

# Molecular Forensic Technology

1. Core Technique – PCR
2. Short Tandem Repeats
3. Application – one locus
4. DNA Profiling

## Core Technology Polymerase Chain Reaction

- Technique for producing large amounts of a single piece of DNA even from a complex mixture of DNA.

### Requirements

- Target DNA – blood spot or mouth swab
- Primers – small single stranded pieces of DNA that flank the DNA you want to amplify
- Thermostable DNA Polymerase
- Thermocycler

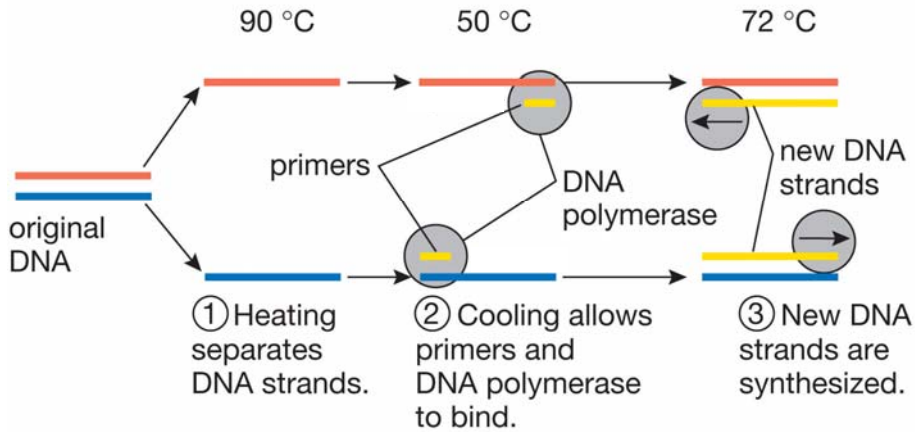
### – Three Temperatures

- Denaturation
- Annealing
- Extension



# On cycle of PCR doubles amount of DNA

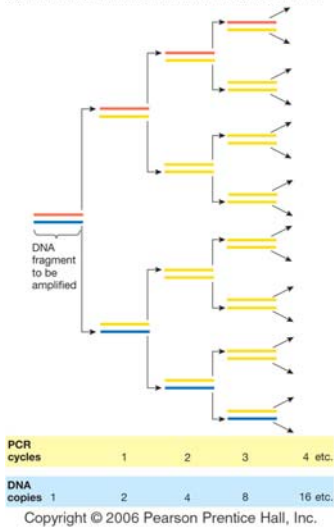
## (a) One PCR cycle



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## Multiple rounds of PCR

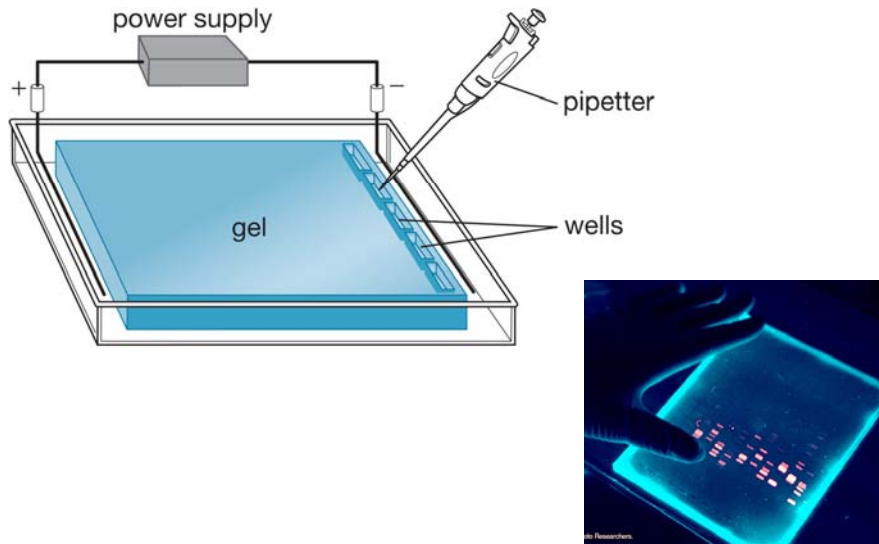
(b) Each PCR cycle doubles the number of copies of the DNA



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- Each round of PCR doubles the amount of target DNA
- 20 cycles yields 1 million identical molecules.

# Electrophoresis



## DNA Fingerprinting

### PCR and Forensic Genotyping

- Genotyping – distinguish the DNA of individuals
- Applications
  - Paternity Testing
  - Forensic Application
- Technique
  - Short Tandem Repeat (Microsatellite DNA)

# Short Tandem Repeat

- What is a STR
  - Region on one chromosomes with simple repeated sequence (Short tandem repeat)

- Example GT repeats

GCCTTAGTCGAGTGTGTGTGTGTGTGTGTGGCTTCAAGAA

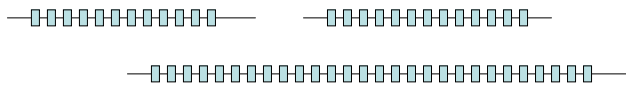
- Hypervariable

Example allele had 10 repeats



Other Possible Alleles

11 repeats, 12 repeats, 22 repeats etc.



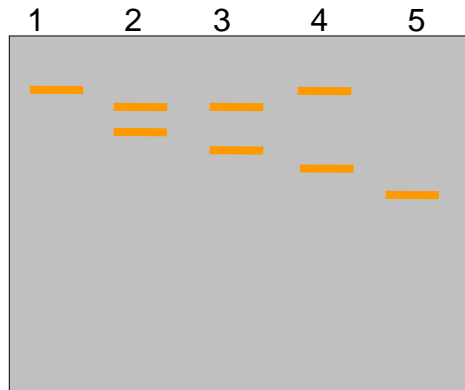
# Genotypes for STR

- Homozygous
  - Both alleles have the same # repeats
    - Example homozygous for 11 repeat
- Heterozygous
  - Two alleles have different # of repeats
    - Heterozygous for 11 and 15 repeats

# PCR to determine Genotype

- Design primers to flanking regions
- GCCTTAGTCGAGTGTGTGTGTGTGTGTGTGTGGCTTCAAGAA
  - Forward Primer GCCTTAGTCGAG
  - Reverse Primer TTCTTGAAAGC
- Different Alleles distinguished by size. – the more repeats the larger the PCR product – test by electrophoresis
- What will homozygote look like?
- What will heterozygote look like?

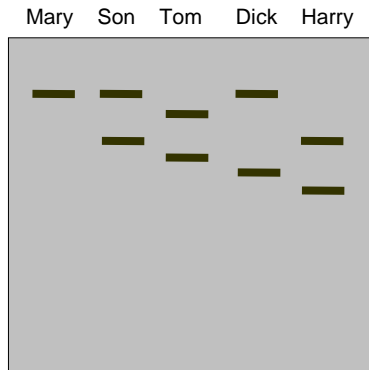
## STR's of 5 individuals



Who is homozygous and who is heterozygous?

Example Application  
-Paternity testing

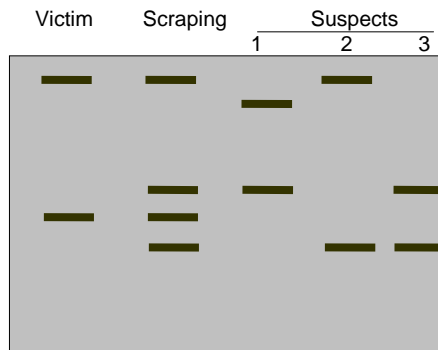
Are any of these men the father of Mary's son?



Who can be rule out as the father?  
Does this test prove the identity of the father?

Example 2: Forensics

Analysis of fingernail scrapings from a victim.  
Who can be ruled out?  
Does this prove who killed the victim?

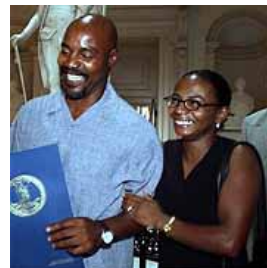


# DNA Profiling

- FBI analyzes 13 different STR
- A DNA profile is the genotype at all 13 different loci.
- The expected frequency of even the most common genotype at the 13 loci is 1 in 10 billion.

# Marvin Anderson Story

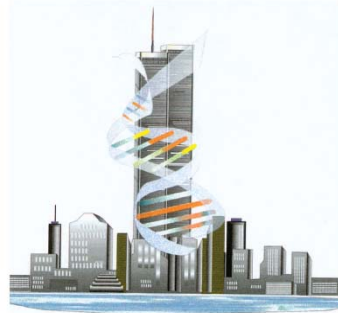
- 1982 – a young white women was raped in Ashland South Carolina by a black male.
- During the crive, the rapist had bragged he “had a white girl.”
- Policed focused on Marvin Anderson because he was the only black man in the area with a white girl friend
- Mr. Anderson was identified as the rapist in a lineup and convicted and sentenced to 210 years in prison.
- 6 years after Mr. Anderson was convicted a second man, John Otis confessed to the crime. However, the judge refused to accept the confession and Mr. Anderson was kept in prison.
- The Innocence Project took up the case. They obtained a sample of fluids accidentally saved from the case, conducted STR analysis and demonstrated Mr. Otis was the rapist.
- Marvin Anderson was released after 15 years for a crime he didn't commit.



Marvin Anderson  
The 99<sup>th</sup> person freed by  
the Innocence Project

# Identify victims of 9/11

- Only 293 intact bodies were recovered from the World Trade Center
- 20,000 fragments of bone and tissue were recovered, some as small as a finger tip.
- NY medical examine collected personal items of known victims. 7000 razor blades, toothbrushes combs etc.
- DNA from the personal items was compared to DNA from the tissue.
- As of April 2005, when the process was suspended, only 1,592 victims had been identified.



# Polish Dragnet

- Over a six year period, a rapist from Swinoujscie (northwest Poland) committed at least 14 rapes.
- DNA profiles obtained from semen stains left at the scenes of crime gave information that one and the same man had committed all the rapes.
- Police decided to genotype all men between 22-38 in the region.
- Of the initial 421 men tested none match the rapist. However, one male matched at 9 of the ten loci tested. At the 10 locus one of the alleles differed. Therefore, This man wasn't the rapist because there wasn't a perfect match
- However he had to be closely related to the rapist. The police obtained a swab from this man's brother and the brothers DNA matched at 19 of 19 STR loci -a perfect match. He was charged with committing 14 acts of rape.