KEY CONCEPT A population shares a common gene pool.

In most populations, individuals have different characteristics, or traits. A phenotype is a trait produced by one or more genes, and a single population may have a range of phenotypes for any given trait. In order for natural selection to occur, a population must have different phenotypes to be selected for or against. In this way, a variety of phenotypes makes it more likely that certain individuals will survive different environmental pressures.

In order for a population to have a variety of phenotypes, it must have genetic variation. Genetic variation comes in the form of different alleles for any given gene. A population’s gene pool is the combined alleles of all the individuals in a population.

Biologists measure the genetic diversity of a population by calculating the frequencies, or rates, of each allele in the gene pool. An allele frequency is therefore a measure of how common a certain allele is in the gene pool.

Genetic variation comes from two main sources:

- Mutations are random changes in DNA. Some mutations cause a new allele to form. If a mutation occurs in a reproductive cell, it can be passed on to offspring.
- Recombination is a process in which new allele combinations can form in offspring. Most recombination occurs during meiosis, when the alleles in each parent’s gametes are arranged in new ways.

Some biologists are studying hybridization as another source of genetic variation. Hybridization occurs when individuals of two related but different species mate.

1. What makes up a population’s gene pool?

2. How is genetic variation measured in a population?

3. Describe how mutation and recombination provide genetic variation to populations.

4. Why must a population have genetic variation in order for natural selection to occur?
KEY CONCEPT  Evolution occurs in patterns.

Natural selection is not random. Natural selection can push a population's traits in a certain direction depending on the environmental pressures. And the resulting changes in allele frequencies add up over time. Two clear trends that can occur as a result of natural selection are convergent evolution and divergent evolution.

- **Convergent evolution** is the evolution toward similar traits in unrelated species. This occurs when unrelated species adapt to similar environments.
- **Divergent evolution** is the evolution toward different traits in related species. This occurs when related species adapt to different environments.

Different species can also shape each other over time. Coevolution is a process in which two or more species evolve in response to changes in each other. The relationships that evolve can be beneficial to both species or competitive.

**Extinction** is the elimination of a species from Earth.

- Background extinctions occur continuously at a low rate and occur at about the same rate as speciation. They can be caused by local changes in an ecosystem.
- Mass extinctions occur much less frequently, but they are much more intense. They occur suddenly in geologic time, due to global catastrophic events, and can destroy hundreds or thousands of species at a time.

The theory of **punctuated equilibrium** states that speciation occurs suddenly and rapidly in geologic time, and is followed by long periods with little evolutionary change. The rapid speciation of one ancestral species into many descendant species is called adaptive radiation.

1. Why is natural selection not considered a random event?

2. Two related species become more different over time. What type of evolution is this an example of?

3. Contrast background extinctions and mass extinctions.

4. Describe the theory of punctuated equilibrium.