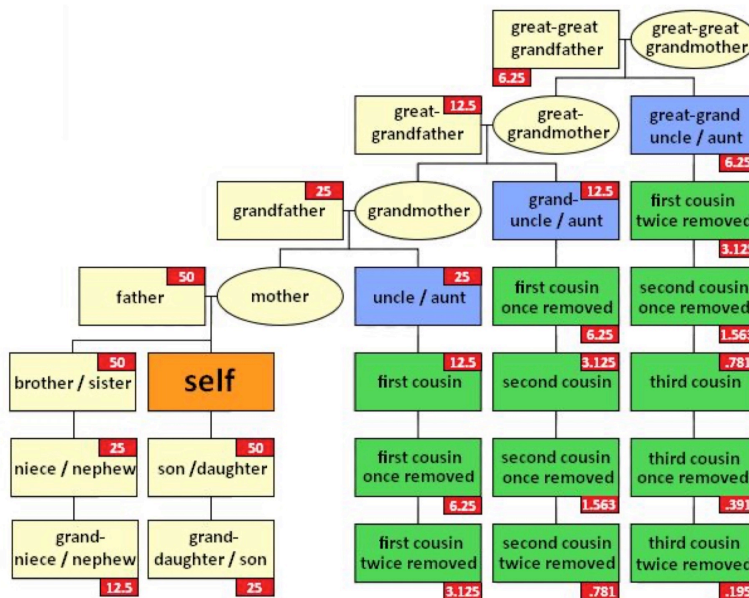
<https://familyhistorydaily.com/genealogy-help-and-how-to/dna-ethnicity-reports-compare/>

### How does it work??

Each company uses slightly different sequences to analyze, but comparison methods of relatedness are similar.

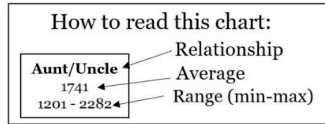
- <https://www.yourdna.com/scp>
- [https://thegeneticgenealogist.com/wp-content/uploads/2017/08/Shared\\_cM\\_Project\\_2017.pdf](https://thegeneticgenealogist.com/wp-content/uploads/2017/08/Shared_cM_Project_2017.pdf)
- [https://isogg.org/wiki/Autosomal\\_DNA\\_statistics](https://isogg.org/wiki/Autosomal_DNA_statistics)

% Relatedness between Individuals in the same family



# The Shared cM Project – Version 4.0 (March 2020)

Blaine T. Bettinger  
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Half GG-Aunt/Uncle 208 103 - 284	Great-Grandparent 887 485 - 1486						Great-Great-Aunt/Uncle 420 186 - 713	GGG-Aunt/Uncle 117 25 - 238	GGGG-Aunt/Uncle 51 0 - 154	Other Relationships	
Half 1C2R 125 16 - 269	Half Great-Aunt/Uncle 431 184 - 668	Grandparent 1754 984 - 2462				Great Aunt/Uncle 850 330 - 1467	1C2R 221 33 - 471	2c2R 71 0 - 244	3C2R 36 0 - 166	6C 18 0 - 71	
Half 2c1R 66 0 - 190	Half 1C1R 224 62 - 469	Half Aunt/Uncle 871 492 - 1315	Parent 3485 2376 - 3720		Aunt/Uncle 1741 1201 - 2282	1C1R 433 102 - 980	2c1R 122 14 - 353	3C1R 48 0 - 192	4C1R 28 0 - 126	6C1R 15 0 - 56	
Half 3c 48 0 - 168	Half 2c 120 10 - 325	Half 1C 449 156 - 979	Half-Sibling 1759 1160 - 2436	Sibling 2613 1613 - 3488	SELF	1C 866 396 - 1397	2c 229 41 - 592	3c 73 0 - 234	4c 35 0 - 139	5c 25 0 - 117	6C2R 13 0 - 45
Half 3c1R 37 0 - 139	Half 2c1R 66 0 - 190	Half 1C1R 224 62 - 469	Half Niece/Nephew 871 492 - 1315	Niece/Nephew 1740 1201 - 2282	Child 3487 2376 - 3720	1C1R 433 102 - 980	2c1R 122 14 - 353	3C1R 48 0 - 192	4C1R 28 0 - 126	5C1R 21 0 - 80	7C 14 0 - 57
Half 3c2R 27 0 - 78	Half 2c2R 48 0 - 144	Half 1C2R 125 16 - 269	Half Great Niece/Nephew 431 184 - 668	Great-Niece/Nephew 850 330 - 1467	Grandchild 1754 984 - 2462	1C2R 221 33 - 471	2c2R 71 0 - 244	3C2R 36 0 - 166	4C2R 22 0 - 93	5C2R 18 0 - 65	7C1R 12 0 - 50
Half 3c3R 60 0 - 120	Half 2c3R 208 103 - 284	Half 1C3R 60 0 - 120	Half GG Niece/Nephew 208 103 - 284	Great-Great-Niece/Nephew 420 186 - 713	Great-Grandchild 887 485 - 1486	1C3R 117 25 - 238	2c3R 51 0 - 154	3C3R 27 0 - 98	4C3R 19 0 - 60	5C3R 13 0 - 30	8C 11 0 - 42

Minimum was automatically set to 0 cM for relationships more distant than Half 2C, and averages were determined only for submissions in which DNA was shared

## How does it work??

How do you compare relatedness to a family member using an unknown DNA sample?

[www.gedmatch.com](http://www.gedmatch.com)

Over 1.8 million DNA profiles are in this open-source database. Anyone can register for free access and to upload their own (or others') DNA sequence.

## Cases

The Golden State Killer: East Area Rapist in Sacramento, CA

<https://www.washingtonpost.com/news/true-crime/wp/2018/04/27/golden-state-killer-dna-website-gedmatch-was-used-to-identify-joseph-deangelo-as-suspect-police-say/>

Joseph DeAngelo was the first individual identified using GEDmatch.com using DNA left at a crime scene and outside his home. He was arrested and confessed in 2018.

"The East Area Rapist is believed to have killed 12 people, raped at least 51 and burglarized hundreds of homes from 1974 through May 1986 along the length of California."

Read more here: <https://www.sacbee.com/latest-news/article209913514.html#storylink=cpy>

## Cases

Law Enforcement use of GEDmatch.com:

Initially, all uploaded data was accessible to any users, including law enforcement. Now, data can be accessed only when DNA data donors have chosen to opt-in for use by law enforcement. This change occurred in 2019.

<https://www.youtube.com/watch?v=FiiKfrulvcE>

Your problem or challenge

Should I have my DNA analyzed by a commercial firm?

# Potential Issues

Things to consider prior to having your DNA analyzed:

- Who should have access to your DNA?
- Who will have access to your DNA?
- What are the implications of sharing your DNA identity with others?
  - new relatives
  - new relationships
  - law enforcement access