PCR, DNA Fingerprinting, and DNA Sequencing

- Polymerase Chain Reaction is DNA Replication in a Test Tube
    - PCR copies a specific DNA sequence
    - Can take a very small amount of DNA and make millions of copies for testing.
    - PCR requires primers that can target certain sections of DNA.
    - The three steps of PCR
        - Denaturation(split into single strands using heat)
        - primers attach
        - Extension (DNA polymerase makes complimentary strand)
    - Steps are repeated over and over to amplify the DNA.
- Electrophoresis
    - An agrose gel (jello-like) allows pieces of DNA to pass through it in response to an electrical charge.
    - DNA is negatively charged and is attracted to the positive electrode.
    - Shorter pieces move further/faster.
    - Stain or some other method is used to see the bands.
- DNA Fingerprints Can Identify Individuals
    - Focusing on highly variable sections of DNA
    - Sections can vary in sequence or in length.
    - Used in forensics to rule out suspects or as evidence against a suspect.
    - RFLP (restriction fragment length polymorphism)
        - Differences in sequences alter restriction enzyme cutting sites
        - Different cutting sites make different lengths of DNA pieces.
    - VNTRs (Variable-number tandem repeats)
        - Differences in length is caused by repeated sections of DNA bounded by restriction enzyme sites
        - More repeats equals a longer DNA segment
    - STRs (Short tandem repeats)
        - Really short VNTRs (2,3,4,5)
        - Have primer sites on either side for PCR
        - Used for PCR analysis in forensic work to generate DNA profiles (Combined DNA Index System, CODIS)
    - Paternity Test
        - Match markers between mother and child. Rest of the markers must come from father.
- DNA Sequencing
    - Figuring out the bases on a strand of DNA.
    - Used in the Human Genome Project to sequence all of human DNA.
    - Have sequenced other organisms
    - Large-scale genome sequencing is automated and uses fluorescent dye–labeled dideoxynucleotides.

Population Genetics

- A population is a group of individuals with a common set of genes that lives in the same geographic area and can or does interbreed.
- A population's gene pool is all of the alleles present in that population. Due to population dynamics, the gene pool can change over time.
- The Hardy-Weinberg Law Describes the Relationship between Allele Frequencies and Genotype Frequencies in an Ideal Population
    - The Hardy-Weinberg law makes two predictions:
        - (1) the frequency of the alleles in the gene pool does not change over time; and
        - (2) after one generation of random mating, the genotype frequencies for two alleles can be calculated as $p^2 + 2pq + q^2 = 1$ where p equals the frequency of allele *A* and q is the frequency of allele *a*

- The Hardy-Weinberg model assumes
  - 1.that there is no selection,
  - 2.that no new alleles arise from mutation,
  - 3.that there is no migration into or out of the population,
  - 4.that the population is large, and
  - 5.that random mating occurs.
- An example of how the Hardy-Weinberg law can be applied to humans is analysis of susceptibility to HIV-1 infection based on the genotype for the *CCR5* HIV-1 receptor gene.
- Ex. Percent of the population that carries the CF gene.