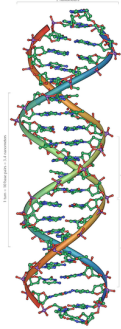


DNA Forensics



Reading: http://www.ornl.gov/sci/techresources/Human_Genome/elsi/forensics.shtml

How does it work?

99.9% of DNA sequences identical among individuals.

Look at sequences that differ.
The FBI used 13 regions and put information into database (this is sometimes known as a DNA fingerprint).

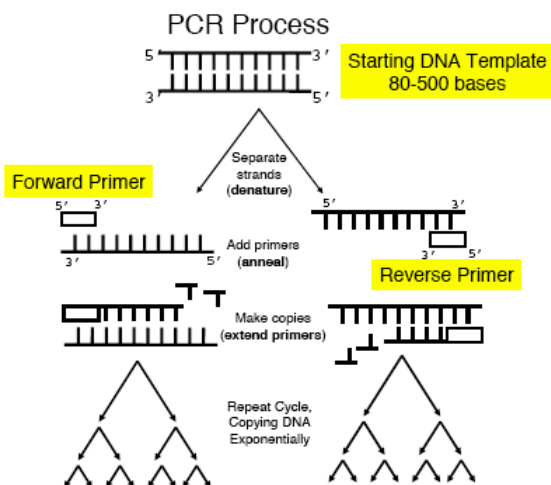
Isolate DNA

From suspect: cheek swab

From crime scene

What type of analysis is used?

PCR is the basis for most current analysis
Because it is soooo sensitive!!!!



Butler, J.M. (2001) *Forensic DNA Typing*, Figure 4.2, ©Academic Press

From 1 molecule of DNA, 30 cycles can produce over 1×10^9 molecules of DNA.



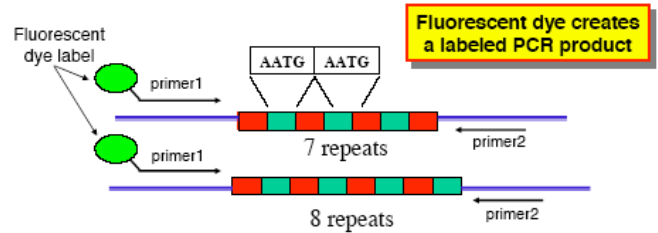
PCR can be used to detect:

Single Nucleotide Polymorphisms (SNPs)
Difference detected by DNA sequencing.

Variable Number Tandem Repeats (VNTRs)
Differences detected by observing the sizes of the PCR products.

Short Tandem Repeats (STRs)
Differences detected by observing the sizes of the PCR products.

Short Tandem Repeats (STRs)



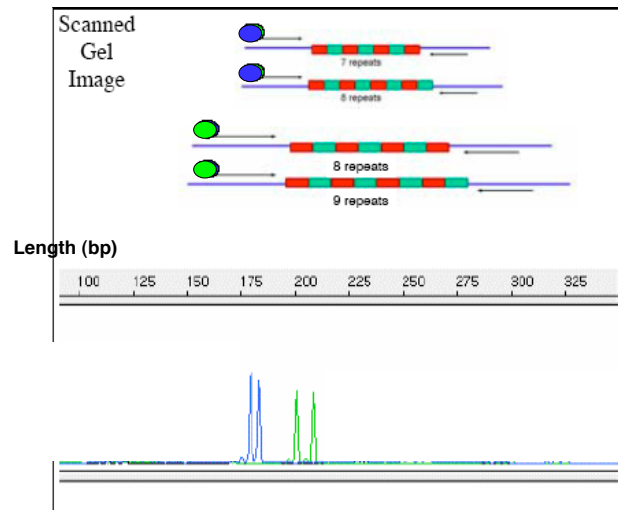
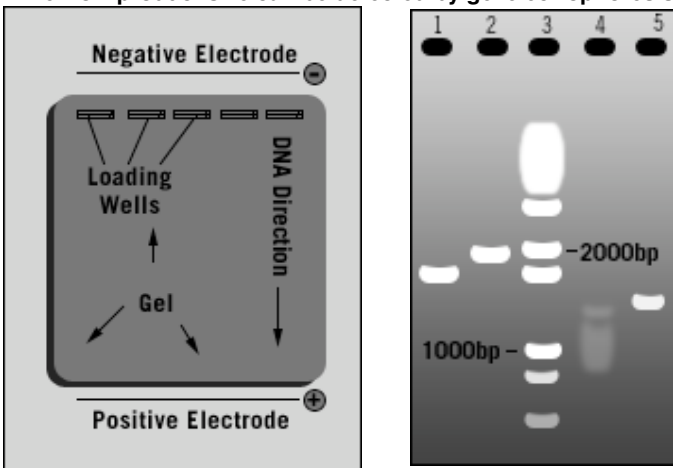
the repeat region is variable between samples while the flanking regions where PCR primers bind are constant

Homozygote = both alleles are the same length

Heterozygote = alleles differ and can be resolved from one another

Primer positions define PCR product size

The PCR product size can be detected by gel electrophoresis



How do we calculate probabilities?

We have a DNA sample from a crime scene, and it matches the suspect's DNA for a single STR. What is the likelihood of this happening by chance?

Let's say that there are 7-44 repeats at this STR locus or 38 possible alleles. This is conveniently the number of slots in a roulette wheel.

Both the DNA sample and the suspect have 22 and 31 repeats at this locus. In other words, one chromosome has 22 copies of the repeat; the other 31.

If we spin the roulette wheel twice, the probability of getting a 22 and a 31 is:
 $2 \times 1/38 \times 1/38 = 1/722$

How do we calculate probabilities?

We can now say "the chance of obtaining this DNA profile if the DNA in the forensic sample came from an individual other than the defendant is 1 in a 722."

If there was a second STR locus with a match, and it also contained 38 alleles, the likelihood of this happening by chance is $1/722 \times 1/722 = 1/521,284$

As you can see with more STR loci, we can be more confident that we have the right person. Of course, the lack of a match means the suspect cannot be the person that left the DNA sample.

How do we calculate probabilities?

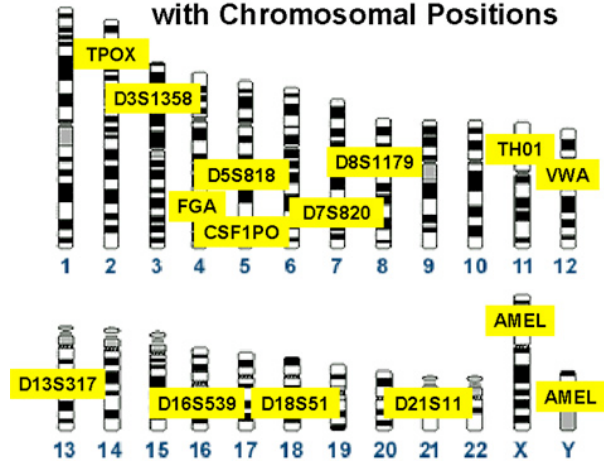
Not all alleles have an equal probability, so the frequencies of each allele is estimated by measuring its frequency in a sample of the population.

Different groups will have different allele frequencies.

In the end, we can say something like

“The frequency of the DNA profile obtained from the stain on White House intern Monica Lewinsky's dress was reported to be 1 in 7.9 trillion.”

13 CODIS Core STR Loci with Chromosomal Positions



CODIS blends forensic science and computer technology into a tool for solving crimes.

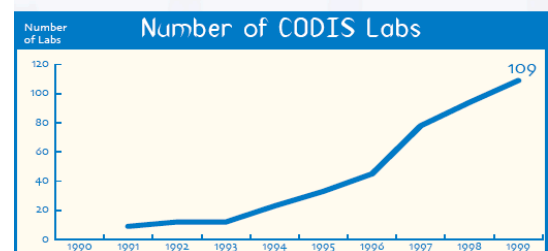
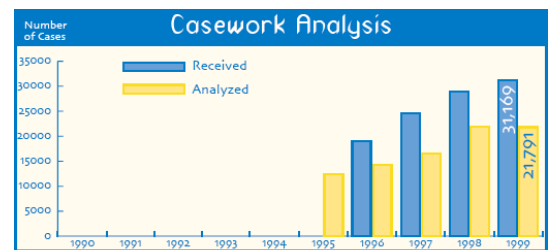
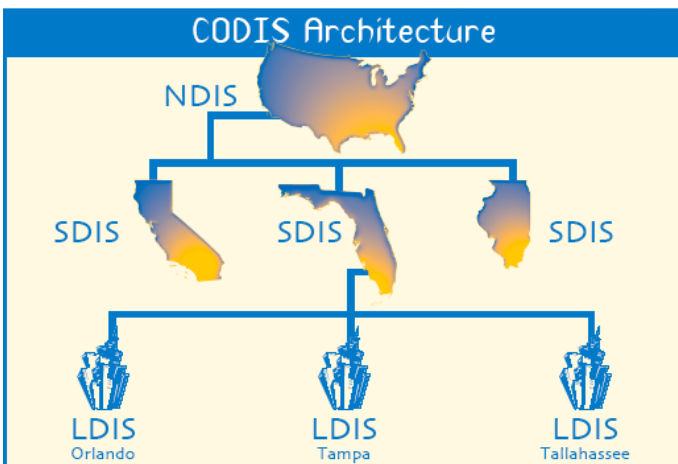
CODIS began as a pilot project in 1990 serving 14 state and local laboratories.

The DNA Identification Act of 1994 formalized the FBI's authority to establish a national DNA index for law enforcement.

The National DNA Index System (NDIS) became operational in 1998.

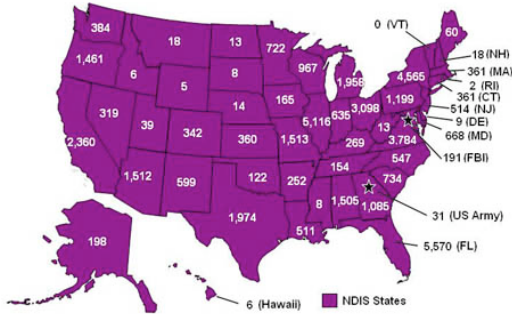
The **Forensic Index** contains DNA profiles from crime scene evidence.

The **Offender Index** contains DNA profiles of individuals convicted of sex offenses (and other violent crimes) with many states now expanding legislation to include other felonies.



Through February 2007
46,325 Investigations Aided in 49 States and 2 Federal Laboratories.

"Investigations Aided" is a metric that tracks the number of criminal investigations where CODIS has added value to the investigative process.



California

Statistical Information	Total
Offender Profiles	711,042
Forensic Samples	11,719
Number of CODIS Labs	20
NDIS Participating Labs	20
Investigations Aided	2,360

Clark McMillan

Year of Incident: 1979

Jurisdiction: TN

Charge: Rape, Robbery

Conviction: Aggravated Rape, Robbery With A Deadly Weapon

Sentence: 119 Years

Year of Conviction: 1980

Year of Exoneration: 2002

Sentence Served: 22 Years

Real perpetrator found? Yes

Contributing Causes: Eyewitness Misidentification

Compensation? Yes

<http://www.Innocenceproject.org/>



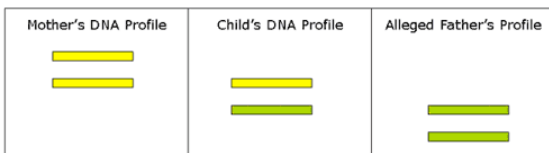
Metaphase Paternity Test
 Elevating DNA testing standards



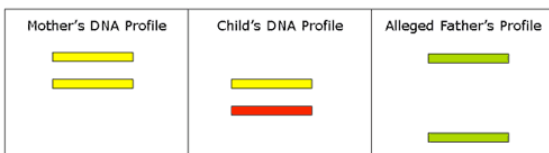
INTERNATIONAL PATERNITY LABS



Paternity Not Excluded



Paternity is Excluded



Paternity testing

Many labs use CODIS STRs.

Calculate probabilities that individual is the father.

CODIS is used for

Identification of criminals

Identification of family members

Identification in certain fatality cases