Chapter 9

DNA: THE INDISPENSIBLE FORENSIC SCIENCE TOOL

DNA (deoxyribonucleic acid)

DNA codes for proteins
Everyone's DNA is unique w/ exception of identical twins
DNA made by linking a series of repeating units called nucleotides.

The sugar/phosphate make up backbone of DNA "ladder"

The nitrogen bases make up the "rungs" of the ladder

The Bases

Four types of bases in DNA structure:
adenine (A) bonds w/ thymine (T).
Guanine (G) bonds w/ cytosine (C)

DNA Typing

Tandem repeats seem to act as filler or spacers between the coding regions of DNA.

all humans have the same type of repeats, but there is tremendous variation in the number of repeats each of us have.

Two main procedures: STR analysis and RFLP

RFLP

Length differences associated with relatively long repeating DNA strands are called **restriction fragment length polymorphisms** (RFLP)

Different lengths result from cutting DNA molecule w/ restriction enzymes

-Typically, a core sequence consists of 15 to 35 bases in length and repeats itself up to a 1000x

RFLP

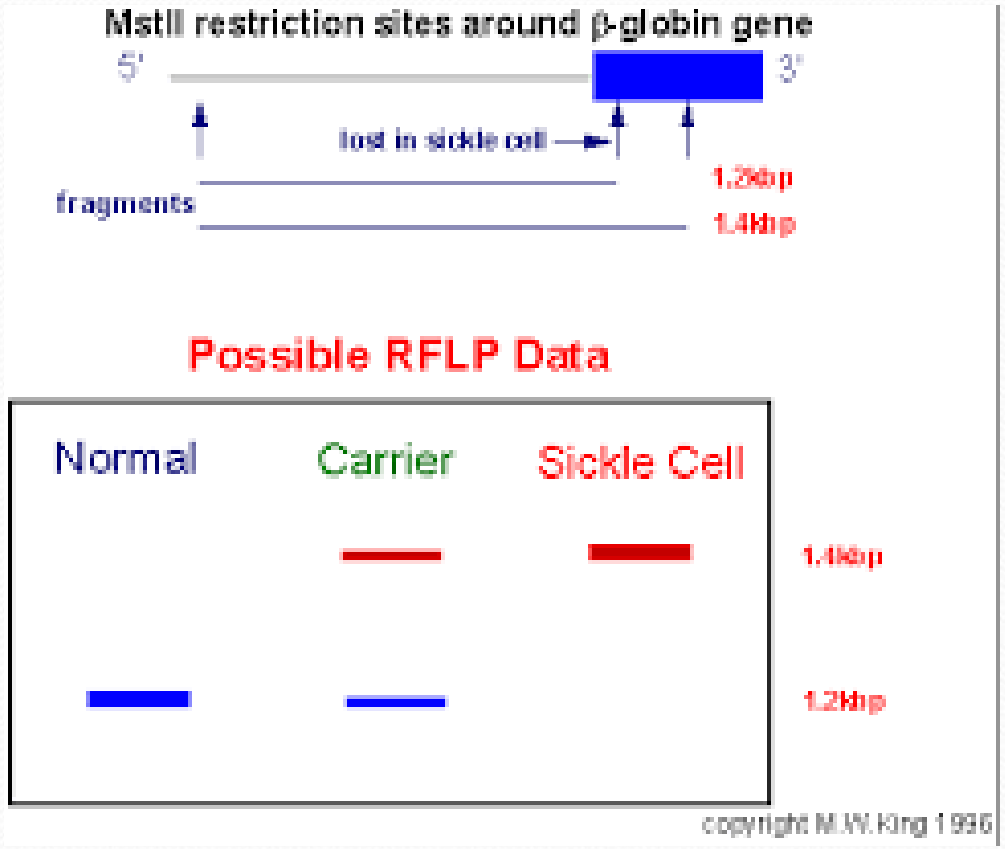
Advantages

RFLP's completely unique from person to person(except id.twins)
Can be used to identify genetic diseases

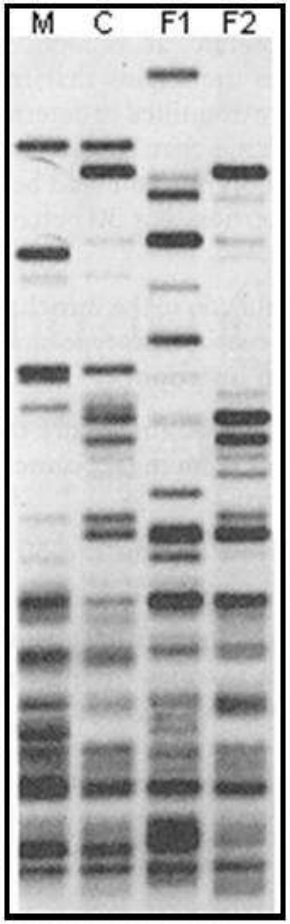
Disadvantages

Requires a lot of DNA
Can't be used with PCR to copy more DNA
Degrades more quickly
Can't store results in database

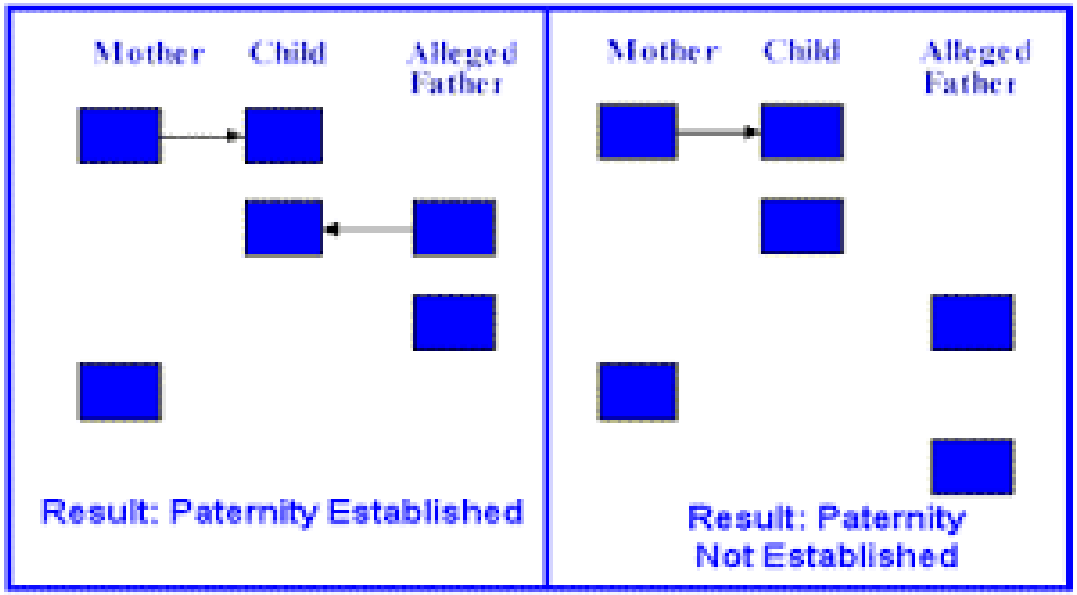
RFLP Data for sickle cell



Paternity Test



Paternity test



PCR

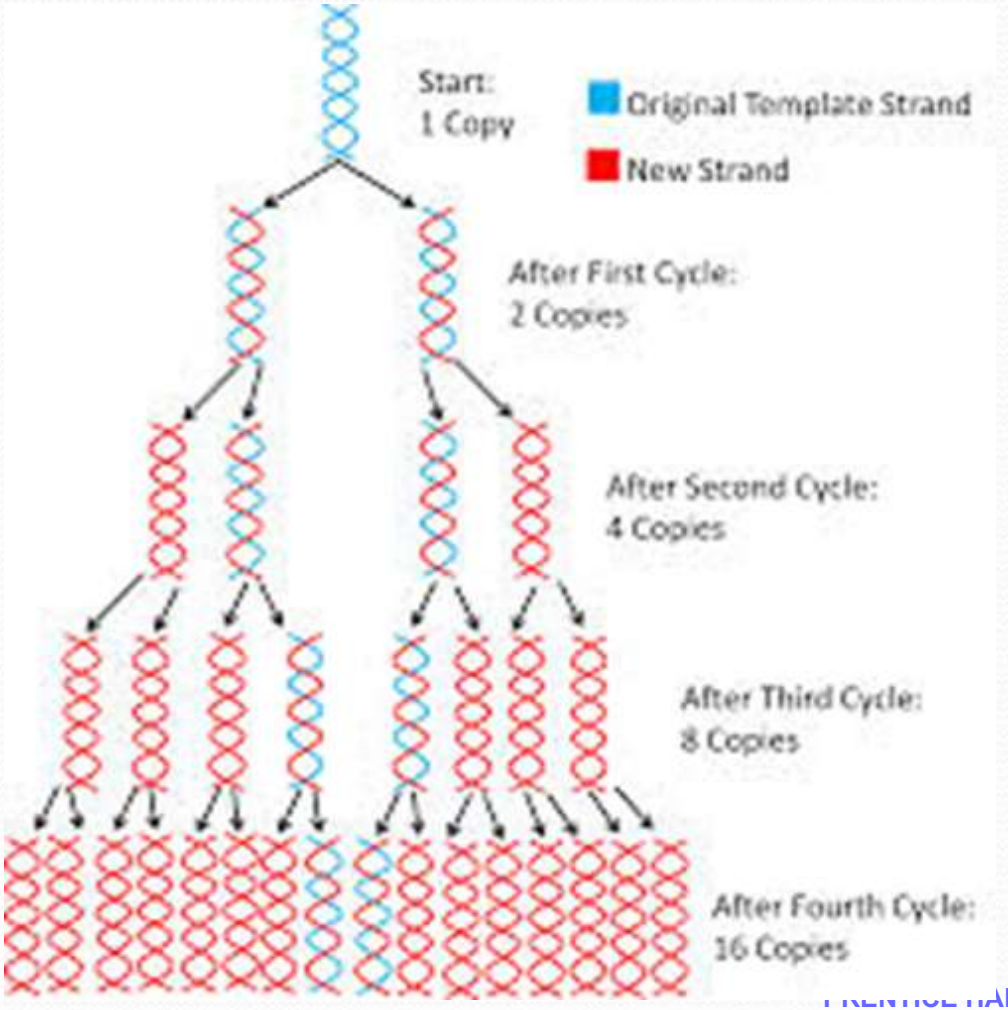
Polymerase chain reaction (PCR) is a technique for replicating small quantities of DNA or broken pieces of DNA found at a crime scene

This means that sample size is no longer a limitation in characterizing DNA recovered at a crime scene.

3 STAGES: denaturing, annealing, synthesizing

3 stages PCR:

1) Denature: DNA strands separated
2) Annealing: primer attaches to DNA site being copied
3) Synthesizing: piece of DNA is copied/total DNA is doubled with each cycle



Short Tandem Repeats

DNA

short tandem repeat (STR) analysis, most widely used DNA profiling procedure.

STRs are locations on the chromosome that contain short sequences that repeat themselves within the DNA molecule.

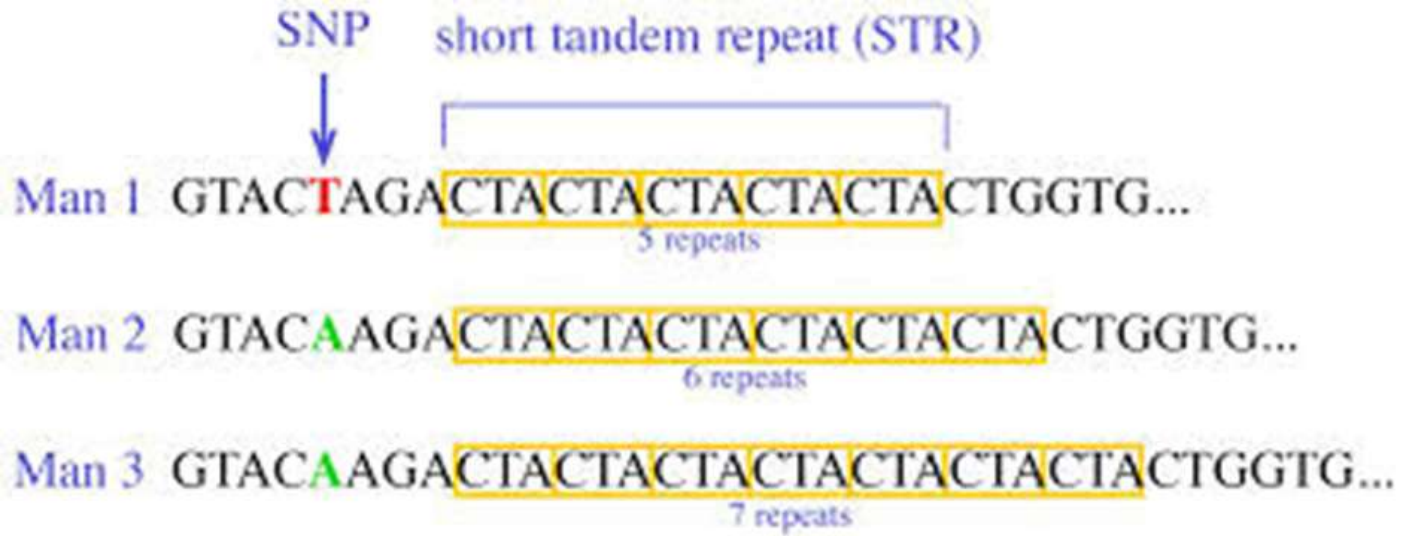
STRs repeating sequences of 3 to 7 bases in length, entire strand of an STR is also very short, less than 450 bases in length.

STR Advantages

STRs less susceptible to degradation and may often be recovered from bodies or stains that have been subjected to extreme decomposition.
STRs are ideal candidates for multiplication by PCR
STR is numerical data and can be kept in a database
With STR, requires 100x less DNA than normally required for RFLP analysis.

DNA

STR example



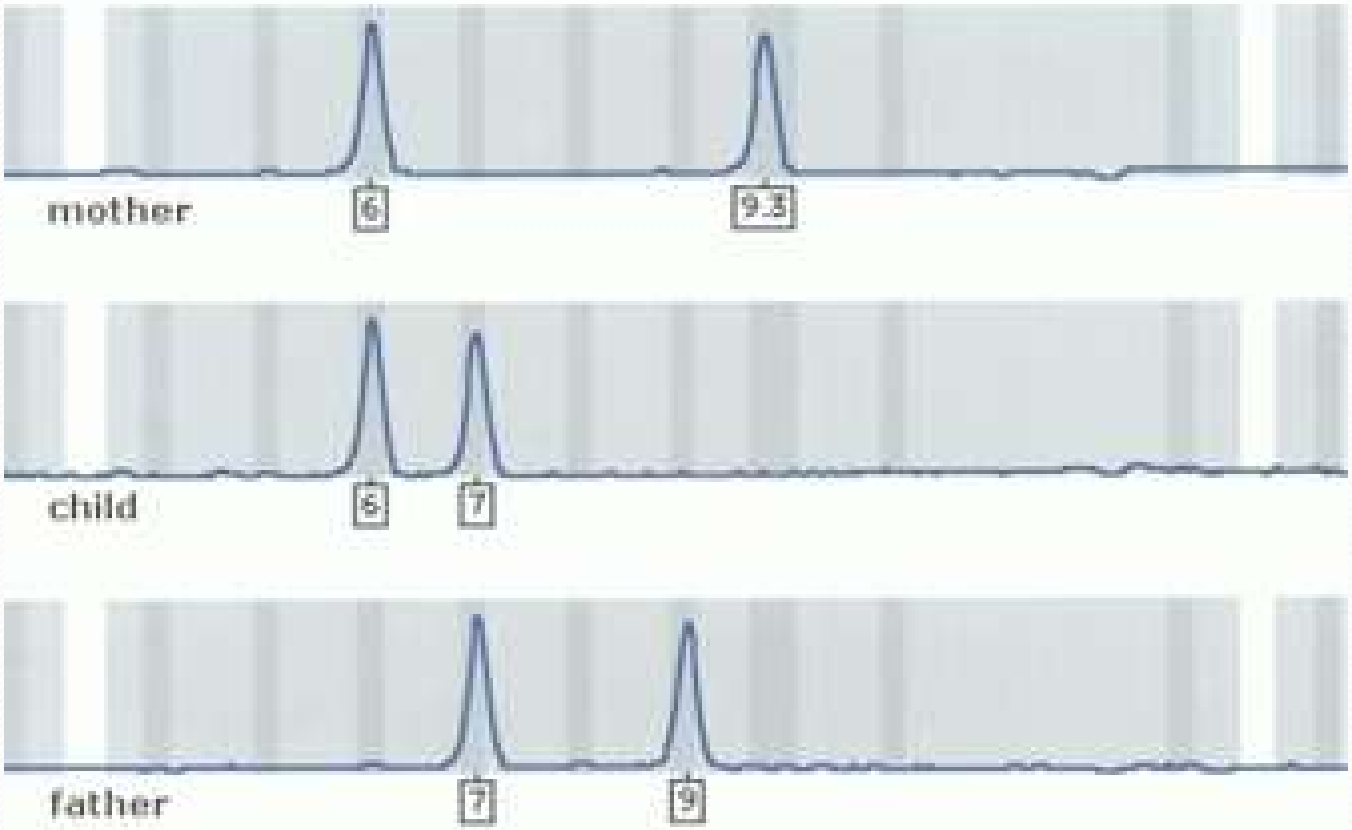
Standardizing STR Testing

U.S. crime laboratories have standardized 13 STRs for entry into a national database (CODIS).
A high degree of discrimination can be attained by multiplexing -analyzing a combination of STRs and determining the product of their frequencies.

STR Analysis

http://www.dnalc.org/view/15983-Today-s-DNA-profile.html

Paternity Test



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Case: 456789 Name	MOTHER Jane	CHILD Jenny	Alleged FATHER John
Date Collected:	1/1/2010	1/1/2010	1/1/2010
Test No.	456789-10	456789-20	456789-30

Locus	PI	Allele Sizes		Allele Sizes		Allele Sizes	
D8S1179	1.55	10	14	13	14	11	13
D21S11	2.02	27	29	29	30	29	30
D7S820	1.17	8	10	8	10	10	11
CSF1PO	1.65	11	12	11		11	12
D3S1358	1.88	14	17	15	17	14	15
TH01	2.62	6	9.3	7	9.3	7	9
D13S317	3.43	13		11	13	11	
D16S539	3.32	9	12	11	12	11	
D2S1338	4.33	19	20	20	24	23	24
D19S433	2.23	13		13		13	14
vWA	3.62	14		14	17	17	
TPOX	1.86	11		8	11	8	
D18S51	3.06	15	17	14	17	13	14
D5S818	1.35	12	13	11	12	11	12
FGA	3.55	21	22	21	24	21	24
Amelogenin		X		X		X	Y

RN: 76206

Interpretation:

Combined Paternity Index: 323,769

Probability of Paternity: 99.9996%

The alleged father is not excluded as the biological father of the tested child. Based on testing results obtained from analyses of the DNA loci listed, the probability of paternity is 99.9996%. This probability of paternity is calculated by comparing to an untested, unrelated, random individual of the Caucasian population (assumes prior probability equals 0.50).

Determine missing person

	Mom	Daughter	Son	Dad
D3S1358	12, 12	12, 14	16, 12	
vWA	11, 14	11, 11	11, 14	
FGA	13, 17	13, 15	17, 15	
TH01	9,9	9, 10	11, 9	

Determine Paternity

	Mom	Son	Dad?
D3S1358	14, 14	14, 15	15, 12
vWA	11, 7	7, 13	13, 8
FGA	6, 8	6,6	6, 9
AMEL	12,14	12, 11	12, 15

Mitochondrial DNA

Another type of DNA used for identification is mitochondrial DNA.

Mitochondria have own DNA

One cell has several mitochondria, a lot of mitochondrial DNA present in 1 cell

Mitochondrial DNA Testing

Mitochondrial DNA typing best for samples, such as hair, for which STR analysis may not be possible.
Forensic analysis of mDNA is more rigorous, time consuming, and costly when compared to nuclear DNA analysis.
all individuals same maternal lineage will be indistinguishable by mDNA analysis.
Two regions of mDNA have been found to be highly variable and a procedure known as **sequencing is used to determine the order of base pairs.**

CODIS

CODIS (Combined DNA Index System) is a computer software program developed by the FBI that maintains local, state, and national databases

DNA profiles from convicted criminals, sex offenders, unsolved crime scene evidence, and profiles of missing persons.

Packaging Biological Evidence

- Wearing disposable latex gloves while handling the evidence is required.
- Clothing from victim and suspect must be collected.
- The packaging of biological evidence in plastic or airtight containers must be avoided because the accumulation of residual moisture could contribute to the growth of DNA-destroying bacteria and fungi.

Packaging Biological Evidence

Each article should be dried and packaged separately in a paper bag or in a well-ventilated box.

Dried blood is removed by using a sterile cotton swab moistened with distilled water , air dried before being placed in a swab box, then a paper or manila envelope.

All biological evidence (blood samples) should be refrigerated or stored in a cool location

Standard/reference DNA specimens must also be collected, such as blood or the buccal swab (swabbing the mouth and cheek).