Microevolution and Macroevolution

- How does Microevolution add up to macroevolution?
- What are species?
- How are species created?
- What are anagenesis and cladogenesis?

Species Concepts

- Biological species concept: Defines species as interbreeding populations reproductively isolated from other such populations.
- Evolutionary species concept: Defines species as evolutionary lineages with their own unique identity.
- Ecological species concept: Defines species based on the uniqueness of their ecological niche.
- Recognition species concept: Defines species based on unique traits or behaviors that allow members of one species to identify each other for mating.

Reproductive Isolating Mechanisms

- Premating RIMs
  - Habitat isolation
  - Temporal isolation
  - Behavioral isolation
  - Mechanical incompatibility
- Postmating RIMs
  - Sperm-egg incompatibility
  - Zygote inviability
  - Embryonic or fetal inviability

Modes of Evolutionary Change

[Diagram showing cladogenesis and anagenesis]
Cladogenesis

Evolution is
“the simple way by which species (populations) become exquisitely adapted to various ends”
All characteristics are due to the four forces

- Mutation creates new alleles - new variation
- Genetic drift moves these around by chance
- Gene flow moves these from one population to the next creating clines
- Natural selection increases and decreases them in frequency through adaptation

Clines

Adaptation?

- An adaptation is an evolved phenotypic trait that increases an organism's reproductive success! that increases their fitness

Success measured as **Fitness**

- Success in natural selection is the ability to put one's genes in the next generation
- This can be directly or indirectly
- Those who put more genes into the next generation are more “fit” than others
Effects on Fitness

- Own reproduction
  - survivorship
  - health
  - sexual opportunities
  - sexual selection
- Reproduction of relatives
  - kin selection

Sexual selection

Kin selection

- helping kin helps own genes
- Vervet alarm calls
- Chimpanzee patrols
- bees or ants

Relatedness
Human variation today is a result of evolution. It is the result of the four forces of evolution shaping our diversity.

Studying Human Variation - a Biocultural approach

Biology is intertwined with human cultural behavior and both shape human diversity.

We have evolved through the four forces of evolution intertwined with cultural behavior.

Adaptation

- any change in an organism, either temporary or permanent, biological or cultural, short or long term, involving physiological, structural, behavioral or structural changes, aimed at improving the organism's functional performance in the face of environmental stress.

Genetic adaptation

- only such changes that is the result of natural selection.
Adaptability and Acclimatization

Genetic Adaptation

Example - lactose tolerance

lactose tolerance is due to the lactase persistence allele (2q21)

Across the world...

Across the world...

<table>
<thead>
<tr>
<th>Population</th>
<th>Percentage Lactose Absorbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>African American</td>
<td>80-94</td>
</tr>
<tr>
<td>African American</td>
<td>20-30</td>
</tr>
<tr>
<td>Apache</td>
<td>0</td>
</tr>
<tr>
<td>Chipewyan</td>
<td>20</td>
</tr>
<tr>
<td>Pueblo</td>
<td>0</td>
</tr>
<tr>
<td>Hawaiian</td>
<td>36</td>
</tr>
<tr>
<td>Australian Aboriginal</td>
<td>16</td>
</tr>
<tr>
<td>Papuan New Guinea</td>
<td>11</td>
</tr>
</tbody>
</table>

The A haplotype conferring lactose tolerance has an 86% frequency in the northern European population, but only 36% in southern European populations.

WHY?

- high frequency in populations with a long history of dairying and using milk
- tolerance selected for in populations with dairy in diet
- even a modest selective advantage (5-10%) could result in high frequencies in just 6000 years

Example: Sickle cell

Clinal map of Sickle Cell
Sickle Cell and Malaria

<table>
<thead>
<tr>
<th>Relative fitness</th>
</tr>
</thead>
<tbody>
<tr>
<td>HbAHbA</td>
</tr>
<tr>
<td>0.85</td>
</tr>
<tr>
<td>HbAHbS</td>
</tr>
<tr>
<td>1.00</td>
</tr>
<tr>
<td>HbSHbS</td>
</tr>
<tr>
<td>0.0-0.33</td>
</tr>
</tbody>
</table>

What do humans need to adapt to?

Skin color and solar radiation