

# Forensic DNA Typing Issues

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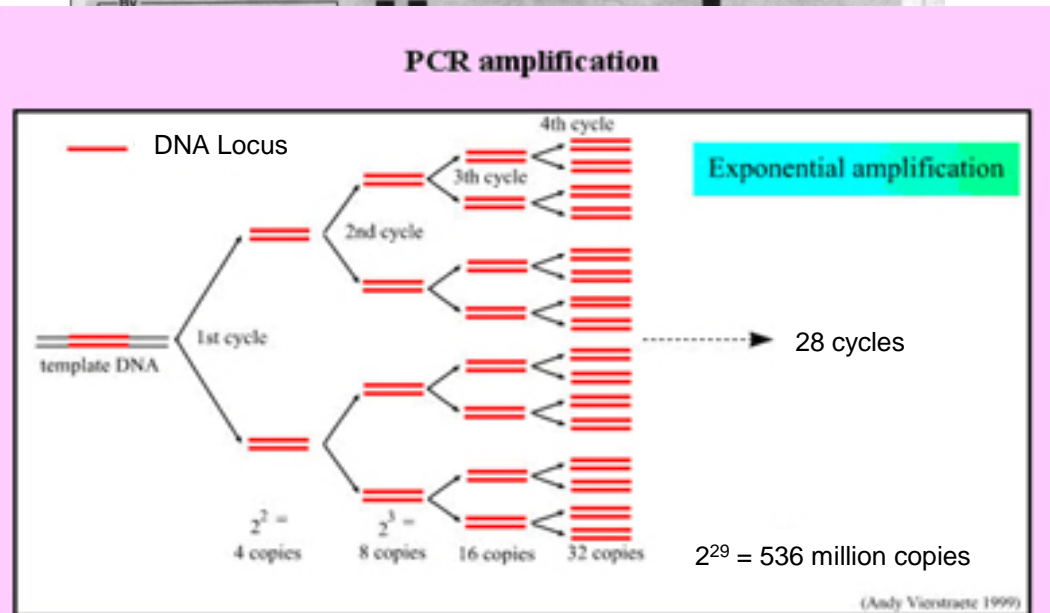
# January 1992 Rape/Murder

*R v Jarrett* (1994) 62 SASR 443

## PCR DNA Challenge

PCR = DNA amplification (copying) method

Exponential copying → sensitivity



# 1982 Homicide, 1996 DNA Testing

## Million-to-one chance that trapped a killer

### No way out when the past caught up with a murderer

By SYLVIA KRIVEN

The past caught up with Rodney Keith Winters when he was concreted around a pool at his home near Maitland, New South Wales, on August 29 last year.

Detectives walked up to the father of three and arrested him for the murder of Cheryl Anne Trace, 29, at the Edinburgh RAAF air base on December 4, 1982.

Cheryl's strangled and semi-clad body was found lying on bark chips in a plantation of shrubs beside an accommodation block early that morning.

She had been seen there the night before at a regular disco at the base, held every Friday after pay day.

Winters was questioned many times about Cheryl's death — in 1982, 1983 and 1985.

But this time, there was no way out for the former RAAF armaments fitter turned BHP operator, as police told him they were following up a chance of a million-to-one.

As Winters stood by the cement mixer, the arresting officer told him: "The samples you gave when you were at Edinburgh Air Base have been DNA-tested. This test shows that the semen on the body and clothing is yours. The semen is yours. A figure given to us at this stage of testing is a million-to-one."

Winters replied: "What do you mean? I assisted in the inquiries back there. It can't be my semen because I didn't do the crime."

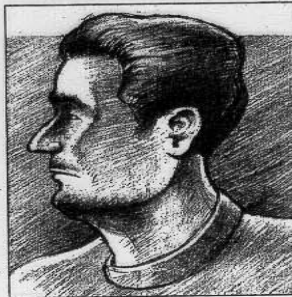
But yesterday, Winters changed his mind.

He pleaded guilty in the Supreme Court to Cheryl's murder and was remanded in custody for sentencing on a date to be fixed.

His arrest and subsequent court appearance followed the recent revision of scores of unsolved murders, dating back to 1946, by scientists at the State Forensic Science Centre, applying new techniques in DNA testing.

DNA, or deoxyribonucleic acid, is the genetic material found in all body cells, with no two people having the same composition, other than identical twins.

Court files show that on November 14 last year, the centre's most senior forensic scientist, Dr Angela Van Daal, concluded



An artist's impression of Winters.



Cheryl Anne Trace: murdered.

Approximately 99.9 per cent of the population would be excluded as the source of this DNA

in a report to the Office of the Director of Public Prosecutions that Winters could not be excluded as the source of semen taken from Cheryl's body.

"Approximately 99.9 per cent of the population would be excluded as the source of this DNA," she wrote.

In a supplementary report, on March 21 this year, Dr Van Daal said 95 per cent of people would be excluded as the source of DNA found on another swab taken from Cheryl's body and that "Winters cannot be excluded from being the second source of the DNA (after Cheryl's own DNA) on the swab".

Court files reveal Winters had been stationed at the base since mid-October, 1982, but lived off the base with his wife, at Smithfield Plains.

On Friday, December 3, 1982, he met up with friends and attended a St Barbara Day celebration at the base. St Barbara is the patron saint of armors.

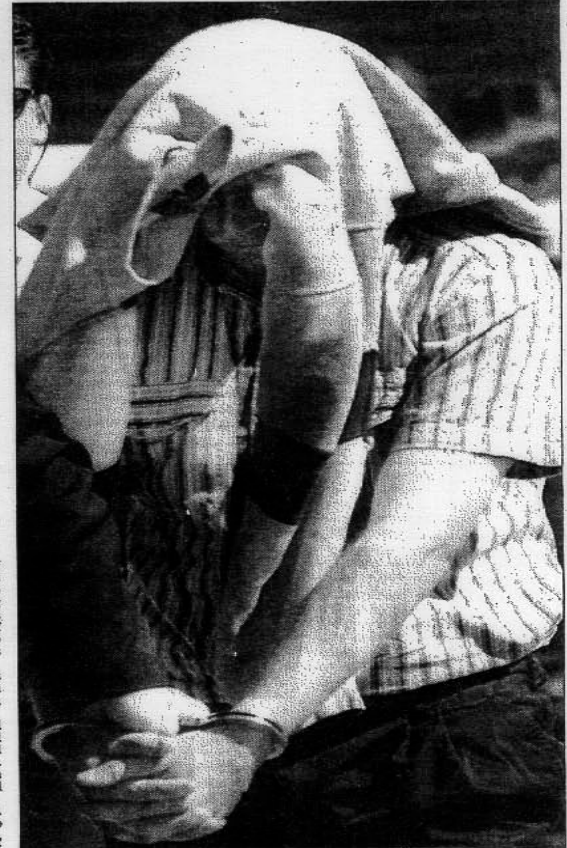
The celebration began with a sports day and ended with a disco at the Sportsman's Bar in the Airmen's Club from 7.30pm, to which civilians were allowed, including Cheryl, who was waiting for a divorce from her husband and father of her seven-year-old son, was at the disco with her younger sister Gail, 17, and Gail's friend, Lori.

After the disco, the girls joined at least another 12 people for drinks in a common room in Block 53. That's where her sister, Gail, last saw her, about 1.15am.

Gail later told police she and Lori stayed on at the base and, although they looked for her at 1.45am, they assumed she had caught a taxi to her parents' home nearby.

Yesterday, Cheryl's mother, Mrs Eileen Trace, who now lives in Portland, declined to comment about Winters' admission.

"I don't want to talk about it," she said. Cheryl's father, Mr John Trace, who lives near Rockhampton, Queensland, was told first by *The Advertiser* about Winters' plea and also declined to comment.



Rodney Keith Winters led into Singleton Court yesterday.

# DNA: Power of Exclusion

MOMENT OF FREEDOM

## After falsely serving 19 years, Danny Brown is home

BY [DALE EMCH](#)  
BLADE STAFF WRITER

For almost two decades, Danny Brown hadn't walked outside a prison without his wrists being shackled and armed guards at his side.

Yesterday, he emerged alone and unchained from the Lucas County jail into the pale afternoon sunshine shortly after a judge granted him a new trial for a murder he's been imprisoned for since 1981.



Danny Brown hugs James McCloskey of Centurion Ministries, who was involved in his fight to get a new trial. THE BLADE/LISA DUTTON

## Man Go's Free After Serving Four Years on False Rape Accusation

2 Comm

{ Posted on December 15, 2009 at 10:00pm in Shame on Them }



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## DNA Clears Another Man Falsely Convicted Of Rape After Serving Prison Bid

Posted by [iLiveHipHop.com](#) on February 6, 2010 at 11:09am in Politics

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Talk about vindication after being railroaded by New York police over 30 years ago, Freddie Peacock, a mentally ill New York man, was exonerated Thursday after DNA testing showed he was innocent after spending nearly six years in prison for a 1976 rape he insisted he didn't commit in 1976.

Peacock's conviction was based on a false confession police attributed to him just hours after the early morning rape of a 24-year-old woman who lived in the same apartment building in Rochester.

According to The Associated Press, State Judge David Egan vacated the conviction after lawyers for Peacock and Monroe County prosecutors agreed DNA evidence obtained from the victim's underwear and from Peacock in 2008 proved he wasn't the rapist.

# DNA Databases: Cold Hits

## Break in cold case rape tied to DNA databank

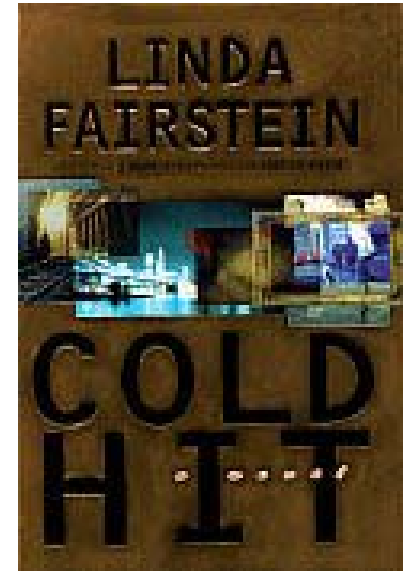
Posted: Oct 13, 2010 5:15 AM



MADISON (WKOW) – Court records show a man was criminally charged in connection with a 2000 Madison rape after crime scene DNA was cross referenced with a DNA database and turned him up as a match.

Christopher Golden, 39, was charged Monday with second degree sexual assault.

Records show Golden allegedly punched and raped a 37-year old woman as she returned to her car in a downtown parking garage on North Pinckney Street during the early morning hours of June 16, 2000.



## DNA Nabs Sex Offender for 1977 Murder

Monday January 1, 2007

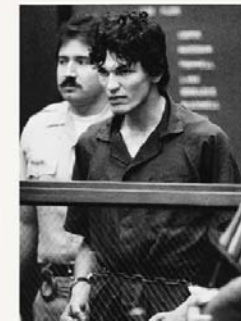


A "cold hit" match of DNA collected from a convicted sexual offender has helped California authorities make an arrest in the 1977 rape and murder of 17-year-old Mary Ann Quigley. The state crime lab matched DNA in the Quigley case to a 47-year-old registered sex offender in Santa Clara.

San Francisco police link 'Night Stalker' Richard Ramirez to girl's 1984 slaying

13 Oct 2009 11:31 CDT

Rub  
Los Angeles



A cold hit in a national DNA database leads to the accusation in year-old's death. A new genetic sample is taken from the death inmate for confirmation.

San Francisco police announced Thursday that DNA evidence linked Richard Ramirez, the Southern California serial killer known as the "Night Stalker," to the 1984 slaying of a 9-year-old girl.

Ramirez, who is on death row for a string of murders committed there than two decades ago, submitted DNA samples to detectives Wednesday morning at San Quentin State Prison, according to the San Francisco Police Department.

Authorities are also trying to determine whether Ramirez is connected to any other slayings in the San Francisco area during that time.

The unsolved case of the young girl's killing was reopened five years ago when Police Inspector Holly Pera recalled it from her days as young patrol officer.

"That's part of the reason why the case was relooked at," Pera said during a news conference. "It's the type of case -- as a new offic

# Familial Searching

Killer who was trapped by his relative's DNA;  
Man who threw brick into lorry driver's cab  
traced by a world-first technique.

## Brick thrower jailed over death

**A man has been jailed for six years for throwing a brick through a lorry driver's windscreen, causing him to suffer a fatal heart attack.**

Michael Little, 53, was driving along the M3 last year when the brick was hurled at his 40-tonne lorry.



Michael Little was praised by police for keeping his lorry under control

Craig Harman, 20, of Glamis Close, Frimley, Surrey, admitted manslaughter at the Old Bailey.

Mr Little, from Hornchurch, Essex, managed to steer his vehicle to safety off the motorway but died later.

## Killer convicted thanks to relative's DNA

› 17:55 20 April 2004 by [Shaoni Bhattacharya](#)  
› For similar stories, visit the [Crime and Forensics](#) Topic Guide

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The first criminal conviction based on a new DNA technique which uses relatives' DNA to track a suspect was made in the UK on Monday.

Craig Harman of Frimley, Surrey was convicted of manslaughter and jailed for six years on the basis of "familial DNA searching", which linked him to the crime scene via a close relative's DNA profile.

Harman threw a brick from a bridge over a motorway which crashed through the windscreen of Michael Little's lorry in March 2003. As the brick hit his chest, 53-year-old Little suffered a heart attack, though he still managed to steer his vehicle out of harm's way before dying.

# Low Template DNA Typing

*R. v Hoey* [2007] NICC 49 (20 December 2007)

## Setback for LCN DNA

**Omagh Bombing Trial Outcome - LCN DNA is not Reliable as Evidence**

Dec 22, 2007 [Karen Lotter](#)



Moments before the Omagh bomb went off. - [www.wesleyjohnston.com](http://www.wesleyjohnston.com)

When Sean Hoey was freed in Belfast, Northern Ireland after being accused of 29 counts of murder for the Omagh Bombing, the troubles for LCN DNA were just beginning.

Sean Hoey was cleared on 20 December 2007 of 56 charges including the murders of 29 people in the [Omagh bomb attack](#) in Belfast, Northern Ireland, in a case that was essentially built on forensic evidence - in particular DNA.

According to all reports, highly unreliable DNA evidence, chaotic police record-keeping and allegations that police had falsified evidence, undermined the prosecution case against Sean Hoey in the Omagh Bombing trial almost from day one.

Omagh bombing: Sean Hoey found not guilty



# DNA Typing Issues

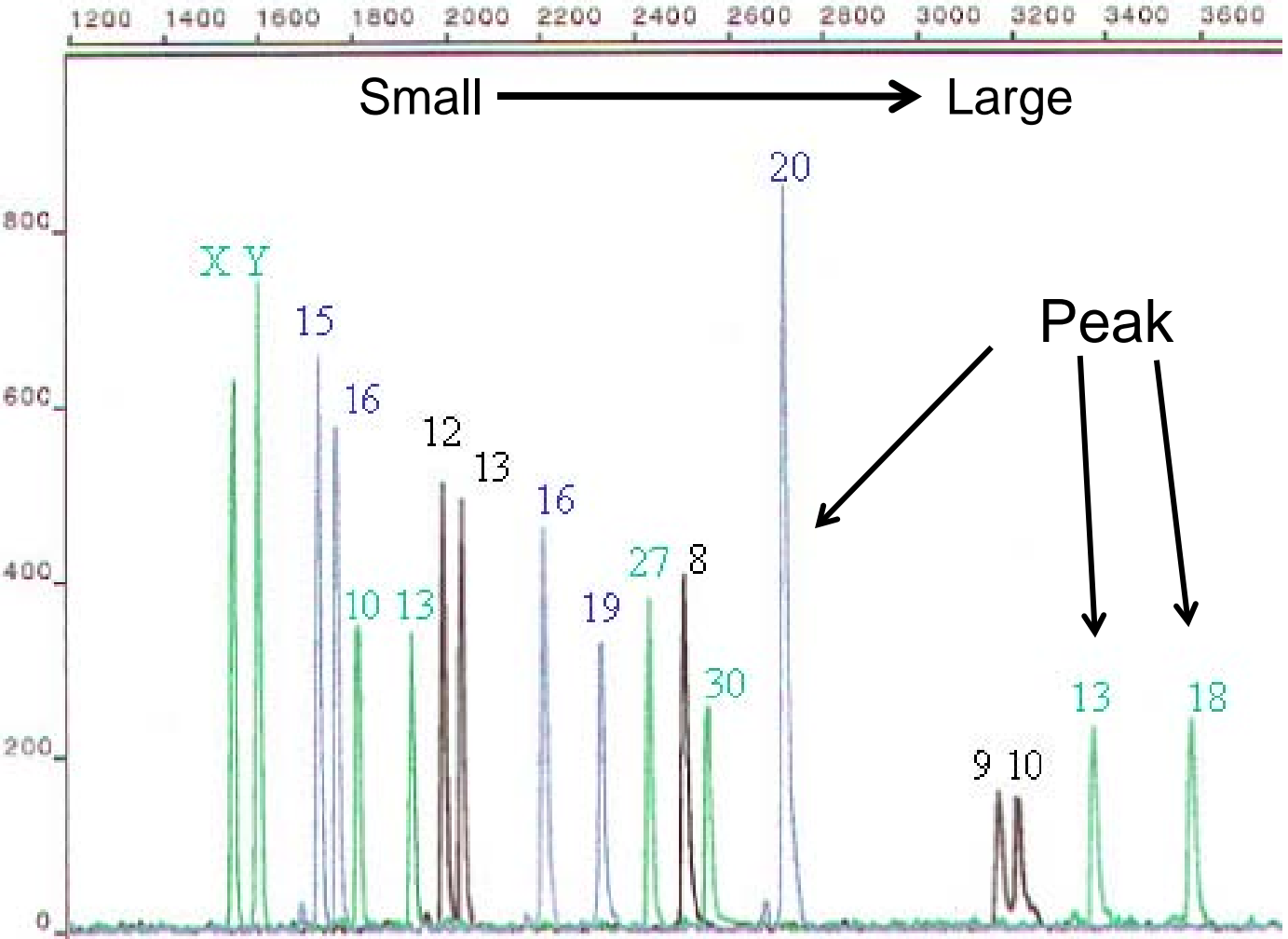
- DNA Profile Interpretation
  - Stutter
  - Peak Height Ratio
  - Mixtures
- Low Template DNA (LT-DNA) Analysis
- Mixture Samples
- Case Examples
- ‘DNA Only’ Cases



# DNA Profile

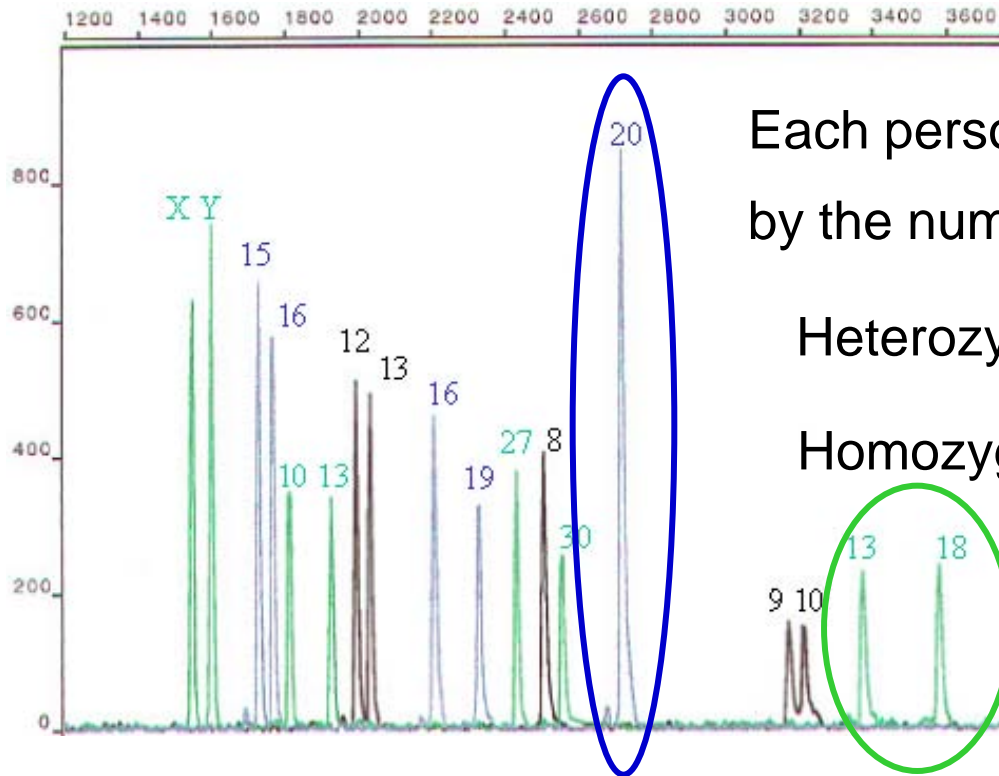
Time to Detection (Laser) →

Relative Fluorescent Unit (RFU)



# STR DNA Profile

The DNA Markers (Loci) are Short Tandem Repeats (STRs)



Each person has two alleles (represented by the numbers) at each STR locus

Heterozygote = two different alleles

Homozygote = two alleles same

DNA Testing – like a barcode

DNA Profile: X,Y 15,16 10,13 12,13 16,19 27,30 8 20 9,10 13,18

# DNA Profile Interpretation

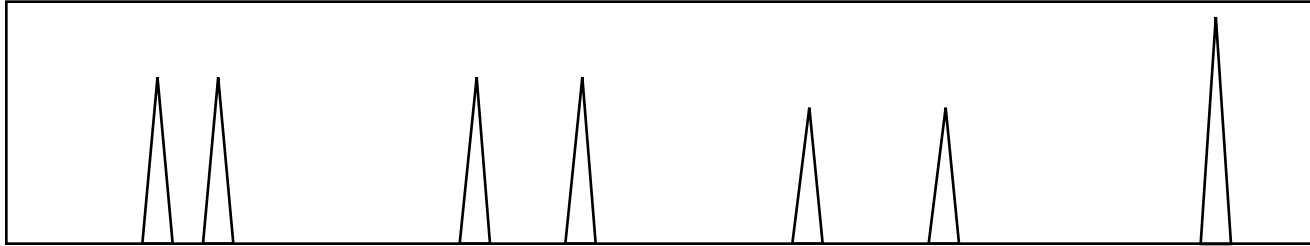
Locus 1

Locus 2

Locus 3

Locus 4

Reference  
from  
Suspect

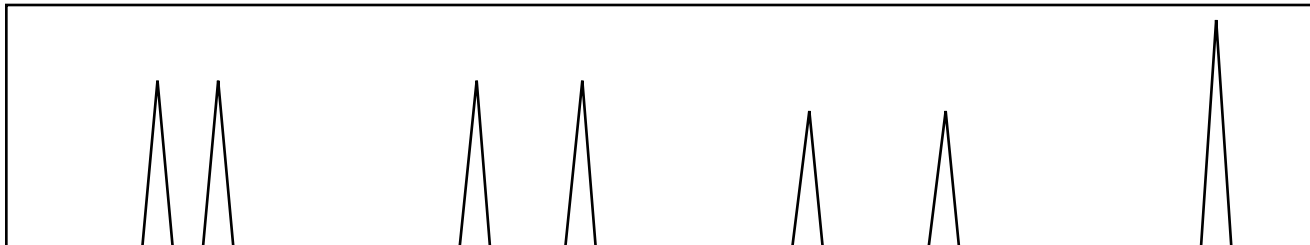


Evidence A



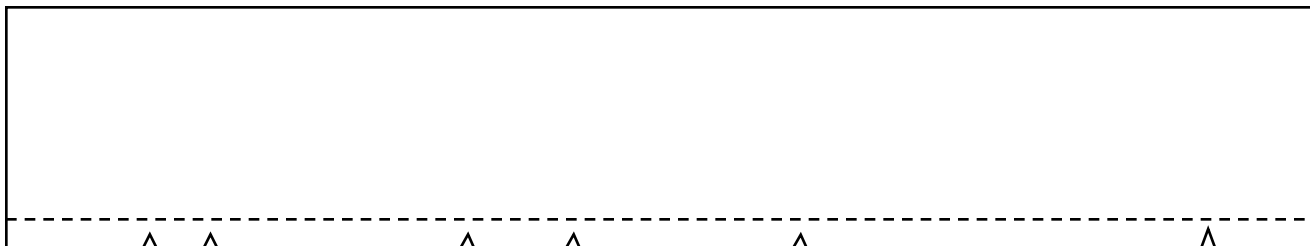
Exclusion

Evidence B



Inclusion  
(Failure to  
Exclude )

Evidence C



Inconclusive

Interpretation threshold

# DNA Profile Interpretation

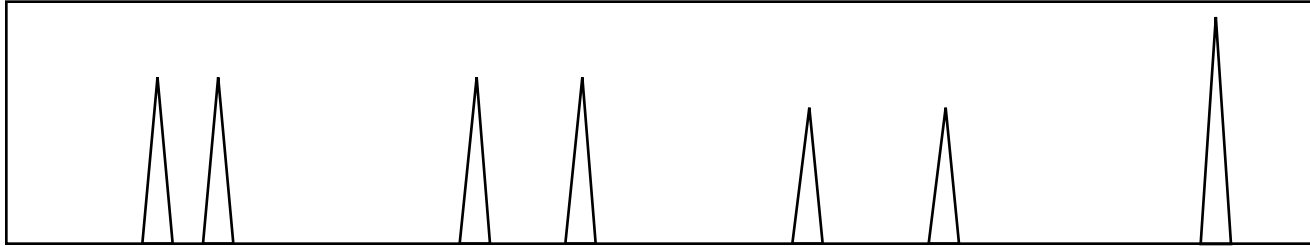
Locus 1

Locus 2

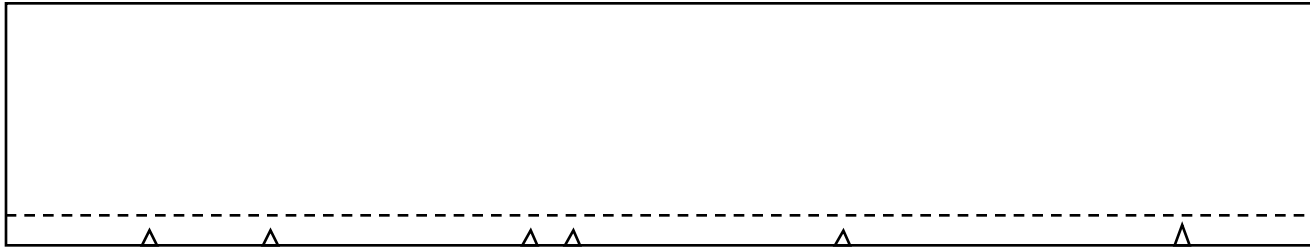
Locus 3

Locus 4

Reference  
from  
Suspect



Evidence D



Exclusion

Interpretation threshold

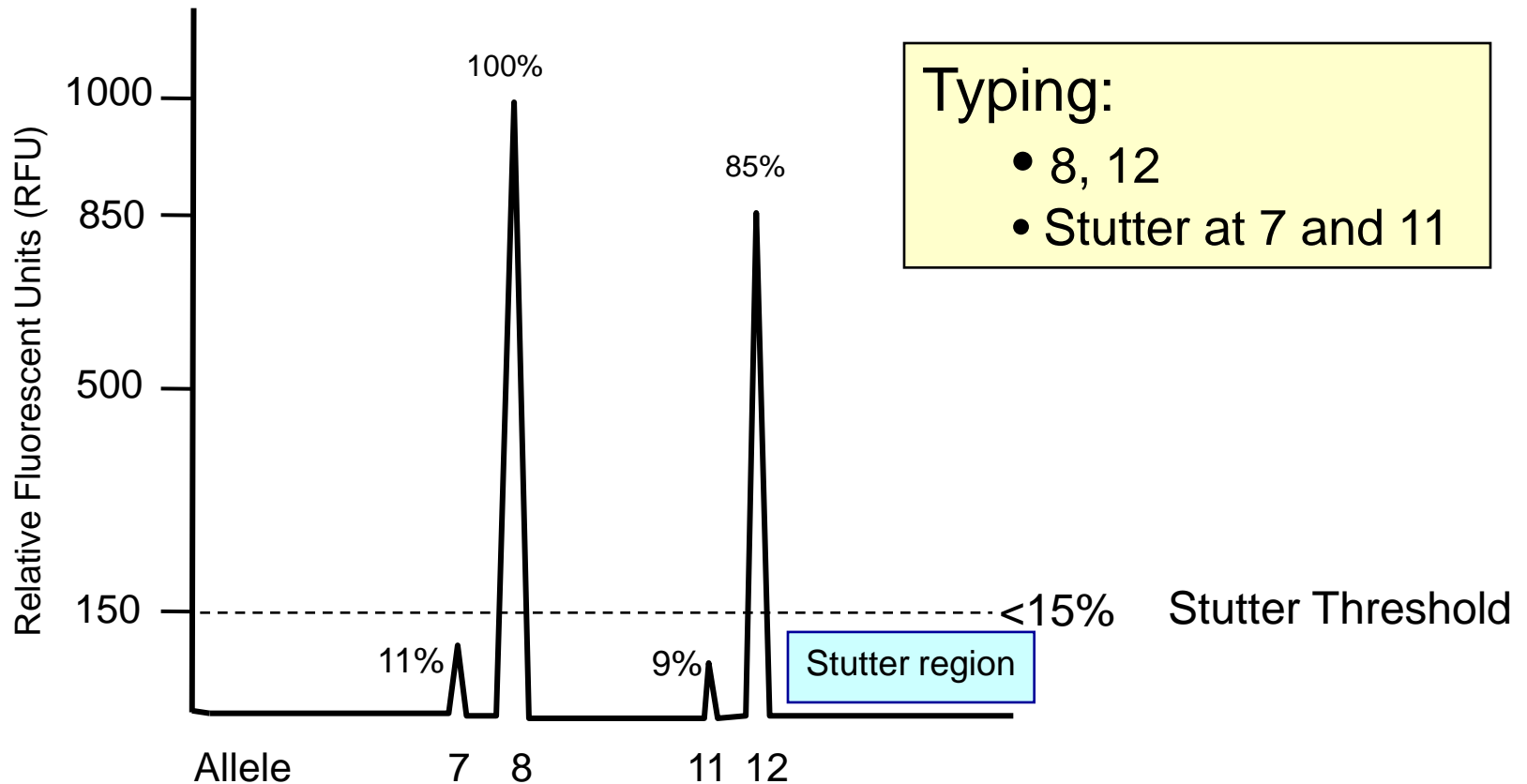
# DNA Profile Interpretation

1. Stutter
2. Peak Height Ratio
3. Mixtures

# 1. Stutter

## Stutter

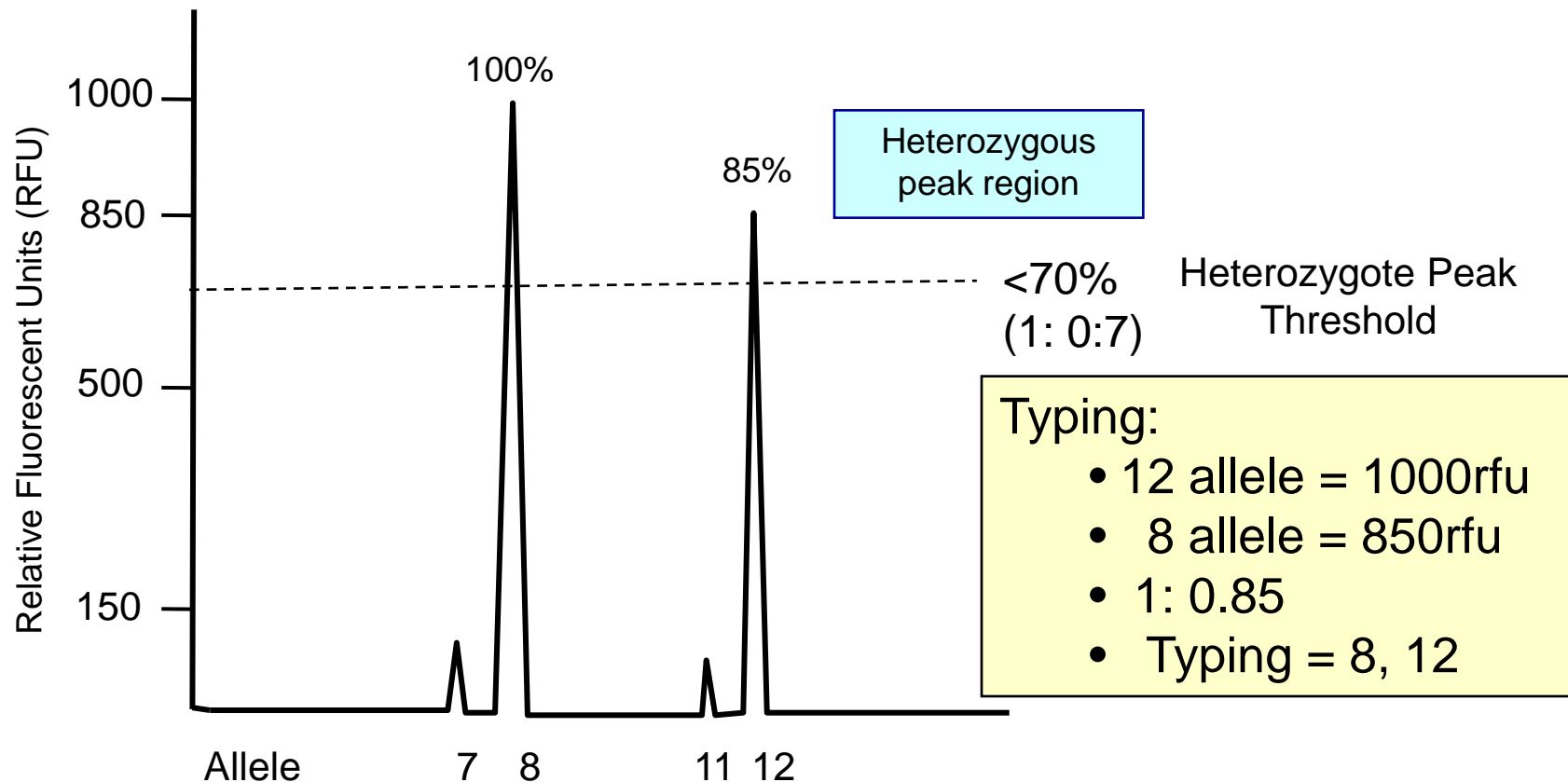
- PCR Reaction artefact
- Appearance of a peak in the n-1 allele position



## 2. Peak Height Ratio (PHR)

### Heterozygote PHR

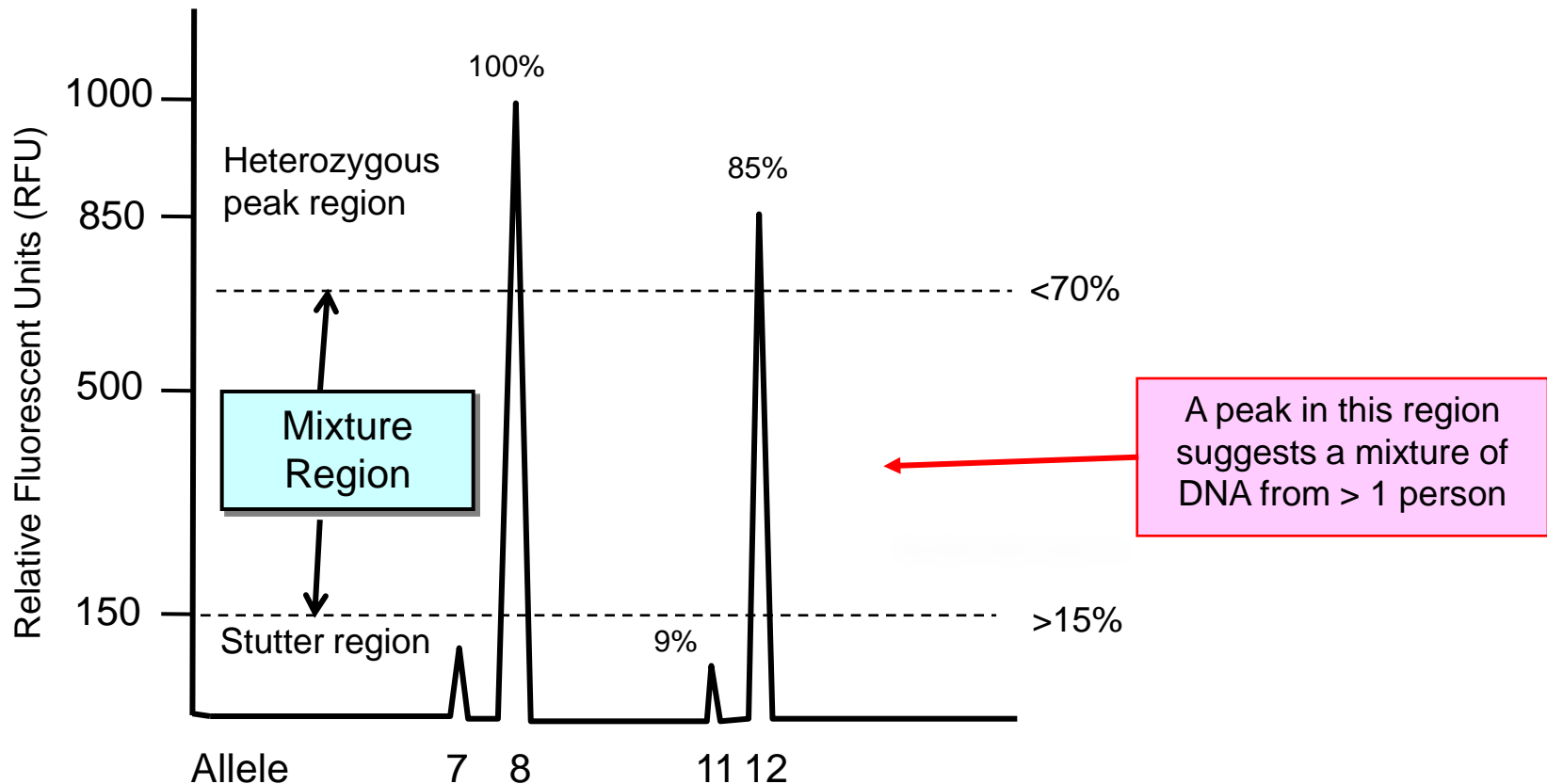
- Level of balance between the two alleles from one person
- Theoretically 1:1 ratio



# 3. Mixtures

Single source sample: DNA from one person

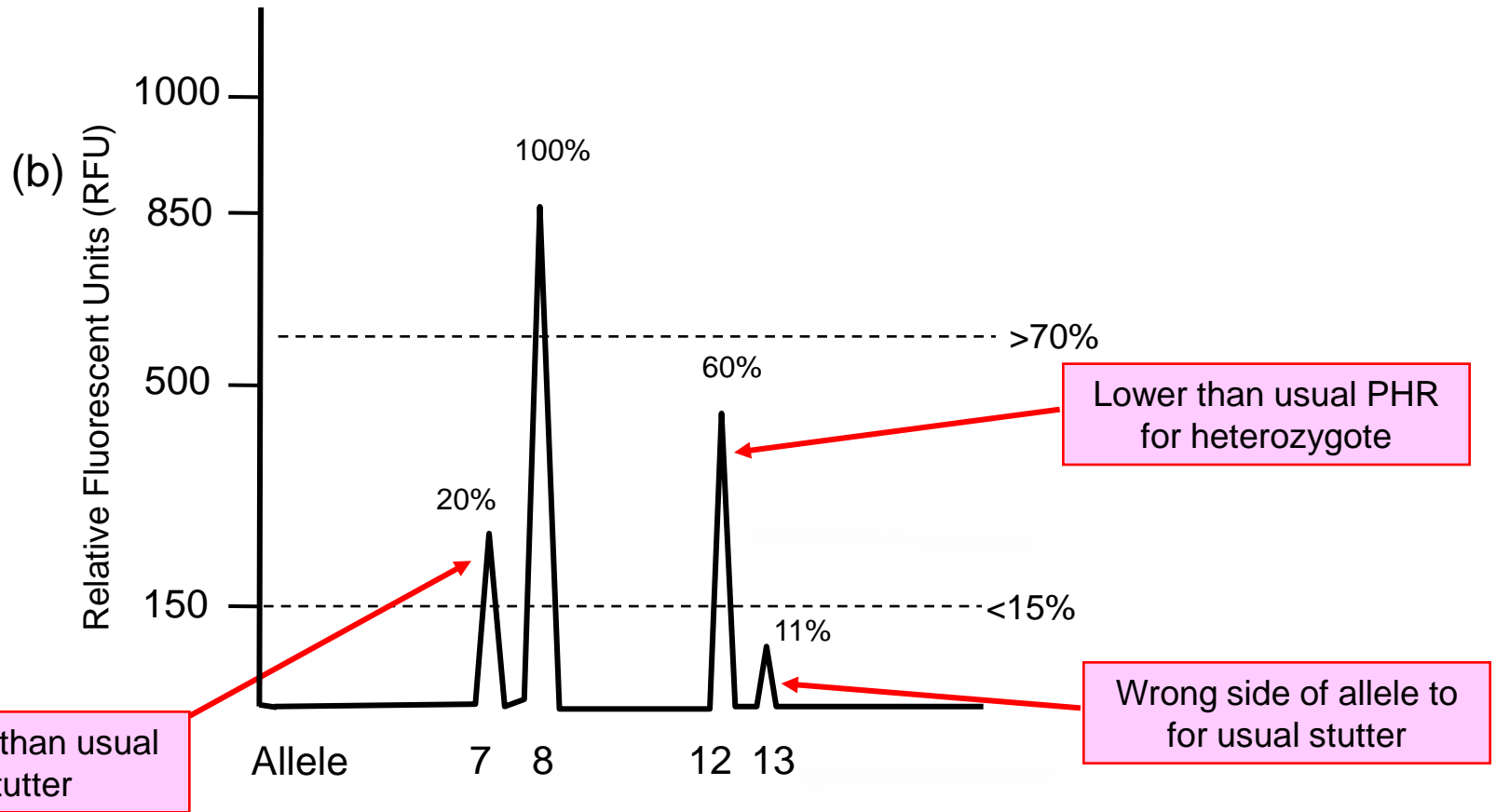
Mixture: DNA from more than one person





# 3. Mixture Example

Mixture: DNA from more than one person



# DNA Typing Issues

- DNA Profile Interpretation

- Stutter

- Peak Height Ratio

- Mixtures

- Low Template DNA (LT-DNA) Analysis

- Mixture Samples

- Case Examples

- 'DNA Only' Cases

# Low Template DNA (LT-DNA) Analysis

1. LT-DNA typing → increased sensitivity
  - more PCR amplification cycles
2. LT-DNA Analysis → any DNA sample where the results are below the threshold for reliable interpretation
  - ~ 100pg DNA (17 cells)

# NATA Accreditation

## NATA Validation Requirement

- Developmental process used to acquire the necessary information to assess the ability of a procedure to obtain a result reliably
- Determine the conditions under which such results can be obtained and
- **Determine the limitations of the procedure.**
- **Identifies critical aspects of a procedure which must be carefully controlled and monitored.**

Definition from the NATA Forensic Science FAD document

(<http://www.nata.asn.au/publications/category/4-nata-accreditation-requirements>).

# Importance of DNA Quantitation

## DNA amount

(log scale)

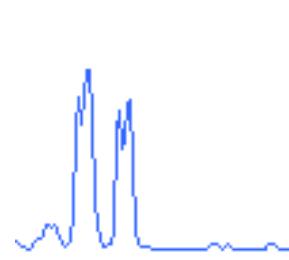
100 ng

10 ng

1 ng

0.1 ng

0.01 ng



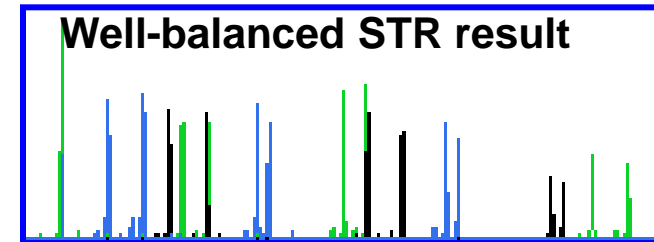
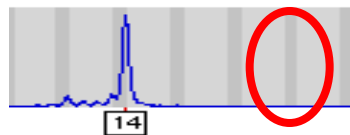
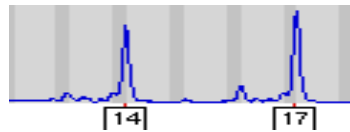
## Too much DNA

- Artifacts

**STR Kits Work Best in This Range**

2.0 ng

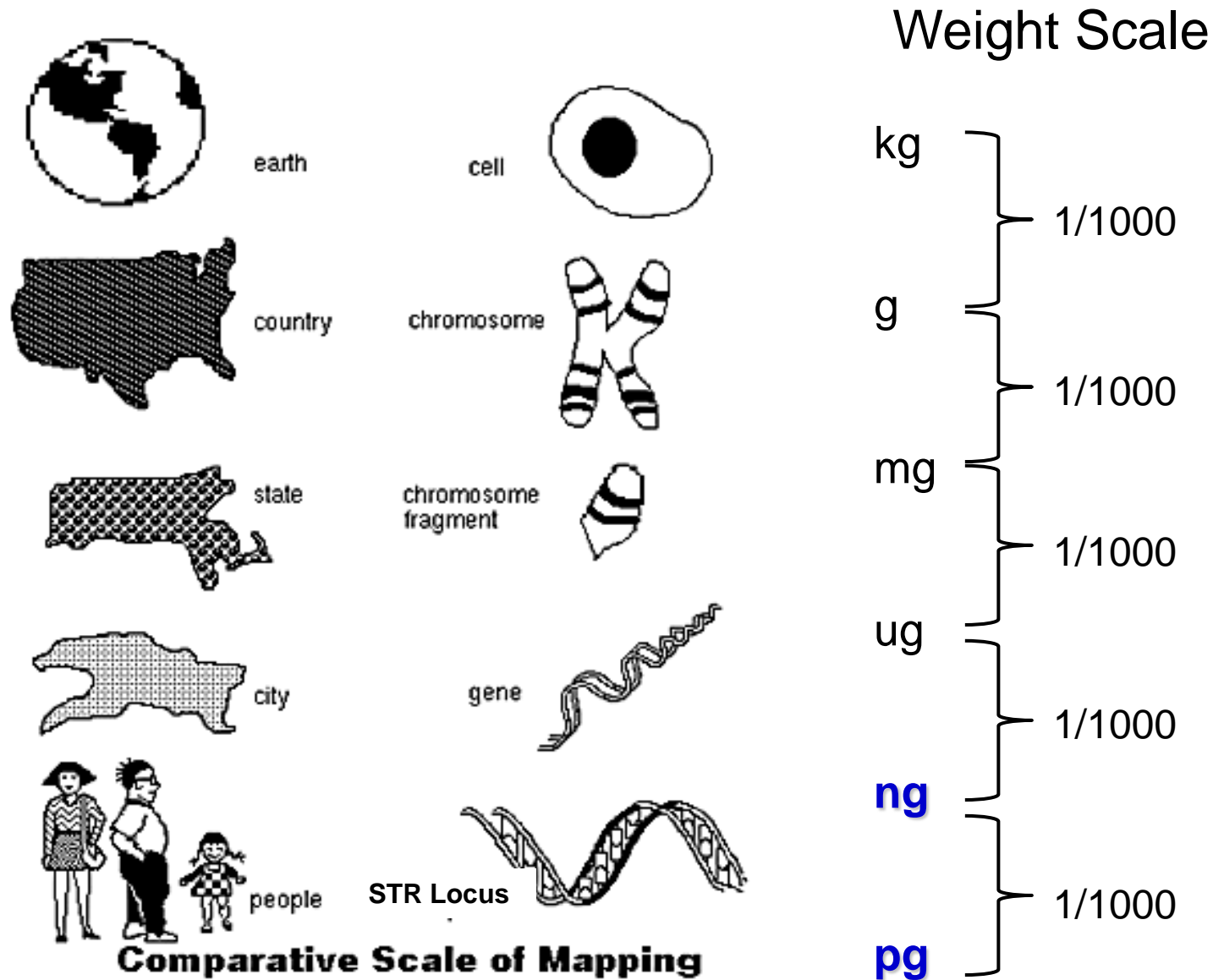
0.2 ng



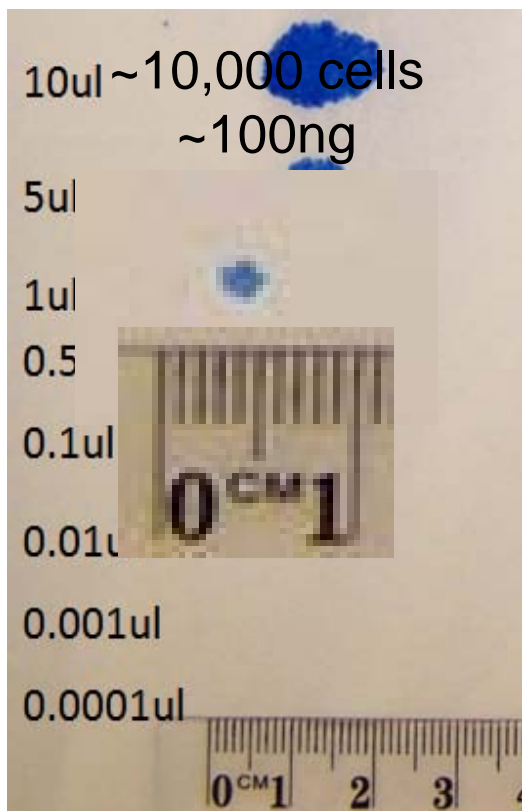
## Too little DNA

- Peak imbalance
- Allele drop-out

# Relative Size Scale



# DNA Typing Amounts



Volume	Approximate DNA Available	
	Blood	Semen
10ul	250 - 500ng	1.2ug - 4.0ug
5ul	125 - 250ng	600ng - 2.0ug
1ul	25 - 50ng	120ng - 400ng
0.5ul	12.5ng - 25ng	60ng - 200ng
0.1ul	2.5ng - 5ng	12ng - 40ng
0.01ul	0.25ng - 0.5ng	1.2ng - 4.0ng
0.001ul	25pg - 50pg	0.12ng - 0.4ng
0.0001ul	2.5pg - 5pg	12pg - 40pg



= DNA typing amounts



= LT-DNA amounts

# Number of Cells in DNA Amounts

Amount DNA (ng)	Amount DNA (pg)	Number of Cells*
2ng	2000pg	333
0.5ng	500pg	83
0.1ng	100pg	17
0.05ng	50pg	~8
0.01ng	10pg	~2

\* 1 human diploid cell has 6pg (0.006ng) DNA



= DNA typing amounts

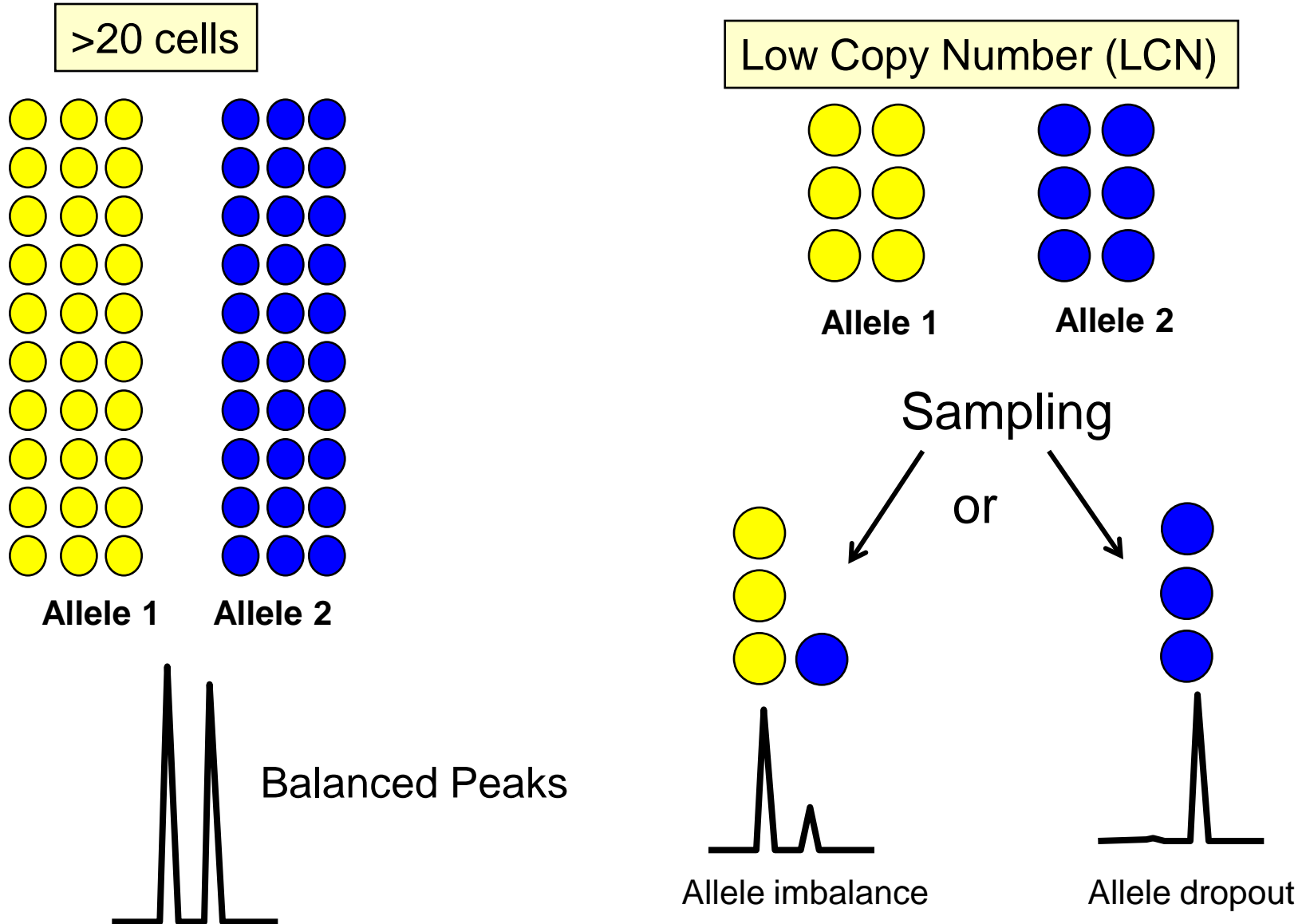


= LT-DNA amounts



# Why is LT-DNA an Issue?

Stochastic Effects or Random Sampling Effects



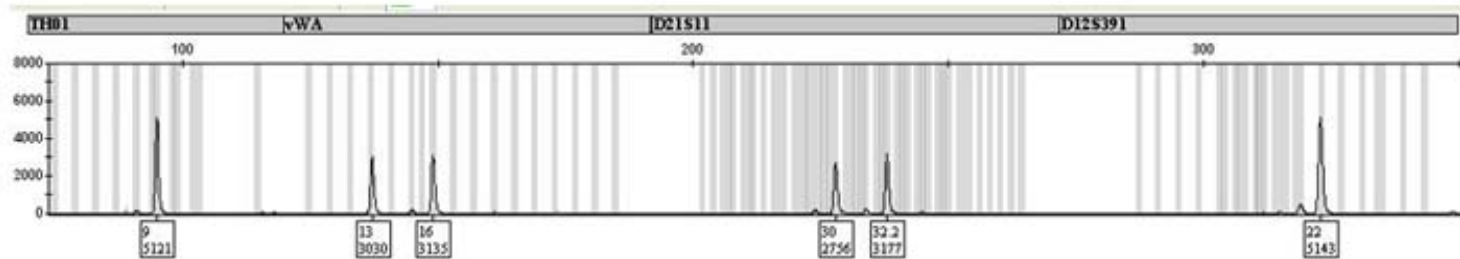
# LT-DNA\*: Stochastic effects

- Trademarks of LT-DNA stochastic effects
  - Exaggerated stutter (up to 50%)
  - Exaggerated peak height imbalance (0 to 100%)
  - Allelic drop-out (extreme peak height imbalance)
  - Allelic drop-in (contamination)

\* LT-DNA using non-standard reaction conditions  
(eg increased PCR cycles)

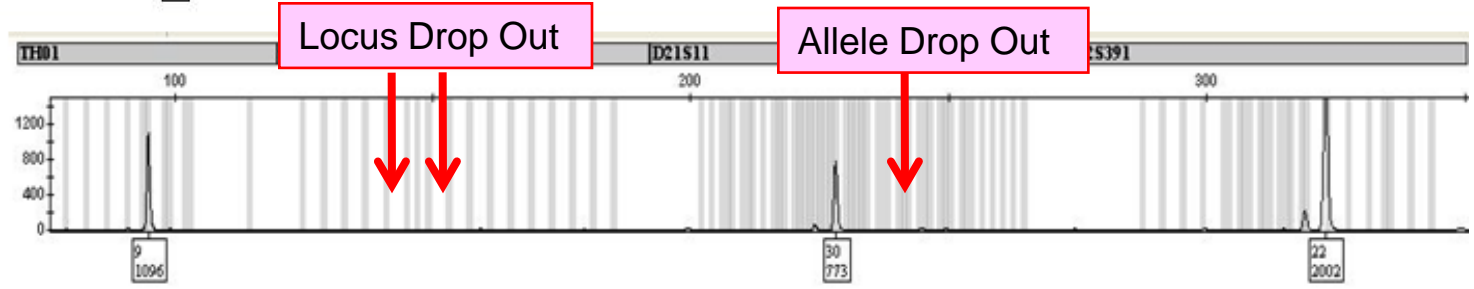
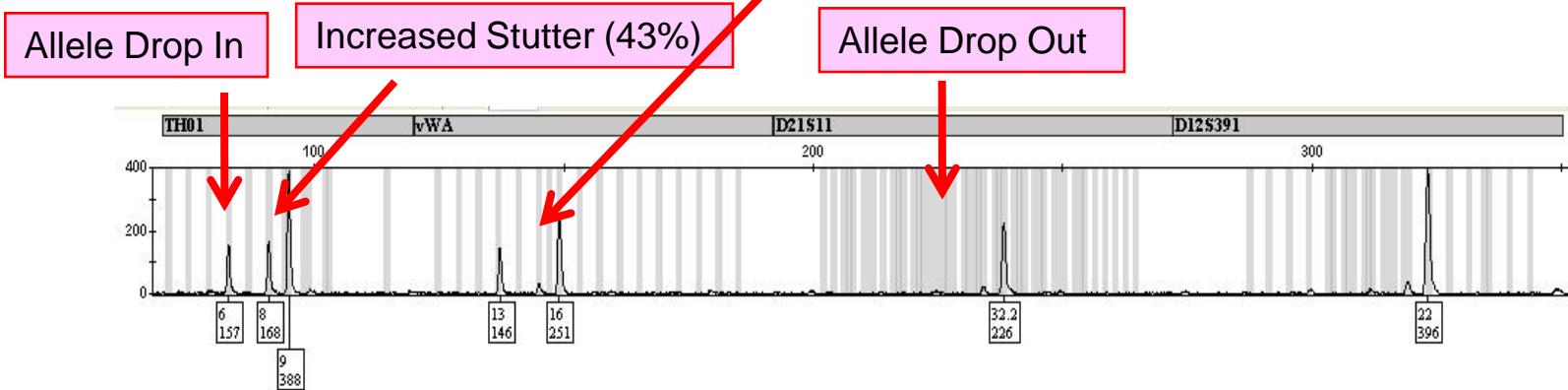
# Comparison of STR Result with Different DNA Amounts

## 1ng Standard Result



## 33pg LT-DNA: 2 replicates

Heterozygote peak imbalance (57%)



# LT-DNA “Solution”: Consensus DNA Profiles

- Split DNA sample into 2 or 3 and do 2 or 3 STR reactions

Amount DNA	Number of Cells/Reaction	
	Single STR Reaction	Three STR Reactions
100pg	17	5
48pg	8	2-3
12pg	2	0.6