

Challenging DNA Evidence

The Fifth Judicial District of Pennsylvania
Criminal Division
February, 2015
Pittsburgh, PA

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



Cybergenetics

Cybergenetics © 2003-2015

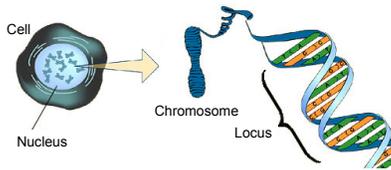
National Academy of Sciences

"Strengthening Forensic Science" (2009), page 100.

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.

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

DNA biology



Short tandem repeat

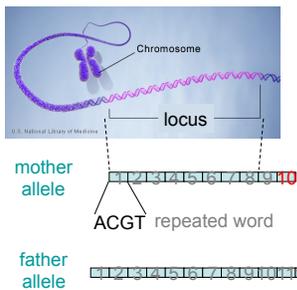
DNA locus paragraph

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
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

23 volumes in cell's DNA encyclopedia

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

DNA genotype



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

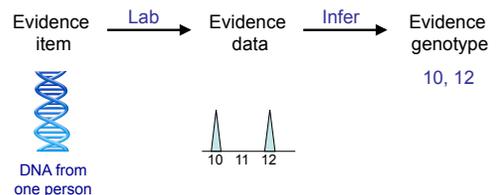
An allele is the number of repeated words.

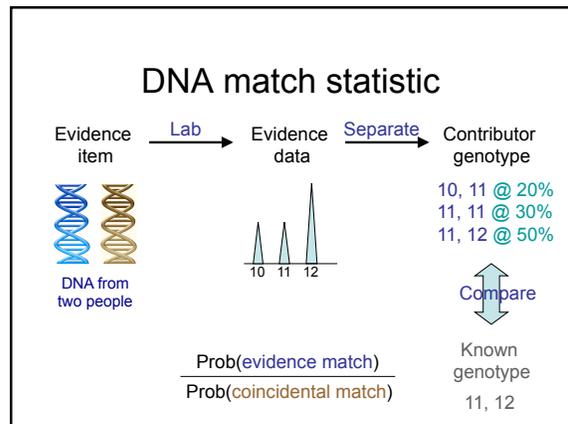
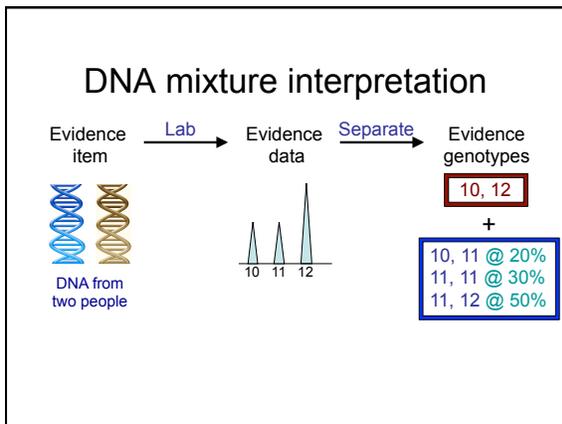
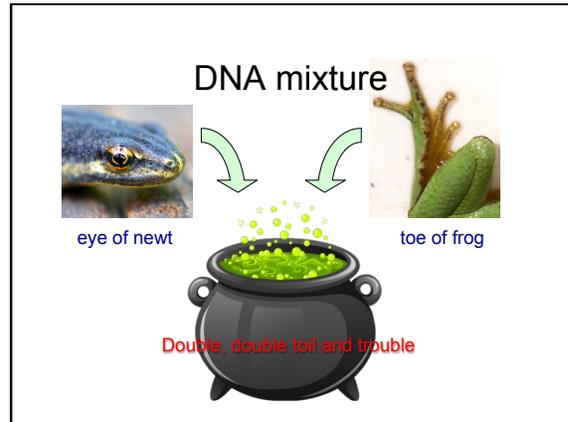
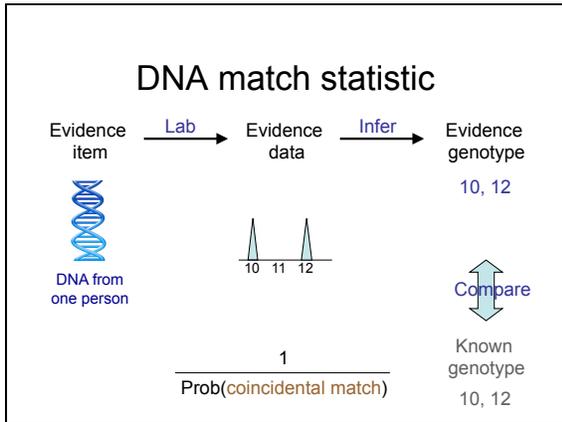
A genotype at a locus is a pair of alleles.

10, 12

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

Simple DNA evidence





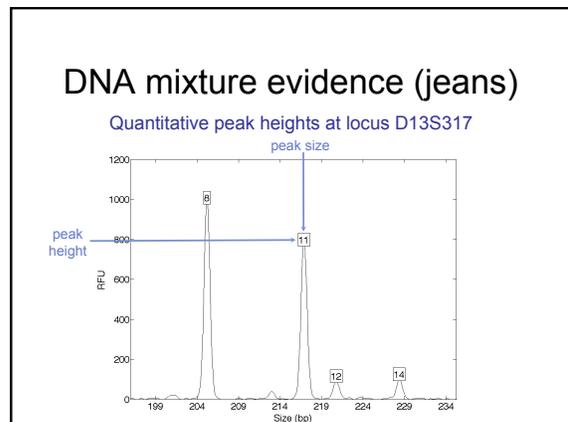
Pennsylvania v Ralph Skundrich

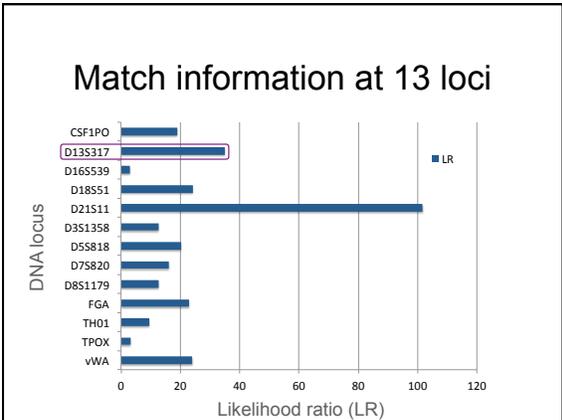
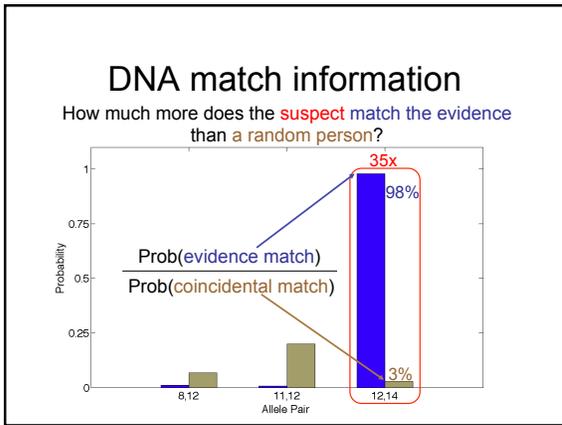
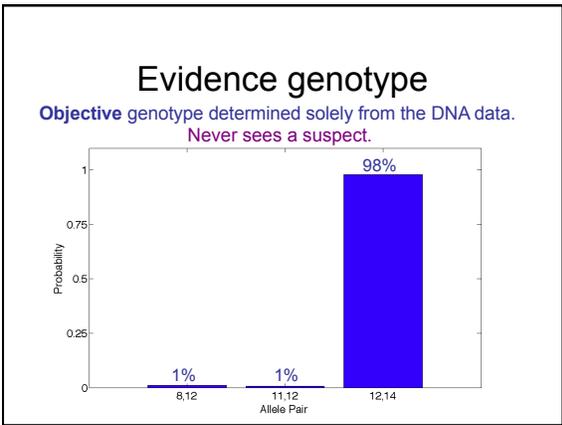
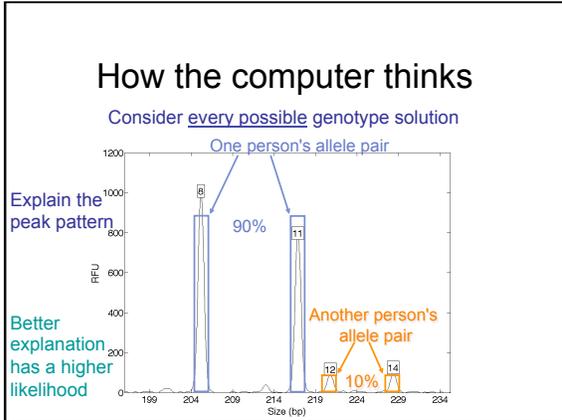
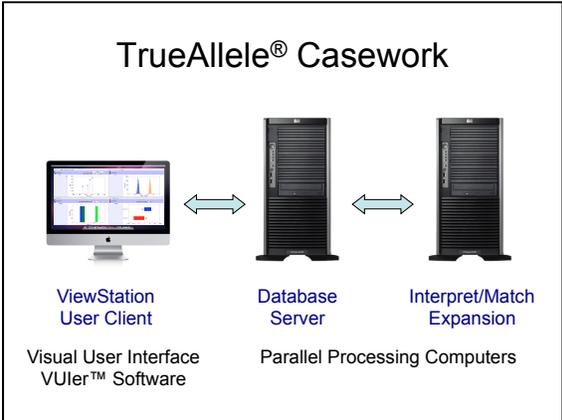
On July 25, 2002, a Pittsburgh college student, 18, was threatened with a gun and sexually assaulted in her Shadyside apartment.

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.





Is the suspect in the evidence?

A match between the jeans and Ralph Skundrich is:

2.1 quadrillion times more probable than coincidence

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

Pennsylvania v Ralph Skundrich

Man sentenced to 75-150 years for rape

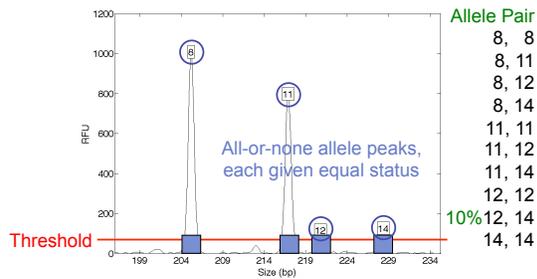
April 17, 2014 11:43 PM
By Paula Reed Ward / Pittsburgh Post-Gazette

"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

Data summary – “alleles”

Over threshold, peaks are labeled as allele events



Probability of inclusion (PI)

Calculation at locus D13S317

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

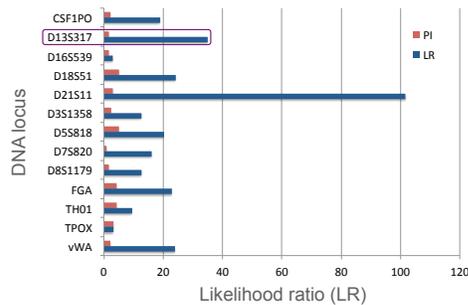
$$(.10 + .32 + .31 + .035)^2 = (.765)^2 = .585$$

Threshold match statistic is 1/PI

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

Computer match statistic is 35

Match statistic comparison



Information comparison

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

Validated genotyping method

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;in press.

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

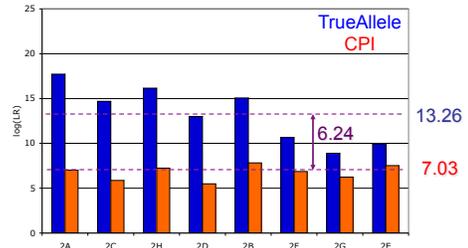
Perlin MW, Legler MM, Spencer CE, Smith JL, Allan WP, Belrose JL, Duceman BW. Validating TrueAllele® DNA mixture interpretation. *Journal of Forensic Sciences*. 2011;56(6):1430-47.

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.

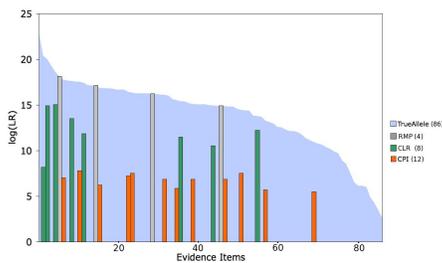
Perlin MW, Legler MM, Spencer CE, Smith JL, Allan WP, Belrose JL, Duceman BW. Validating TrueAllele® DNA mixture interpretation. *Journal of Forensic Sciences*. 2011;56(6):1430-47.

Preserves more match information



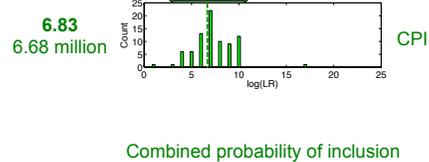
Perlin MW, Belrose JL, Duceman BW. New York State TrueAllele® Casework validation study. *Journal of Forensic Sciences*. 2013;58(6):1458-66.

Preserves more DNA evidence



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.

CPI information



MIX05: Thresholds not reproducible

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

Some Differences in Reporting Statistics

LabID	Kits Used	Caucasians	African Americans	Hispanics
130	ProPlus/Collier	1.10E+15	2.13E+14	3.00E+15
34	ProPlus/Collier	2.40E+11	7.00E+10	9.00E+10
33	ProPlus/Collier	2.94E+08	1.13E+08	1.74E+09
6	ProPlus/Collier	420,000,000	3,500,000	280,000,000
9	ProPlus/Collier	1.14E+07	1.97E+07	1.54E+08
79	ProPlus/Collier	930,000	47,906	1,350,000
16	ProPlus/Collier	434,600	31,710	359,100

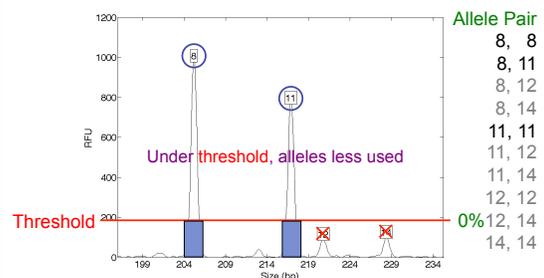
213 trillion (14)

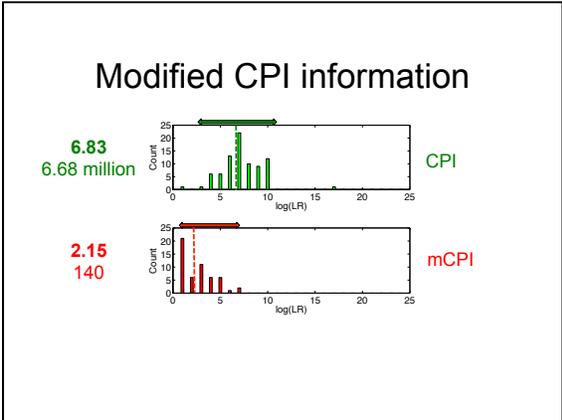
31 thousand (4)

Remember that these labs are interpreting the same MIX05 electropherograms

SWGDM 2010 guidelines

Higher threshold for human review





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: Thresholds falsely include

# Labs	Report Conclusions	Reasons given
6	Exclude Suspect C	detailed genotype checks (ID+); TrueAllele negative LR (ID+); assumed major/minor and suspects did not fit (ID+); 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	<i>All over the road...</i>

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

TrueAllele reinterpretation

The Washington Post
Virginia reevaluates DNA evidence in 375 cases
July 16, 2011

“Mixture cases are their own little nightmare,” says William Vosburgh, director of the D.C. police’s crime lab. “It gets really tricky in a hurry.”

“If you show 10 colleagues a mixture, you will probably end up with 10 different answers”
Dr. Peter Gill, Human Identification E-Symposium, 2005

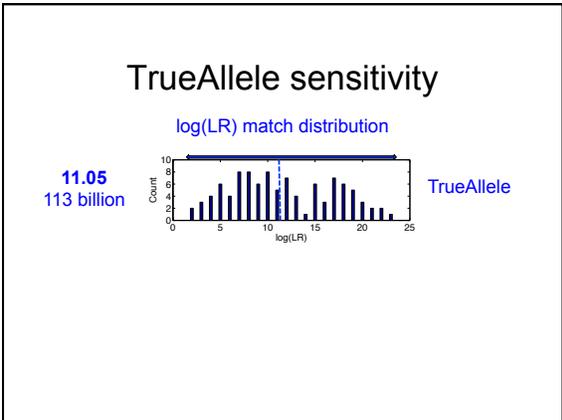
Perlin MW, Dormer K, Hornyak J, Schiermeier-Wood L, Greenspoon S. TrueAllele® Casework on Virginia DNA mixture evidence: computer and manual interpretation in 72 reported criminal cases. *PLOS ONE*. 2014;(9)3:e92837.

Sensitivity

The extent to which interpretation identifies the correct person

True DNA mixture inclusions

101 reported genotype matches
82 with DNA statistic over a million



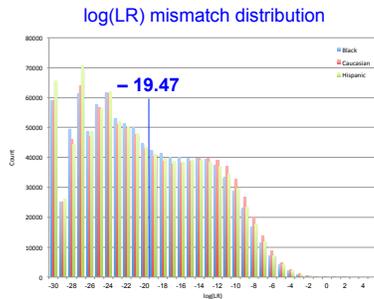
Specificity

The extent to which interpretation does not misidentify the wrong person

True exclusions, without false inclusions

101 matching genotypes x 10,000 random references
x 3 ethnic populations,
for over 1,000,000 nonmatching comparisons

TrueAllele specificity



Reproducibility

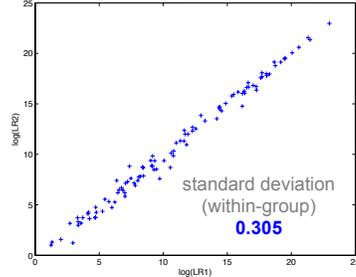
The extent to which interpretation gives the same answer to the same question

MCMC computing has sampling variation

duplicate computer runs
on 101 matching genotypes
measure log(LR) variation

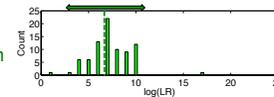
TrueAllele reproducibility

Concordance in two independent computer runs



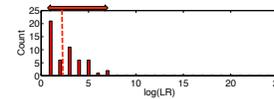
Comparison of methods

6.83
6.68 million



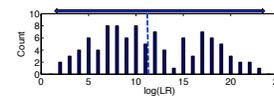
CPI

2.15
140



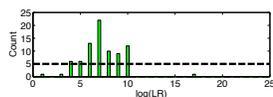
mCPI

11.05
113 billion

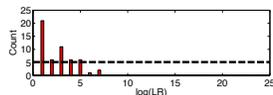


TrueAllele

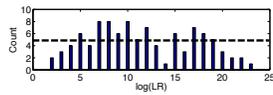
Accuracy of methods



CPI



mCPI



TrueAllele

Threshold methods do not correlate with information

Small coefficient of determination ($r^2 = 0.090$) leaves over 90% of the variance unexplained.
To the extent that TrueAllele quantitative modeling measures identification information, the CPI binary allele inclusion method is measuring something else.

Small coefficient of determination ($r^2 = 0.087$) leaves over 90% of the variance unexplained.

Since TrueAllele quantitatively measures identification information, the mCPI stochastic threshold method apparently measures some other data attribute.

Conservative results

Five matches, TrueAllele less than CPI.
Ten comparisons, no statistical support:

TrueAllele	CPI	mCPI
-10.64		
-6.52		
-5.05		
-4.87		
-4.86	3.48	
-3.22	6.04	6.34
-2.99	4.23	
-2.18		
-1.41	4.08	
-0.67	2.95	0.60

TrueAllele Virginia trials

144 cases analyzed
72 case reports – 10 trials

City	Court	Charge	Sentence
Richmond	Federal	Weapon	50 years
Alexandria	Federal	Bank robbery	90 years
Quantico	Military	Rape	3 years
Chesapeake	State	Robbery	26 years
Arlington	State	Molestation	22 years
Richmond	State	Homicide	35 years
Fairfax	State	Abduction	33 years
Norfolk	State	Homicide	8 years
Charlottesville	State	Homicide	15 years
Hampton	State	Home invasion	5 years

Cross examination

“Cross-examination is the greatest legal engine ever invented for the discovery of truth.”
– Dean John Henry Wigmore

- Is the DNA a mixture of two or more people?
- How did you calculate the match statistic?
- What is the scientific basis of that calculation?
- Have you or others validated the method?
- What is the method's false positive rate?
- How has its reliability been demonstrated?
- Are there peer-reviewed validation studies?

Federal Rules of Evidence 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.

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 scientific community

TrueAllele admissibility

State	Year	Challenge	Outcome
Pennsylvania	2009	Frye	admitted
Pennsylvania	2012	Appellate court	precedent
California	2013	Kelly-Frye	admitted
Virginia	2013	Spencer-Frye	admitted
Ohio	2014	Daubert	admitted
Louisiana	2014	Daubert	admitted
New York	2015	Frye	admitted

<http://www.cybgen.com/information/admissibility/page.shtml>

Pennsylvania Foley precedent

2012 PA Super 31
 COMMONWEALTH OF PENNSYLVANIA, Appellee
 v.
 KEVIN JAMES FOLEY, Appellant
 No. 2009 WDA 2009

Appeal from the judgment of sentence of June 1, 2009
 in the Court of Common Pleas of Indiana County,
 Criminal Division at NO.01: CP-22-CR-0001170-2007

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. Herli's methodology, we have failed to prove that Dr. Herli's testimony constituted "novel" scientific evidence. See *Batz*, 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.*

New York v. John Wakefield

Judge Michael Coccoma
 Deputy Chief Administrative Judge
 for the Courts outside New York City

Frye hearing: October, 2014
 Schenectady, NY

Peer review
 Validation studies
 Scientific community
 Legal acceptance
 Expert testimony

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 TrueAllele® vLidation developed by New York State Police and Cybergenetics Corp. The DNA Subcommittee offers a binding recommendation to the Commission on Forensic Science that it be used by NYSF Forensic Investigation Center by approved for forensic genetics.
 Very truly yours,
 Jack Bullerose, 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

WTC DNA data reanalysis

18,000
 victim remains

2,700
 missing people



match

Findings

The evidence shows that computerized probabilistic approaches and likelihood ratio principles used by Cybergenetics TrueAllele Casework are superior to current methods. Moreover, Cybergenetics TrueAllele Casework has been demonstrated to be one of, if not, the most advanced method of interpreting DNA profiles from mixed and low-template DNA. It has been proved to be more accurate than CPI and CLR, preserves more of the identification information, eliminates examiner bias, produces a match value which human review may not, and permits standardization of mixture reporting whereas human review approaches can lead to very different match statistics on the same DNA data.

Over 25 cases, 20 reports; 5 trials, 1 exoneration

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	finger nail	Anthony Morgan	stipulation	life
weapons	gun	Thomas Doswell	guilty plea	1 year
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
incest rape	clothing	Terry L.	guilty	40 years

Incest rape: Allegheny, PA

From age 7 to 14

Item	Description	Daughter	Father
7A	T-shirt – stain area 1	10.5 quadrillion	4.55 quadrillion
7B	T-shirt – stain area 6	673 thousand	3.64 trillion
7C	T-shirt – stain area 7	117 billion	7.69 trillion
12A	Bra	566 million	5 million

Incest rape: Westchester, NY

From age 7 to 14

Description	Daughter	Father
Comforter stain 9	10.4 thousand	543 quadrillion
Comforter stain 21	73.4 quadrillion	167 trillion
Comforter stain 26	77.5 quadrillion	303 trillion
Comforter stain 30	2.1 billion	544 quadrillion
Comforter stain 31	68.1 quadrillion	33.4 quadrillion

Incest rape

Estimates for father-daughter rape:

- High prevalence (1% of girls)
- Low detection (under reported)
- Routine DNA evidence (1,000 cases)

With mixtures of relatives,
most crime labs cannot report a statistic,
and the DNA evidence is not used.

The TrueAllele computer
routinely separates mixtures of relatives,
and produces reliable match statistics.

TrueAllele in criminal cases

Used in over 200 cases for DNA evidence

Testimony:

- state
- federal
- military
- foreign

For:

- prosecution
- defense

Crimes:

- armed robbery
- child abduction
- child molestation
- murder
- rape
- terrorism
- weapons

TrueAllele in the United States

Laboratory systems or case reports in 23 states



More TrueAllele 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