II: EVOLUTION

Intro

- Evolution is a “scientific theory.”
  - Theory does not mean it’s just a wild guess.
  - A LOT OF EVIDENCE has led to the scientific consensus.
  - Multiple Independent Lines of Evidence (MILE)
    - E.g. fossil record, genetic evidence, homologous structures, vestigial structures.
    - Homologous: similar structures that have been inherited from a common ancestor.
    - Vestigial: structures inherited from a common ancestor that have lost their original function(s).
- DARWIN’S THEORY & LAMARCK’S THEORY
  - **Darwin’s:** random mutations introduce variation—after which particular organisms with favorable traits survive and reproduce in greater numbers (AKA natural selection).
  - **Lamarck’s:** organisms obtain particular traits as necessary during their lifetimes (disproven).

Intro

- Natural Selection vs. Artificial Selection
  - Natural: selection in response to natural selection pressures.
  - Artificial: selective breeding (by humans).

- Evolutionary “Fitness”
  - How well an organism can survive and reproduce in its particular environment.

- Inbreeding vs. Interbreeding
  - Inbreeding: breeding b/w closely related organisms.
    - Can increase the chances for deleterious recessive traits to be expressed.
  - Interbreeding: breeding b/w significantly different organisms.

- Polygenic vs. single-gene traits
  - Some traits are in part determined by a combination of genes (e.g. eye color).
    - Polygenic
  - Some are influenced by just one gene.
    - Single-gene
  - Don’t forget that the environment (“nurture”) plays a role too.

Bacteria (background)

- Single-celled, prokaryotes without a nucleus.
- Characterized by shape, cell wall, and movement.
- Reproduce by binary fission.
  - Asexual reproduction!
- Transfer of genetic info can occur through horizontal gene transfer!

- Generation times are SHORT—thus, can evolve VERY rapidly.

Antibiotic Resistance

- Antibiotics will kill all bacteria if applied for a nominal amount of time.
- Misusing antibiotics (underusing them) leads to more-resistant bacteria surviving, reproducing in greater numbers, and thus developing antibiotic resistance.
- Simple!

- HOWEVER: disinfectant chemicals (e.g. dish soap) do not contribute to antibiotic resistance!

Population Genetics: Intro

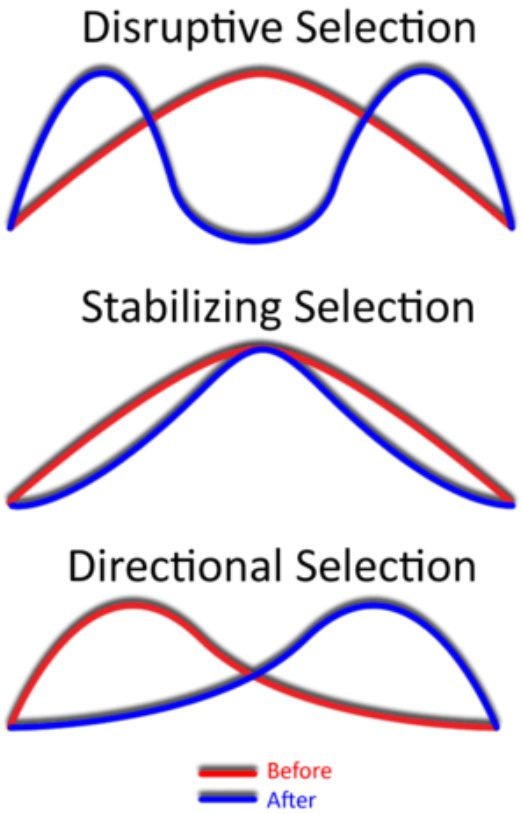
- Population: a group of individuals that belong to the same species and live in the same area (and therefore reproduce together).
- A gene pool is the combined genetic information of all the members of a population.

Population Genetics: Variation

- Sources of variation:
  - Mutations – the ultimate source of all variation in life on Earth
  - Gene flow – variation in populations
    - between different populations of the same species
    - between closely related species
    - horizontal gene transfer (bacteria, viruses)
  - Recombination (through sexual reproduction) - variation in individuals, not in the population
    - meiosis and sexual reproduction produce a random mixture of genetic information from two parents

Population Genetics: Types of Selection

- Directional Selection:
  - Selection for a more extreme phenotype
  - For single-gene traits: selection for homozygous (dominant or recessive)
- Stabilizing Selection:
  - Selection for the intermediate phenotype
  - For single-gene traits: selection for heterozygous
- Disruptive Selection:
  - Selection for the extreme phenotypes
  - For single-gene traits: selection for homozygous (dominant and recessive)



Population Genetics: Genetic Drift

- Refers to random changes in allele frequency (i.e. evolution that is not due to natural selection)
  - A chance event (e.g. disease/disaster) could eliminate all of the organisms with a particular trait/allele
  - Rare alleles may not be passed down by any remaining organism during sexual reproduction
- Has a disproportionate effect in small populations
- Decreases genetic diversity (especially rare alleles)
  - Populations with less genetic diversity are less able to evolve and adapt to environmental change, because they have fewer alleles that may allow some organisms to survive in future environments

Population Genetics: Genetic Drift

TYPES:

- Genetic bottleneck (e.g. in endangered species)
  - Occurs when population size is sharply reduced, due to natural disasters, disease, or human activities
  - Results in a loss of genetic variation, and reduced ability to survive environmental change
- Founder Effect
  - A small group of individuals colonizes a new habitat
  - The founders do not represent the diversity of the original population
  - Any unusual alleles that happened to be present in the founders will be passed on to many descendants (and have a much higher frequency) in the new population

Population Genetics: Rate of Evolution

Which factors increase the rate of evolution?

- Strong / weak selection?
- Long / short generation time?
- Large / small population size?

NOTE:

- Small populations have less variation to start with, less opportunity for more variation (i.e. mutations), and a greater potential for genetic drift (which tends to decrease variation) – so they are slower to adapt, yet less stable and more likely to go extinct.