Allele Frequencies: Changing

Chapter 15
Changing Allele Frequencies

1. **Mutation** – introduces new alleles into population
2. **Natural Selection** – specific alleles are more likely to be passed down because they are somehow advantageous
3. **Non-random Mating** – individuals of one genotype are more likely to mate with individuals of same genotype
   - Think of an example of this happening?
Changing Allele Frequencies

4. **Migration** – individuals with specific genotypes move in or out of a population

5. **Genetic Drift** – random changes in allele frequencies
   - Caused by random sampling of specific genotypes
   - Often seen in small, isolated populations

Can you think of why?
- Nothing to do with natural selection
Nonrandom Mating

Populations (not just humans either) often choose mates based on phenotypes

• Effectively this means certain genotypes are selected over others

• HWE requires populations mate at random

• What sort of genotypes are selected?
  – Looks, intelligence, abilities
  – Race, proximity, language
Nonrandom Mating

Also occurs when one male mates with a disproportion amount of females

- That person’s genotypes are based down to the next generation at a much higher rate than HWE would expect

- Can you think of examples of this?
  - A man with many wives
  - Genghis Khan or other leaders
  - A prize stallion, bull, ram or tomato
Nonrandom Mating

• Other factors:
  – Consanguineous marriages (between close relatives)
  – “Endogamy” – restricted marriages within a religion or community
  – Support groups for a shared disorder lead to increases in meeting a spouse with same genetic disorder

• Traits lacking phenotypes often in HWE
  – Blood types
Migration

When new alleles or genotypes move into a population, that population’s frequencies change

• May see **Clines** – gradual changing in allele frequencies while moving from one geographical area to the next

• Or may see dramatic **Borders** – where allele frequencies are quite different because of some isolating factor – examples?
Genetic Drift

Random changes in allele frequencies

• Nothing to do with selection, natural or artificial

• A sampling error of alleles:
  – Imagine reaching into a bag of jelly beans with 10 colors of beans and pulling out a handful of one color – rare, but not impossible

• Occurs more often in small isolated populations – why?
Founder Effect

When a small group of people leave a large population and found a new population – their alleles are over represented in the new population

• More extreme effects:
  – Smaller number of founders
  – New population more isolated

• Think of distinct groups rather than a melting pot effect
Bottlenecks

When there is a large decrease in the numbers of the population – the small population left contributes to allele frequencies

• Usually caused by dramatic environmental change
• Majority of population does not survive
• Remaining population contributes entirely to genetics of population
Bottlenecks

- Because only a few are left the remaining population has a restricted gene pool
- Therefore some alleles will be lost and others will be amplified

100 Alleles

Environmental Change

Increase in population – all from only 4 alleles
Genetic Drift

Random allele changes

1. Founder Effect
   - When a small group moves and founds an entire new population

2. Bottleneck
   - When some change in the environment ends up killing off a large segment of the population – leaving only a few to repopulate

• Compare and contrast these
Mutation

Whenever one allele changes into another; introducing a new allele

• We covered the causes of mutations already:
  – Spontaneous
  – Radiation, chemical or etc induced

• Although these do change HWE, this is a small effect compare to other changes we have learned
Natural Selection

When certain phenotypes are more likely to survive or have offspring – those alleles will increase in each generation

- **Negative Selection:**
  - Removal of harmful alleles

- **Positive Selection:**
  - Increase of protective alleles

- This is evolution happening
Evolution

Evolution simply means change over time

• Geneticists define evolution as:

  Changing allele frequencies

• Most scientist’s agree with Darwin’s mechanism of how evolution happens:

  Survival of the fittest – those with the best genes have the most offspring

• “Natural Selection”
Natural Selection

Case of Tuberculosis (TB)

- TB is caused by a bacterial infection
- When first exposed people die quickly, however as time passes population becomes “resistant”

- Positive Selection:
  - People who are resistant are more successful

- Negative Selection:
  - The deadliest bacteria kill people before bacteria can be passed on
Natural Selection

Case of Sickle Cell Disease

• Sickle cell disease is autosomal recessive
• Heterozygotes are fine, homozygous recessive affected and die
• Turns out that being heterozygous is actually protective against Malaria
• The parasite cannot infect someone who is heterozygous for sickle cell
Natural Selection

“Balanced Polymorphism” – when a detrimental allele is actually protective as a heterozygote

• Balanced – protective effect of heterozygote balances out negative effect of homozygous recessive

• Also known as:
Heterozygous Advantage
Natural Selection

When certain phenotypes are more likely to survive or have offspring – those alleles will increase in each generation

• Negative Selection:
  – Removal of harmful alleles

• Positive Selection:
  – Increase of protective alleles

• Changing allele frequencies over time
Artificial Selection

This is the human act of purposely selecting certain traits over others

• Agriculture
  – What examples can you think of?
• Pure breed dogs
• Basically it’s us forcing evolution to happen in a certain direction
• Changing allele frequencies directly
Summary of Forces:

Forces that change allele frequencies:

• Nonrandom Mating
• Migration
• Genetic Drift
• Mutation
• Selection (natural or artificial)

All are happening, overlapping and interacting in most populations
Summary of Forces:

(a) Hardy-Weinberg equilibrium
- 25% (5/20) green
- 25% (5/20) blue
- 25% (5/20) red
- 25% (5/20) yellow

Population doesn't change

(b) Nonrandom mating
- Genotype mates more often

(c) Migration
- 20% (5/25) green
- 32% (8/25) blue
- 28% (7/25) red
- 20% (5/25) yellow

(d) Genetic drift
- 20% (2/10) green
- 20% (2/10) blue
- 30% (3/10) red
- 30% (3/10) yellow

(e) Natural selection
- Cannot reproduce

33 1/3% (5/15) green
33 1/3% (5/15) blue
33 1/3% (5/15) red
33 1/3% (5/15) yellow

(f) Mutation
- 15% (3/20) green
- 25% (5/20) blue
- 50% (10/20) red
- 10% (2/20) yellow
Hardy-Weinberg Equilibrium

Allele Frequencies don’t change over generations
Nonrandom Mating

Certain alleles are over represented because that genotype had more offspring.
Migration

New alleles are introduced into population
Genetic Drift

Allele Frequencies change due to random sampling errors (Founder or Bottleneck Effects)
Mutation

New alleles are introduced
Natural Selection

Harmful alleles are removed (Negative), beneficial alleles are increased (Positive)
Summary of Forces:

Forces that change allele frequencies:

• Nonrandom Mating
• Migration
• Genetic Drift (founder and bottleneck)
• Mutation
• Selection (natural or artificial)
• Know all and know differences between them, and how they affect HWE
Next Class:

- Read Chapter Sixteen

- Homework – Chapter Fifteen Problems;
  - Review: 1, 3, 5, 12, 14, 15
  - Applied: 2, 3, 6, 12