The Theory of Evolution

Mechanisms of Evolution

Notes Pt. 4
Population Genetics &
Evolution

– IMPORTANT TO REMEMBER: Populations, not individuals, 
evolve.

– Population = a group of individuals of the same species 
living in a particular area at the same time.

– All alleles of a population’s genes = its GENE POOL.

– The percentage of any one specific allele is known as the 
allelic frequency.
Variations in the Same Species

- Any variations (differences among members of a species) within the same species, like people having different heights, are caused by different alleles in the gene pool.
Changes in Allelic Frequency

- If the allelic frequency stays the same over many generations, it is in genetic equilibrium, and is not evolving.
- But, changes in the allelic frequency can be caused by mutations or by chance, known as genetic drift. This results in evolution.
Genetics Review

– Genes: segments of DNA on a chromosome
Alleles

- Alleles are different versions of a gene
  - ex) The eye color alleles: blue, brown, etc

Brown Allele from Mom

Blue Allele from Dad

- Individuals have 2 alleles for every gene
Genotype vs. Phenotype

- Genotype: An individual’s genetic make up

- Phenotype: An individual’s appearance

- Genotype determines phenotype
Evolution

- Evolution: A change in a population over time
- Genetic evolution: A change in gene frequency over time
  - Gene frequency: What percent of an allele is present in a population
Mechanisms of Evolution

– Anything that changes the frequency of alleles in a population is a mechanism of evolution

1. Natural Selection
2. Mutation
3. Genetic Drift
4. Gene Flow (Migration)
5. Non – Random Mating
1. Natural Selection

- Individuals with the best adapted phenotypes will survive and pass on their genes to the next generation.
- In the next generation there should be a higher frequency of alleles for the better adapted phenotype.
Natural Selection Example

<table>
<thead>
<tr>
<th>Breed</th>
<th>Generation 1</th>
<th>Generation 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green Allele Frequency</td>
<td>$2/5 = 0.4$</td>
<td>$1/8 = 0.125$</td>
</tr>
<tr>
<td>Brown Allele Frequency</td>
<td>$3/5 = 0.6$</td>
<td>$7/8 = 0.875$</td>
</tr>
</tbody>
</table>
Types of Natural Selection

- Stabilizing: Removes extremes
- Directional: Increases the occurrence of one extreme
- Disruptive/diversifying: Removes average traits, favors both extremes
Artificial Selection

– Selective breeding of domesticated plants and animals to produce offspring with desired genetic traits
2. Mutation

– A mutation in a parent’s DNA could result in offspring with different alleles, changing the allele frequency of the population

<table>
<thead>
<tr>
<th></th>
<th>Generation 1</th>
<th>Genes</th>
<th>Generation 2</th>
<th>Genes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green Allele Frequency</td>
<td>2/2 = 1</td>
<td></td>
<td>2/3 = 0.67</td>
<td></td>
</tr>
<tr>
<td>Brown Allele Frequency</td>
<td>0/2 = 0</td>
<td></td>
<td>1/3 = 0.33</td>
<td></td>
</tr>
</tbody>
</table>
3. Gene Flow (Migration)

- Gene flow is any movement of genes from one population to another.

- Wind, habitat change, moving, etc. can all cause organisms to migrate, causing gene flow.
4. Non-Random Mating

- If organisms can choose their mating partners, then the more desirable alleles will have a higher frequency in future populations.
- This is called sexual selection. Sexual selection can result in some bizarre traits.
5. Genetic Drift

Genetic drift occurs when the allele frequency of a population changes by chance.

<table>
<thead>
<tr>
<th>Allele Frequency</th>
<th>Generation 1</th>
<th>Generation 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green</td>
<td>3/9 = 0.33</td>
<td>1/7 = 0.14</td>
</tr>
<tr>
<td>Brown</td>
<td>6/9 = 0.67</td>
<td>6/7 = 0.86</td>
</tr>
</tbody>
</table>

DIE!
5. Genetic Drift

- Very common in small populations
- Founder Effect: Small population settles a new location (often islands)
- Bottleneck: Occurs after a major population decline (many endangered species)
The Evolution of Species

- Speciation is the evolution of new species.
- This occurs when a species (a group of organisms that can interbreed to produce fertile offspring) can no longer interbreed in their current environment.
Speciation

– Speciation can occur when populations are split apart by geographic isolation, such as volcanoes, fires, sea level changes and other environmental influences.

– Each individual population adapts to its “new” environment, eventually forming a new, different species.

– REMEMBER: this happens over LONG periods of time, like many generations!
Adaptive radiation

- This theory says that one species can migrate, or move by transplantation, to new habitats and change to fit that new environment.
- When this happens, several new species can arise.
Adaptive Radiation (Cont)

– Examples:
  – The Hawaiian Honeycreeper formed 14 new species.
  – Darwin’s Finches
Divergent Evolution

– Adaptive radiation can cause divergent evolution.
– This is when closely related organisms develop body parts that have different functions, like the backbones of snakes and lizards.
– This results in a large amount of BIODIVERSITY all throughout the world!
Hardy- Weinberg Equilibrium

– A population that is not evolving is considered to be in “Hardy- Weinberg Equilibrium” because the allele frequencies do not change.

– The following situations disrupt “Hardy- Weinberg Equilibrium” and cause evolution

1. Natural Selection
2. Mutation
3. Genetic Drift
4. Gene Flow (Migration)
5. Non- Random Mating