

## Understanding DNA

Pennsylvania Conference of State Trial Judges  
Mid Annual Meeting  
Administrative Office of Pennsylvania Courts  
Judicial Education Department  
February, 2016  
Philadelphia, PA

Mark W Perlin, PhD, MD, PhD  
Cybergenetics, Pittsburgh, PA



Cybergenetics

Cybergenetics © 2003-2016

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## National Academy of Sciences



"Strengthening Forensic Science:  
A Path Forward" (2009)

- Human examination bias
- Statistics & reporting
- Underlying scientific basis

Among existing forensic methods, only nuclear DNA analysis has been rigorously shown to have the capacity to consistently, and with a high degree of certainty, demonstrate a connection between an evidentiary sample and a specific individual or source.

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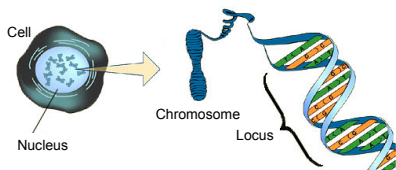
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## DNA biology



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## Short tandem repeat

DNA locus paragraph



23 volumes in cell's DNA encyclopedia

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  
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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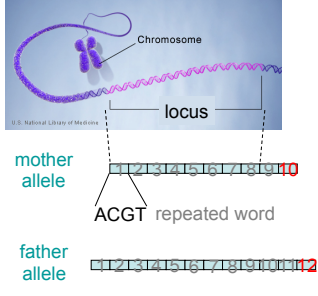
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## DNA genotype



Chromosome

locus

U.S. National Library of Medicine

mother allele  
1 2 3 4 5 6 7 8 9 10  
ACGT repeated word

father allele  
1 2 3 4 5 6 7 8 9 10 11 12

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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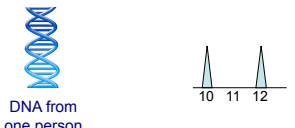
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## DNA laboratory

Evidence item → Lab → Evidence data



DNA from one person

Separations

- Extract
- Amplify
- Detect

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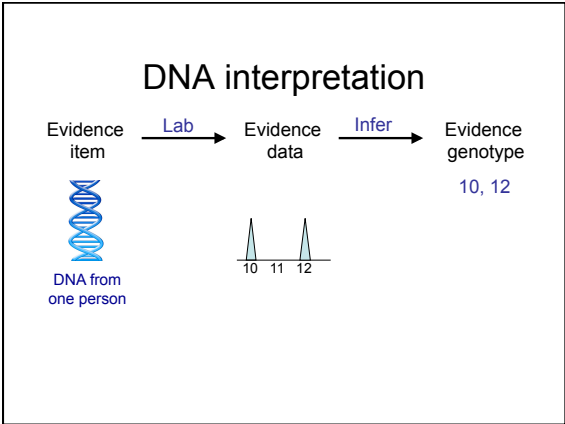
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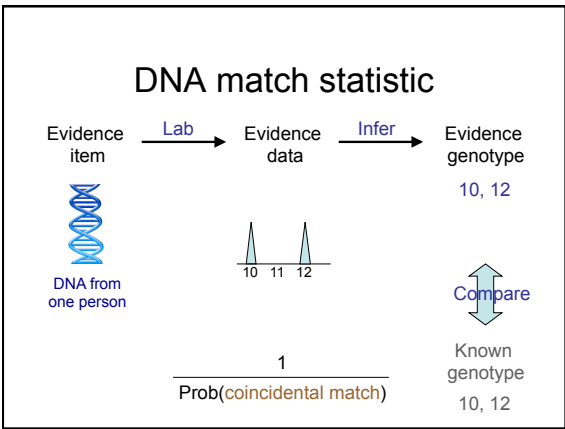
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### National Academy of Sciences

"Strengthening Forensic Science: A Path Forward" (2009)

- Human examination bias
- Statistics & reporting
- Underlying scientific basis

However, ... there may be problems ... with how the DNA was ... interpreted, such as when there are mixed samples

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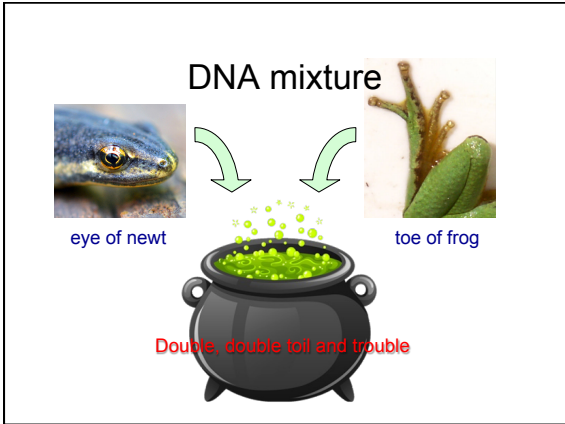
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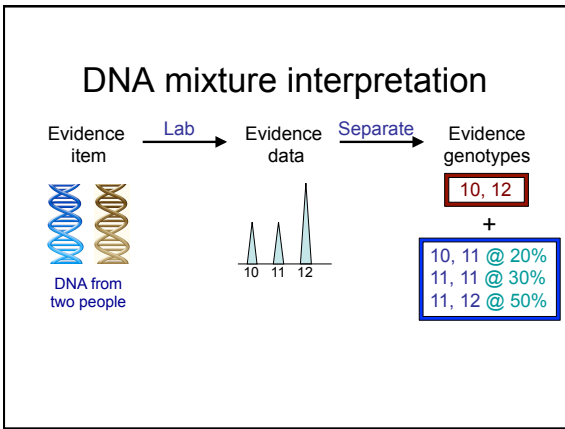
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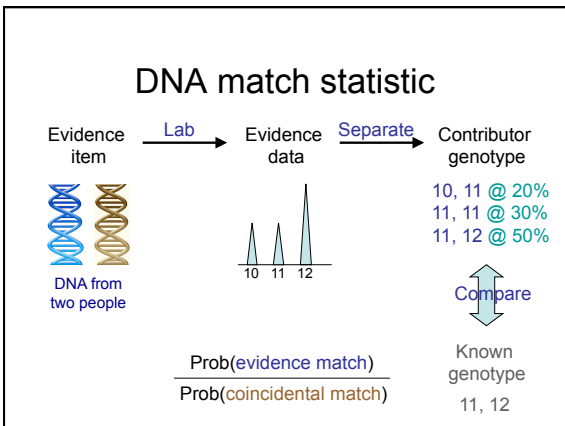
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## Pennsylvania v Ralph Skundrich

On July 25, 2002, a Pittsburgh college student, 18,  
was threatened with a gun and  
sexually assaulted in her Shadyside apartment.

The victim's jeans and T-shirt contained biological evidence.

The Allegheny County crime lab developed  
DNA data from the two evidence items.

Skundrich was identified as a suspect after a DNA match  
was made in the national database in 2009.

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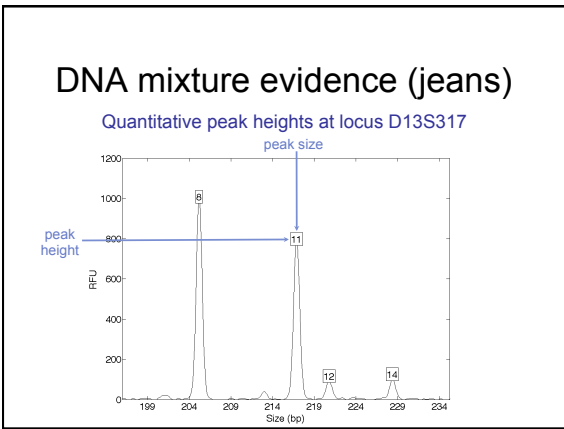
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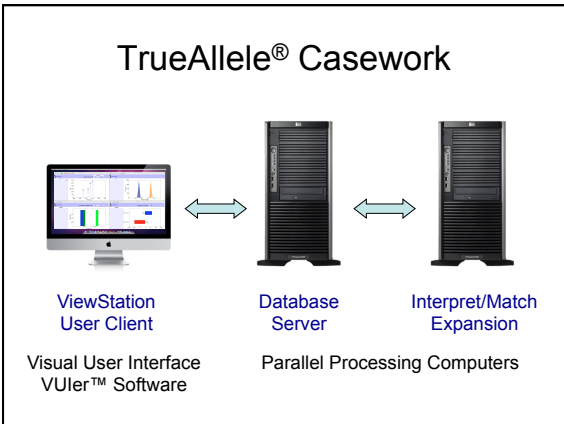
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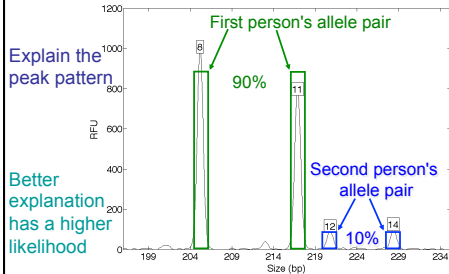
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## How the computer thinks

Consider every possible genotype solution




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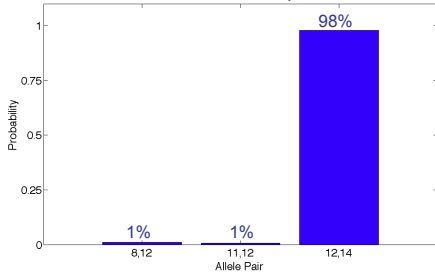
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## Evidence genotype

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




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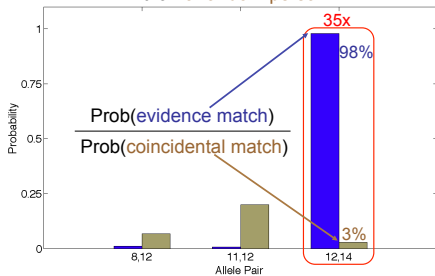
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## DNA match information

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




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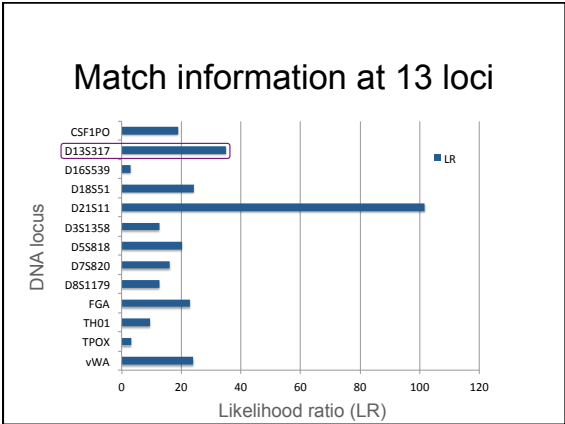
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### Is the suspect in the evidence?

A match between the jeans and Ralph Skundrich is:  
 2.1 quadrillion times more probable than coincidence

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### Is the suspect in the evidence?

A match between the jeans and Ralph Skundrich is:  
 2.1 quadrillion times more probable than coincidence

A match between the T-shirt and Ralph Skundrich is:  
 4.04 quadrillion times more probable than coincidence

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## Pennsylvania v Ralph Skundrich

### Man sentenced to 75-150 years for rape

April 17, 2014 11:43 PM  
By Paula Reed Ward / Pittsburgh Post-Gazette

"This case was solved on DNA alone. There's no way he would have been identified otherwise."  
— *Prosecutor Janet Necessary*

"You need to be removed from society and you are incapable of being rehabilitated. Your days of torturing women are over."  
— *Judge David Cashman*

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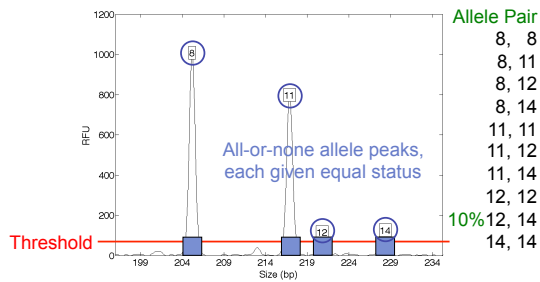
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## Crime lab data summary

Over threshold, peaks are labeled as allele events



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## Probability of inclusion (PI)

Calculation at locus D13S317

*Simple formula:* For all "alleles" over threshold, add up their frequencies, and square the number

$$(.10 + .32 + .31 + .035)^2 = (.765)^2 = .585$$

Threshold match statistic is 1/PI

$$1/ (.585) = 1.71$$

Computer match statistic is 35

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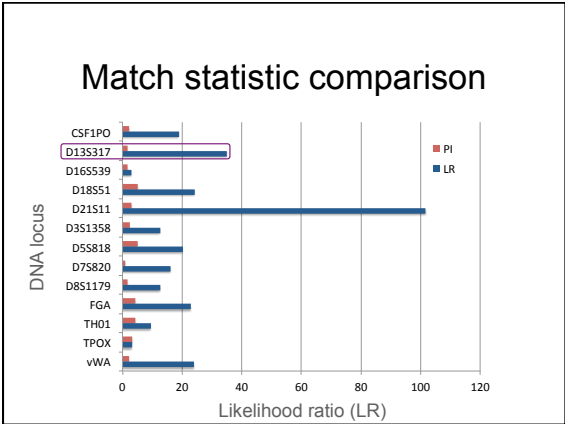
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### Information comparison

Method	Jeans	T-shirt
Combined PI	280 thousand (5)	630 thousand (5)
TrueAllele	2 quadrillion (15)	4 quadrillion (15)

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### Pennsylvania v Kevin Foley

Apr 2006: Blairsville dentist John Yelenic murdered in his Indiana County home

Nov 2007: Trooper Kevin Foley charged with crime

Feb 2008: Defense questions 13,000 DNA match score

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### Three DNA match statistics

Group	Method	Result
FBI	Combined PI	13,000
Boston Univ.	Victim known	22,000,000
Cybergenetics	TrueAllele	189,000,000,000

- Why are there different match results?
- How do mixture interpretation methods differ?
- Which of these methods are reliable?

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### Different interpretation methods

Method	Victim's genotype	Quantitative data
Combined PI	Not assumed	Threshold
Victim known	Assumed	Threshold
TrueAllele	Assumed	All data

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### Frye: general acceptance in the relevant community

- Quantitative STR Peak Information
- Genotype Probability Distributions
- Computer Interpretation of STR Data
- Statistical Modeling and Computation
- Likelihood Ratio Literature
- Mixture Interpretation Admissibility
- Computer Systems for Quantitative DNA Mixture Deconvolution
- TrueAllele Casework Publications

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Threshold: all or none



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Quantitative: shades of gray



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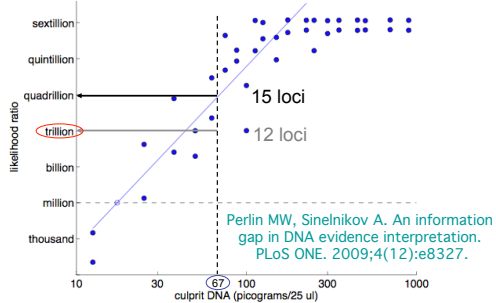
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Expected scientific result



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## TrueAllele admitted into evidence

COMMONWEALTH OF PENNSYLVANIA  
vs  
KEVIN J. FOLEY,  
Defendant.

IN THE COURT OF COMMON PLEAS  
INDIANA COUNTY, PENNSYLVANIA  
NO. 1178 CRIM 2007

### ORDER OF COURT

MARTIN, P.A.

AND NOW, this 2<sup>nd</sup> day of March 2009, this matter having come before the Court on the Defendant's Motion in Limine seeking to exclude the testimony of Dr. Robin Cotton and Dr. Mark Perlin and the Court having held a hearing thereon, it is hereby ORDERED and DIRECTED that the Motion in Limine is Denied.

BY THE COURT,



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## Expert testimony

Dr. Perlin explained to the jury why these apparently different results were expected by DNA science. "The less informative methods ignored some of the data," said Dr. Perlin, "while the TrueAllele computation considered all of the available DNA data."

"A scientist may look at the same slide using the naked eye, a magnifying glass, or a microscope," analogized Dr. Perlin. "A computer that considers all the data is a more powerful DNA microscope."

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Indiana Gazette.com  
Indiana, Pennsylvania  
IN PRINT DAILY. ONLINE ALWAYS.

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### Jury convicts trooper of dentist slaying

Published: Thursday, March 19, 2009 12:46 AM EDT

An Indiana County Court jury this evening convicted state trooper Kevin Foley of first degree murder in the April 13, 2006, slashing death of Blairsville dentist John Yelenic.

"John Yelenic provided the most eloquent and poignant evidence in this case," said the prosecutor, senior deputy attorney general Anthony Krastek. "He managed to reach out and scratch his assailant," capturing the murderer's DNA under his fingernails.

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# Pennsylvania appellate court

J-11008-11  
2012 PA Super 31  
COMMONWEALTH OF PENNSYLVANIA, IN THE SUPERIOR COURT OF PENNSYLVANIA  
Appellee  
v.  
KEVIN JAMES FOLEY, Appellant  
No. 2039 WDA 2009

Appeal from the Judgment of Sentence of June 1, 2009  
in the Court of Common Pleas of Indiana County  
Criminal Division at NOEL: CP-20-08-0001-170-2007

BEFORE: PANELLA, SHOGAN, and COLVILLE, JJ.  
OPINION BY PANELLA, J. FILED: FEBRUARY 15, 2012  
Appellant, Kevin James Foley, appeals from the judgment of sentence entered on June 1, 2009, by the Honorable William J. Martin, President Judge of the Court of Common Pleas of Indiana County, Criminal Division. After careful review, we affirm.

Because Foley has failed to establish the existence of a legitimate dispute over Dr. Nerlin's methodology, he has failed to show that Dr. Nerlin's testimony constituted "novel" scientific evidence. *See Bate*, 998 A.2d at 972. Therefore, we find that the trial court's decision to admit the testimony was not an abuse of discretion. Absent a legitimate dispute, there is no reason to "impede admissibility of evidence that will aid the trier of fact in the search for truth." *Id.*

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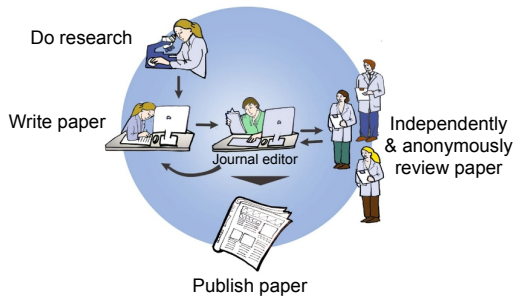
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# Peer-review process



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# Peer-reviewed validation study

FORENSIC SCIENCES  
Journal of Forensic Sci. 2015  
doi:10.1111/1514-0139.12288  
Available online at: [onlinelibrary.wiley.com](http://onlinelibrary.wiley.com)

PAPER  
CRIMINALISTICS

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Mark W. Perlin,<sup>1</sup> Ph.D., M.D.; Jennifer M. Hornyak,<sup>1</sup> M.S.; Garrett Sugimoto,<sup>2</sup> M.S.; and Kevin W.P. Miller,<sup>2</sup> Ph.D.

TrueAllele® Genotype Identification on DNA Mixtures Containing up to Five Unknown Contributors\*

**ABSTRACT:** Computer methods have been developed for mathematically interpreting mixed and low-template DNA. The genotype modeling approach computationally separates out the contributors to a mixture, with uncertainty measured through probability. Confidence of individual genotypes is calculated a likelihood ratio (LR) which measures identification information. This study statistically examined the genotype modeling performance of TrueAllele's "TrueAllele®" computer system. High- and low-template DNA mixtures of known contributor composition containing 2, 3, 4, and 5 contributors were tested. Sensitivity, specificity, and reproducibility were established through LR quantification in each of these mix groups. Coverage analysis tested LR behavior as the randomly generated DNA amount or contributor number. Analysis of variance found that consistent solutions were produced, since a sufficient number of contributors were considered. This study demonstrates the reliability of TrueAllele's operations on complex DNA mixtures of representative forensic composition. The results can help predict an alternative scenario for a DNA mixture analysis.

**KEYWORDS:** forensic science; DNA mixtures; genotype modeling; validation study; likelihood ratio; probabilistic; genotyping

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## TrueAllele validation papers

Perlin MW, Sinelnikov A. An information gap in DNA evidence interpretation. *PLoS ONE*. 2009;4(12):e8327.

Ballantyne J, Hanson EK, Perlin MW. DNA mixture genotyping by probabilistic computer interpretation of binomially-sampled laser captured cell populations: Combining quantitative data for greater identification information. *Science & Justice*. 2013;53(2):103-14.

Perlin MW, Hornyak J, Sugimoto G, Miller K. TrueAllele® genotype identification on DNA mixtures containing up to five unknown contributors. *Journal of Forensic Sciences*. 2015;on-line.

Greenspoon SA, Schiermeier-Wood L, Jenkins BC. Establishing the limits of TrueAllele® Casework: a validation study. *Journal of Forensic Sciences*. 2015;in press.

Perlin MW, Legler MM, Spencer CE, Smith JL, Allan WP, Belrose JL, Duceman BW. Validating TrueAllele® DNA mixture interpretation. *Journal of Forensic Sciences*. 2011;56(6):1430-47.

Perlin MW, Belrose JL, Duceman BW. New York State TrueAllele® Casework validation study. *Journal of Forensic Sciences*. 2013;58(6):1458-66.

Perlin MW, Dormer K, Hornyak J, Schiermeier-Wood L, Greenspoon S. TrueAllele® Casework on Virginia DNA mixture evidence: computer and manual interpretation in 72 reported criminal cases. *PLOS ONE*. 2014;(9)3:e92837.

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## Validation axes

**Sensitivity.** The extent to which interpretation identifies the correct person.

Truly include, don't falsely exclude.

**Specificity.** The extent to which interpretation does not misidentify the wrong person.

Truly exclude, don't falsely include.

**Reproducibility.** The extent to which interpretation gives the same answer to the same question.

Concordant independent computer runs.

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## Reliability (PA Rule 702)

### Testimony by Expert Witness

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 is beyond that possessed by the average layperson;
- (b) 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; and
- (c) the expert's methodology is generally accepted in the relevant field.

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## Daubert v. Merrell Dow Pharmaceuticals (1993)

Plaintiff: Bendectin caused birth defects  
Defendant: no reliable scientific evidence

Judge as gatekeeper

- (1) testable and tested
- (2) peer review and publication
- (3) known error rate
- (4) standards and controls
- (5) generally accepted in the relevant community

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## Frye v. United States (1923)

Defendant: systolic blood pressure deception test  
Government: not reliable scientific evidence

Just when a scientific principle or discovery crosses the line between the experimental and demonstrable stages is difficult to define. Somewhere in this twilight zone the evidential force of the principle must be recognized, and while courts will go a long way in admitting expert testimony deduced from a well-recognized scientific principle or discovery, the thing from which the deduction is made must be sufficiently established to have gained general acceptance in the particular field in which it belongs.

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 STATE OF NEW YORK  
DNA SUBCOMMITTEE  
OF THE  
COMMISSION ON FORENSIC SCIENCE

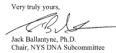
### Scientific community

May 20, 2011

Dear Commissioner Byrne:

Pursuant to Executive Law §995-b (13b) the DNA Subcommittee will assess and evaluate all DNA methodologies proposed to be used for forensic analysis and make recommendations to the Commission.

At the May 20, 2011 meeting the DNA Subcommittee reviewed and evaluated the New York State Police, *Tran-AMar<sup>®</sup> Y-STR* developed by New York State Police and *Chromaplex<sup>®</sup> Y-STR* developed by Applied Biosystems. The DNA Subcommittee offers a binding recommendation to the Commission on Forensic Science that its use by NYSF Forensic Investigation Center be approved for forensic casework.

Very truly yours,  
  
Jack Balthasar, Ph.D.  
Chair, NYS DNA Subcommittee

cc: Gina L. Bianchi, Esq., Deputy Commissioner & Counsel, DCJS  
NYS DNA Subcommittee Members  
NYS Commission on Forensic Science Members

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## WTC DNA data reanalysis

18,000  
victim remains



match

2,700  
missing people



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## Widespread acceptance

*Admitted after Frye or Daubert challenge in:*  
California, Louisiana, New York, Ohio, Pennsylvania,  
South Carolina, Virginia, Australia & United Kingdom

Crime labs use TrueAllele® system in  
California, Maryland, South Carolina & Virginia

Used in five hundred criminal cases in most of the  
United States, for both prosecution and defense

Seventy criminal cases in Pennsylvania  
Adams, Allegheny, Beaver, Berks, Butler, Cambria, Columbia, Delaware, Indiana,  
Luzerne, Lycoming, Mercer, Mifflin, Pike, Washington, Westmoreland, York

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## Source code

Source program  
computer instructions written in a  
human-readable computer language



**Compiler**



Input → Executable program → Output

SOFTWARE THAT RUNS  
ON A COMPUTER

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## Discovery request

Rule of Criminal Procedure 573.  
Pretrial Discovery and Inspection

(B) Disclosure by the Commonwealth.

(1) *Mandatory.*

(e) any results ... of scientific tests, expert opinions ... that are within the **possession or control of the attorney** for the Commonwealth;

(2) *Discretionary With the Court.*

(a) if the defendant files a motion for pretrial discovery, the court may order ... upon a showing that they are **material to the preparation of the defense, and that the request is reasonable:**

(iv) any other evidence specifically identified by the defendant, provided the defendant can *additionally establish* that its disclosure would be **in the interests of justice.**

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## Source code as trade secret

"A **trade secret** may consist of any formula, pattern, device or compilation of information which is used in one's business, and which gives him an opportunity to obtain an advantage over competitors who do not know or use it."  
*Crum v. Bridgestone/Firestone N. Am. Tire* (2006)

TrueAllele source code is a trade secret

"... scientists can validate the reliability of a computerized process even if the "source code" underlying that process is not available to the public. TrueAllele is proprietary software; it would not be possible to market TrueAllele if it were available for free ... TrueAllele has been tested and validated in peer-reviewed studies." *Pennsylvania v Foley*

Courts deny this discovery request –  
California, Maryland, New York, Ohio, Pennsylvania, Virginia

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## Relevance (PA Rule 403)

Excluding relevant evidence for prejudice,  
confusion, waste of time, or other reasons



The court may exclude relevant evidence if its **probative value is outweighed by a danger of one or more of the following:**

- unfair prejudice,
- confusing the issues,
- misleading the jury,
- undue delay,
- wasting time, or
- needlessly presenting cumulative evidence.

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# Commonwealth v Booher

IN THE COURT OF COMMON PLEAS OF BUTLER COUNTY,  
PENNSYLVANIA  
COMMONWEALTH v. CRIMINAL DIVISION  
vs. CP19-CR-1085-2018  
Benjamin Booher

**ORDER OF COURT**  
AND NOW, this 17<sup>th</sup> day of October, 2018, the Court grants the defendant's Motion to preclude the introduction of DNA evidence. The Commonwealth will not be permitted to present the testimony of Amber Morgan which relates the flat spermatozoa were identified in the catch net in front of the catch of M.L.'s underwear. Testimony given will not be permitted to testify of the results as set forth in conclusion seven of the report of July 31, 2018.

By the court,  
  
Timothy F. Givert  
Judge

The Defendant argues and the Court accepts said argument that the evidence itself and the Commonwealth's presentation of it would be misleading and confusing to the jury. A jury will likely hear DNA and assume it links the Defendant to the alleged crime even though it does not. The statistics are misleading and give a false impression to a jury that the Commonwealth's DNA evidence proves that the Defendant committed the offense. Expert testimony of this nature will lead the jury to implicitly conclude that this test proves that Benjamin Booher is the perpetrator, despite the fact that the results of the test only show that he cannot be excluded as a contributor of non-sperm DNA in any of M.L.'s clothing.

It would be extremely prejudicial to the Defendant if forensic scientist

DNA excluded as misleading, confusing & prejudicial

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## Crime lab DNA interpretation

(1)  
Choose, alter, discard,  
edit, and manipulate  
the DNA data signals



(2)  
Compare defendant's  
genotype to edited  
data & decide if he is  
in the DNA evidence



(3)  
If he is "included",  
then calculate a  
DNA mixture statistic




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## Process is not objective science

(1)  
Choose, alter, discard,  
edit, and manipulate  
the DNA data signals



(2)  
Compare defendant's  
genotype to edited  
data & decide if he is  
in the DNA evidence



(3)  
If he is "included",  
then calculate a  
DNA mixture statistic



- Human examination bias
- Statistics & reporting
- Underlying scientific basis

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## DNA statistic shuts down labs

"National accreditation board suspends all DNA testing at D.C. crime lab"  
*The Washington Post* April 27, 2015  
 Did not comply with FBI standards

"New protocol leads to reviews of 'mixed DNA' evidence"  
*The Texas Tribune* September 12, 2015  
 24,468 lab tests affected

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MIX05: NIST mixture interpretation interlaboratory study.  
 Butler JM, Kline MC, National Institute of Standards and Technology  
 Promega's Sixteenth International Symposium on Human Identification, 2005

## MIX05: Statistics not reproducible

National Institute of Standards and Technology  
 Two Contributor Mixture Data, Known Victim

Some Differences in Reporting Statistics

LabID	Kits Used	Cases		
		Caucasians	African-Americans	Hispanics
30	ProPlus/Collier	1.18E+15	2.13E+14	3.09E+15
34	ProPlus/Collier	2.40E+11	2.66E+07	3.93E+10
33	ProPlus/Collier	2.94E+08	1.13E+08	1.74E+09
6	ProPlus/Collier	40,000,000	3,500,000	260,000,000
9	ProPlus/Collier	1.14E+07	1.97E+07	1.54E+08
79	ProPlus/Collier	930,000	47,000	1,350,000
16	ProPlus/Collier	434,620	31,710	399,100

213 trillion (14)  
 31 thousand (4)

Remember that these labs are interpreting the same MIX05 electropherograms

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MIX13: An interlaboratory study on the present state of DNA mixture interpretation in the U.S.  
 Coble M, National Institute of Standards and Technology  
 5th Annual Prescription for Criminal Justice Forensics, Fordham University School of Law, 2014.

## MIX13: Statistics falsely include

**MIX13 Case 5 Outcomes with Suspect C**  
 (whose genotypes were not present in the mixture)

# Labs	Report Conclusions	Reasons given
6	Exclude Suspect C	detailed genotype checks (D+); True/False negative LFs (D-); assumed major/minor and suspects did not fit (D+); 3 labs noted Penta E missing allele 15 (PP16HS)
3	Inconclusive with C only (A & B included)	All these labs used PP16HS
21	Inconclusive for A, B, and C	
70	Include & provide CPI statistics	All over the road...

Range of CPI stats for Caucasian population:  
 FBI allele frequencies: 1 in 9 to 1 in 344,000

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## CPI lacks probative value

J Pathol Inform

Editor in Chief: [James M. Fox](#)  
 Associate Editor: [David J. V. Price](#)  
 Editor: [David J. V. Price](#)  
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Research Article

Inclusion probability for DNA mixtures is a subjective one-sided match statistic unrelated to identification information

Mark William Perlin\*

Forensic crime laboratories have generated CPI statistics on **hundreds of thousands of DNA mixture evidence items**. However, this commonly used match statistic behaves like a **random generator of inclusionary values**, following the LLN rather than measuring identification information. A quantitative CPI number **adds little meaningful information** beyond the analyst's initial qualitative assessment that a person's DNA is included in a mixture. **Statistical methods for reporting on DNA mixture evidence should be scientifically validated before they are relied upon by criminal justice.**

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## Relevance of CPI

Unvalidated DNA match statistic, unrelated to identification

PA Rule 401  
"evidence makes a fact more or less probable"

Probative value

none

PA Rule 403  
"outweighed by a danger of:"

Unfair prejudice  
Confusing the issues  
Misleading the jury

Cumulative evidence

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## Inconclusive mixture

Crime laboratory DNA report  
Crime lab user fee: \$5,000

Conclusions:

Item 1 – Swab of textured areas from a handgun

The data indicates that DNA from four (4) or more contributors was obtained from the swab of the handgun. Due to the complexity of the data, **no conclusions can be made** regarding persons A and B as possible contributors to this mixture.

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## Computer reanalysis

Cybergenetics TrueAllele® report  
Match statistics provide information



Unmix the mixture

Contributor


1

2

3


4

Person A excluded



400,000

Person B included



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40 cases, 8 trials, 3 DNA exonerations  
**TrueAllele in Allegheny County**

Crime	Evidence	Defendant	Outcome	Sentence
rape	clothing	Ralph Skundrich	guilty	75 years
murder	gun, hat	Leland Davis	guilty	23 years
rape	clothing	Akaninyene Akan	guilty	32 years
murder	shotgun shells	James Yeckel, Jr.	guilty plea	25 years
murder	fingernail	Anthony Morgan	guilty	life
weapons	gun	Thomas Doswell	guilty plea	1 year
bank robbery	clothing	Jesse Lumberger	guilty	10 years
drugs	gun	Derek McKissick	guilty plea	2 1/2 years
drugs	gun	Steve Morgan	guilty plea	2 1/2 years
murder	door, clothing	Calvin Kane	guilty plea	20 years
murder	gun	Jaykwaan Pinckney	guilty plea	10 years
child rape	clothing	Dhaque Jones	guilty plea	6 years
shooting	gun	Anthony Jefferson	guilty plea	4 years
weapons	gun	Delmingo Williams	guilty plea	3 years
incest rape	clothing	Terry L.	guilty	40 years
bank robbery	hat	Robert Schatzman	guilty	pending
weapons	gun	Rashawn Walker	guilty	1.5 years
robbery	hat	Lauren Peak	guilty plea	1 year
murder	gun	Chaz White	guilty plea	4 years

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## Post-conviction relief

**Title 42, Chapter 95, Subchapter B**

**§ 9543(a)(2). Eligibility for PCR**  
(ii) Ineffective assistance of counsel

(vi) The unavailability ... of exculpatory evidence that has subsequently become available and would have changed the outcome ...

**§ 9543.1. Post-conviction DNA testing**  
TrueAllele reanalysis of "inconclusive" DNA or inaccurate DNA match statistics

**Han Tak Lee v. Monroe County (PA Innocence)**  
US Court of Appeals for the Third Circuit (2012)  
"fire expert testimony at trial fundamentally unreliable, so entitled to federal habeas relief on due process claim"

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## More DNA mixture information

<http://www.cybgen.com/information>



- Courses
- Newsletters
- Newsroom
- Presentations
- Publications
- Webinars

<http://www.youtube.com/user/TrueAllele>  
TrueAllele YouTube channel



Cybergenetics



perlin@cybgen.com

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