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

- Heating separates DNA strands.
- Cooling allows primers and DNA polymerase to bind.
- New DNA strands are synthesized.

Multiple rounds of PCR

- 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
    GCCTAGTGCGTGCGTGTGTGTGTGTGTGTGGCTTCAAGAA

  • 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
  - GCCTTAGTGCAGTGTGTGTGTGTGTGTGGCTTCAAGAA
    - Forward Primer GCCTTAGTGCAG
    - Reverse Primer TTCTTGAAGC

- 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?

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 crime, the rapist had bragged he “had a white girl.”
- Police 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.
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.