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Examining DNA evidence: TrueAllele® Case Studies

Legal Medicine & Forensic Science course
Duquesne University
March, 2020
Pittsburgh, PA

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Pittsburgh, PA

Cybergenetics

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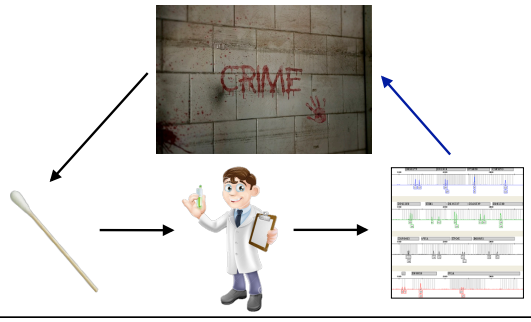
DNA evidence



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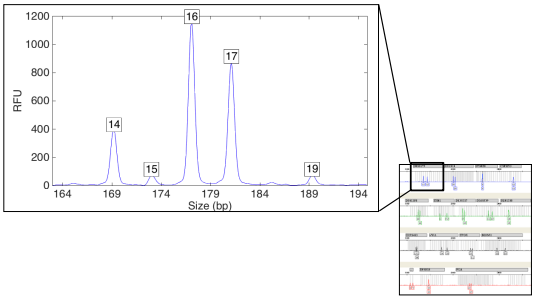
DNA analysis



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When DNA analysis works

- Links people to crime scenes
- Links people to evidence
- Identifies potential perpetrators
- Helps free the innocent
- Victims get closure
- Contributes to justice

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When DNA analysis fails

- Human interpretation
- Low-level DNA
- Degradation
- Mixtures

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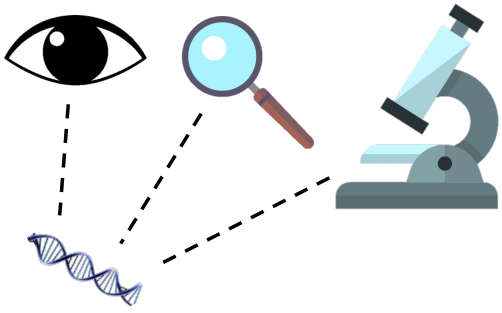
Technology



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Commonwealth of Pennsylvania v. Derrick Gallaway

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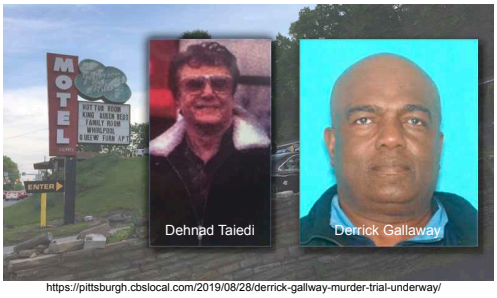
Commonwealth of Pennsylvania v. Derrick Gallaway



https://pittsburgh.cbslocal.com/2019/08/28/derrick-gallway-murder-trial-underway/

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Crime lab findings

Possible bloodstain from door sill plate of lobby door (interior)
Possible bloodstain from parking lot south of lobby
Possible bloodstain from parking lot south of lobby
Possible bloodstain on the back of the bank bag
The DNA profiles obtained from the above listed items match each other and match the DNA profile obtained from the reference sample of Derrick Gallaway.

Possible bloodstain from the inside of the tray (21A)
No conclusion can be made regarding [redacted], Dehnad Taiedi, [redacted], and the unknown male as a possible contributor to the profile due to the complexity of the data.

Due to the complexity of the data, no comparison can be made to the reference sample of Derrick Gallaway.

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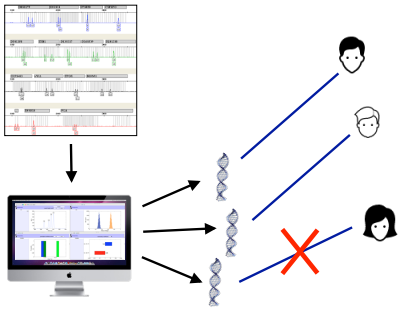
Computer DNA interpretation



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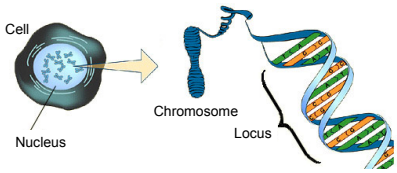
DNA biology



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Short tandem repeat

23 volumes in cell's DNA encyclopedia

DNA locus paragraph

Take me out to the ball game
take me out with the crowd
buy me some peanuts and Cracker Jack
I don't care if I never get back
let me
root root root root root root root root root root
for the home team,
if they don't win, it's a shame
for it's one, two, three strikes, you're out
at the old ball game

"root" repeated 10 times, so allele length is 10 repeats

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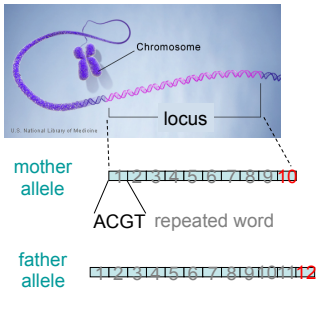
DNA genotype



A genetic locus has two DNA sentences, one from each parent.

An allele is the number of repeated words.

A genotype at a locus is a pair of alleles.

10, 12

Many alleles allow for many many allele pairs. A person's genotype is relatively unique.

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DNA evidence interpretation

Evidence item → Lab → Evidence data → Infer → Evidence genotype

DNA from one person

10, 12

Compare

Known genotype

10, 12

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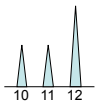
DNA mixture interpretation

Evidence item → Lab → Evidence data → Infer → Evidence genotype

DNA from two people



10, 11 @ 20%
11, 11 @ 30%
11, 12 @ 50%

Compare

Known genotype

11, 12

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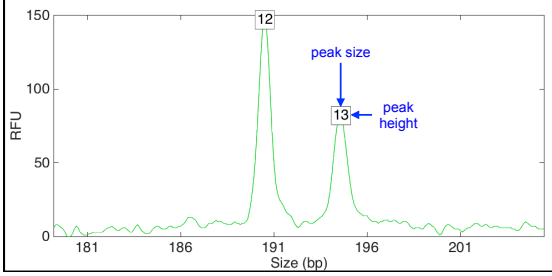
Computers can use all the data

Quantitative peak heights at locus D13S317



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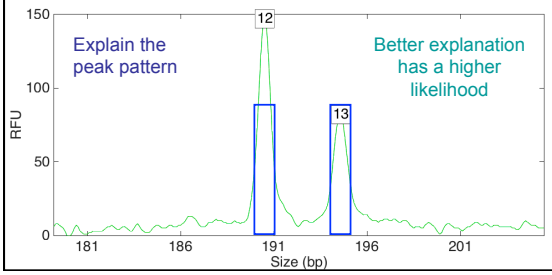
How the computer thinks

Consider every possible genotype solution



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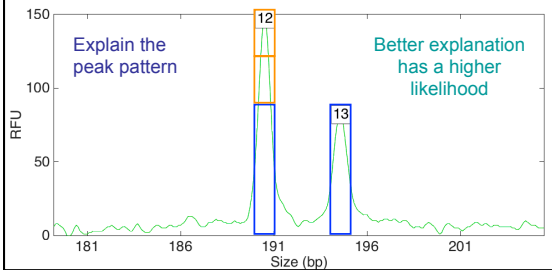
How the computer thinks

Consider every possible genotype solution



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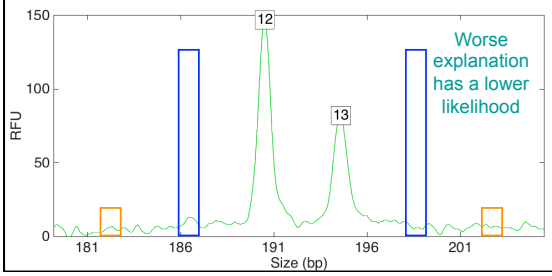
How the computer thinks

Consider every possible genotype solution



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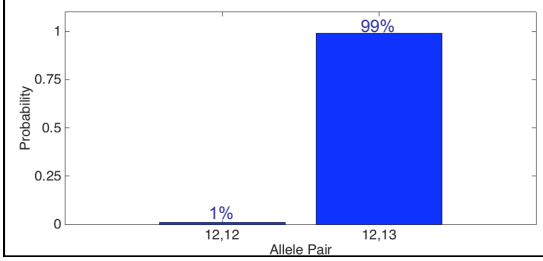
Evidence genotype

Objective genotype determined solely from the DNA data.
Never sees a comparison reference.



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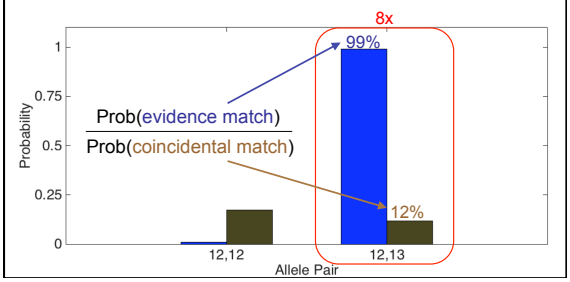
DNA match information

How much more does the suspect match the evidence than a random person?



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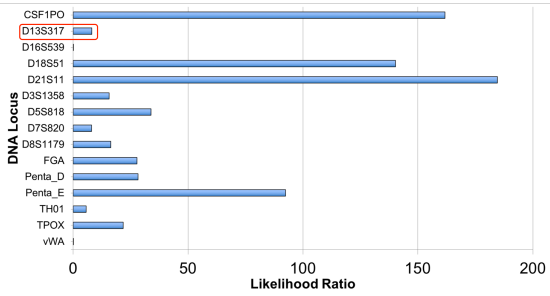
Match information at 15 loci



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Is the suspect in the evidence?

A match between the bloodstain from the inside of the tray and Derrick Gallaway is:

24.6 quadrillion times more probable than a coincidental match to an unrelated African-American person

17.3 quintillion times more probable than a coincidental match to an unrelated Caucasian person

46.3 quintillion times more probable than a coincidental match to an unrelated Hispanic person

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Match statistics

		38	39	40	44
Item	Description	Dehnad Taiedi	Reference	Suspect	Derrick Gallaway
21A	bloodstain from inside of tray				24.6 quadrillion

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Match statistics

		38	39	40	44
Item	Description	Dehnad Taiedi	Reference	Suspect	Derrick Gallaway
21A	bloodstain from inside of tray				16.39

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DNA evidence in the courtroom

- Trial in September 2019
- Cross exam:
  - Race
  - Additional contributors
  - How/when was was DNA deposited?
  - What are the chances it was someone else?
- Outcome: Guilty of first-degree murder, robbery, and tampering with evidence

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State of West Virginia v. Defendant

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State of West Virginia v. Defendant

- April 2016
- House party
- Drugs and alcohol
- Alleged assault
- Taken to hospital
- Sexual assault kit collected

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Crime lab findings

The results identified from the "anal swabs x2" (combined sperm and ecell fractions) are consistent with a mixture of DNA. The primary results identified from the ecell fraction are consistent with the DNA profile of [redacted]. The results identified from both amplifications of the sperm fraction are consistent with a mixture of DNA from three or more individuals. Due to the nature of the sample and the large number of possible contributors, no conclusions were made regarding the inclusion or exclusion of [redacted]

The results identified from the "vaginal swabs x2" (combined sperm and ecell fractions) are consistent with a mixture of DNA. The results identified from the ecell fraction are consistent with the DNA profile of [redacted]. The results identified from both amplifications of the sperm fraction are consistent with a mixture of DNA from three or more individuals. Due to the nature of the sample and the large number of possible contributors, no conclusions were made regarding the inclusion or exclusion of [redacted]

Probabilistic genotyping may prove beneficial on these samples. Currently the WV State Police Forensic Laboratory does not perform this type of analysis.

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Match statistics

Item	Victim	Suspect	Half-brother	Defendant	Suspect
Vaginal swabs	27.60	29.94	11.84	-15.78	

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Vaginal swabs vs. defendant

Number of contributors	Assumed references	Average match statistic
3	none	-9.94
3	victim	-11.40
3	victim, suspect	-12.74
3	victim, half-brother	-41.39
4	victim, suspect, half-brother	-3.44

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TrueAllele Results

Vaginal swabs

Item 01.001, vaginal swabs

TrueAllele assumed that the evidence sample data (Item 01.001) contained three or four contributors, and objectively inferred evidence genotypes solely from these data. Reference genotypes were assumed as known in some calculations that involved comparisons to other reference genotypes. Single and joint data interpretation was performed. Following genotype inference, the computer then compared separated genotypes from this evidence item to provided reference genotypes (Items 01.011, 05.001, 06.001, and 08.001), relative to ethnic populations, to compute LR DNA match statistics. Based on these results:

A match between the vaginal swabs (Item 01.001) and [redacted] half-brother (Item 06.001) is:
4.37 trillion times more probable than a coincidental match to an unrelated African-American person,
693 billion times more probable than a coincidental match to an unrelated Caucasian person,
3.6 trillion times more probable than a coincidental match to an unrelated Southeast Hispanic person, and
8.77 trillion times more probable than a coincidental match to an unrelated Southwest Hispanic person.

A match between the vaginal swabs (Item 01.001) and [redacted] defendant (Item 05.001) is:
6.31 quadrillion times *less* probable than a coincidental match to an unrelated African-American person,
67.1 quadrillion times *less* probable than a coincidental match to an unrelated Caucasian person,
22.8 quadrillion times *less* probable than a coincidental match to an unrelated Southeast Hispanic person, and
21.4 quadrillion times *less* probable than a coincidental match to an unrelated Southwest Hispanic person.

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DNA evidence in the courtroom

- Trial in April 2018
- Teaching about PG
- Cross exam:
  - Lab protocols
  - Sample names
- Outcome:
  - Not guilty of sexual assault

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Trial: Direct exam

- Qualifications
  - Professional activities
  - Method
- Case-specific
  - Establish chain of custody
  - Demonstrative aid

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Trial: Cross exam

- Arguments on:
  - Qualifications
  - Chain of custody
  - Bias
  - Methodology
  - Error
  - Reproducibility
  - DNA transfer
  - And many more...

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Admissibility

Frye (1923)

Daubert (1993)

Scientific testing is key!

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Rule 702.
Testimony by Expert Witnesses

A witness who is qualified as an expert by knowledge, skill, experience, training, or education may testify in the form of an opinion or otherwise if:

(a) the expert's scientific, technical, or other specialized knowledge will help the trier of fact to understand the evidence or to determine a fact in issue;

(b) the testimony is based on sufficient facts or data;

(c) the testimony is the product of reliable principles and methods; and

(d) the expert has reliably applied the principles and methods to the facts of the case.

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Validation

JOURNAL OF FORENSIC SCIENCES

J Forensic Sci, March 2020, Vol. 65, No. 2
doi: 10.1111/1556-4029.14204
Available online at: onlinelibrary.wiley.com

PAPER

CRIMINALISTICS

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Validating TrueAllele® Interpretation of DNA Mixtures Containing up to Ten Unknown Contributors*

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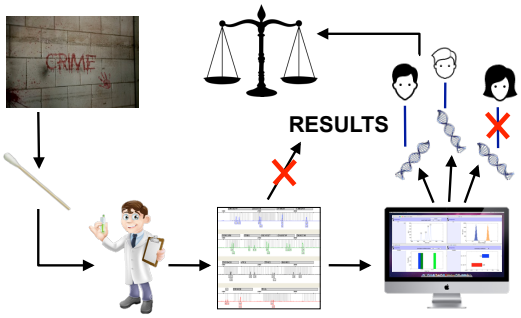
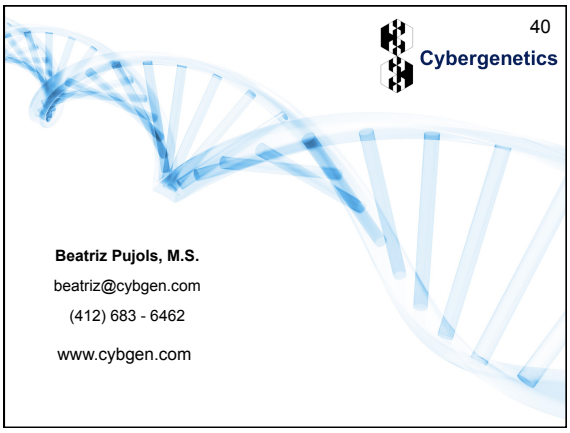
The big picture

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