General Biology 2: Lecture 6

Morgan McCarty

20 September 2023

- Genes in Population
  - Population genetics: study of genes and genotypes in a population
  - Extend of genetic variation, why it exists, how it is maintained, how it changes over generations
  - Helps to understand how genertic variation is related to phenotype variation
  - Phenotypes exposed to outside pressures $\rightarrow$ genes are not
- Genes in Natural populations
  - Can be monomophic (single allele accounts for 99%) or polymorphic (multiple alleles)
  - Polymorphism comes about through various changes
    1. Duplication of gene region
    2. Deletion of significant region of gene
    3. Change in a single nucletide (SNP - single nucleotide polymorphism, smallest and most common change in a gene)
- Allele Frequecy
  - $= \frac{\text{Number of copies of an allele in a population}}{\text{Total number of all alleles for that gene in a population}}$
- Genotype Frequency
  - $= \frac{\text{Number of individuals with a particular genotype in a population}}{\text{Total number of individuals in a population}}$
- Hardy-Weinberg Principle

- Genes remain in equilibrium and allele frequencies remain constant from generation to generation unless acted upon by outside influences
- Binomial Equation
  - $p + q = 1$
  - $p^2 + 2pq + q^2 = 1$
  - p^2 = frequency of homozygous dominant genotype
  - q^2 = frequency of homozygous recessive genotype
  - $2pq$ = frequency of heterozygous genotype
  - p = frequency of dominant allele
  - q = frequency of recessive allele
- Conditions
  1. No mutations - alleles do not change or changes that do occur are balanced by opposite changes
  2. No gene flow - no new alleles are added to the gene pool or no alleles are lost from the gene pool due to migration of individuals into or out of the population
  3. Random mating - individuals pair by chance, not according to genotype or phenotype
  4. No genetic drift - population is large enough to prevent random changes in allele frequencies
  5. No selection or selective pressure - no alleles are favored over others
- If p or q is changed in the next generation, then the population is evolving
- Identifies factors that cause evolution
- If the population is not in Hardy-Weinberg equilibrium, then it is evolving
- Conditions are rarely met
- Provides starting point for studying mechanics of evolution

• Natural Selection

- Adaption of a population to the biotic and abiotic environment

- Biotic: living factors (predators, prey, parasites, competitors)
- Abiotic: nonliving factors (temperature, humidity, pH, salinity, sunlight)
- Types of Selection
    1. Directional Selection: favors one extreme phenotype
    2. Stabilizing Selection: favors intermediate phenotype
    3. Disruptive (Diversifying) Selection: favors two or more extreme phenotypes
    4. Balacing Selection:
        * Maintains genetic diversity
        * Balancecd Polymophisms: two or more alleles are kept in balance and therefore are maintained in a population over the course of many generations
        * Two common ways: heterozygote advantage and frequency-dependent selection (rare individuals have an advantage)