# Populations adapt across generations

An adaptation is a heritable characteristic that improves survival or reproductive success in a particular environment. Natural selection can make advantageous inherited traits more common.

## 1. FOLLOW THE NATURAL-SELECTION CHAIN

**Variation**

Individuals differ; some differences are inherited.

⩛

**Environmental pressure**

Conditions make certain inherited traits more advantageous.

⩛

**Unequal reproductive success**

Individuals with those traits leave more surviving offspring.

⩛

**Change across generations**

Associated alleles and traits can increase in the population.

## 2. FITNESS MEANS CONTRIBUTING TO THE NEXT GENERATION

Fitness is relative reproductive success in the current environment, not simply strength or lifespan. A trait that helps an organism survive matters evolutionarily when it also helps that organism pass its genes to future generations.

## 3. SELECTION DOES NOT CREATE WHAT IS NEEDED

Mutation generates new alleles; sexual reproduction reshuffles existing variation. Mutations do not occur because an organism needs a particular solution. Selection acts on available variation. Without suitable heritable variation, a population may fail to adapt to a new stress.

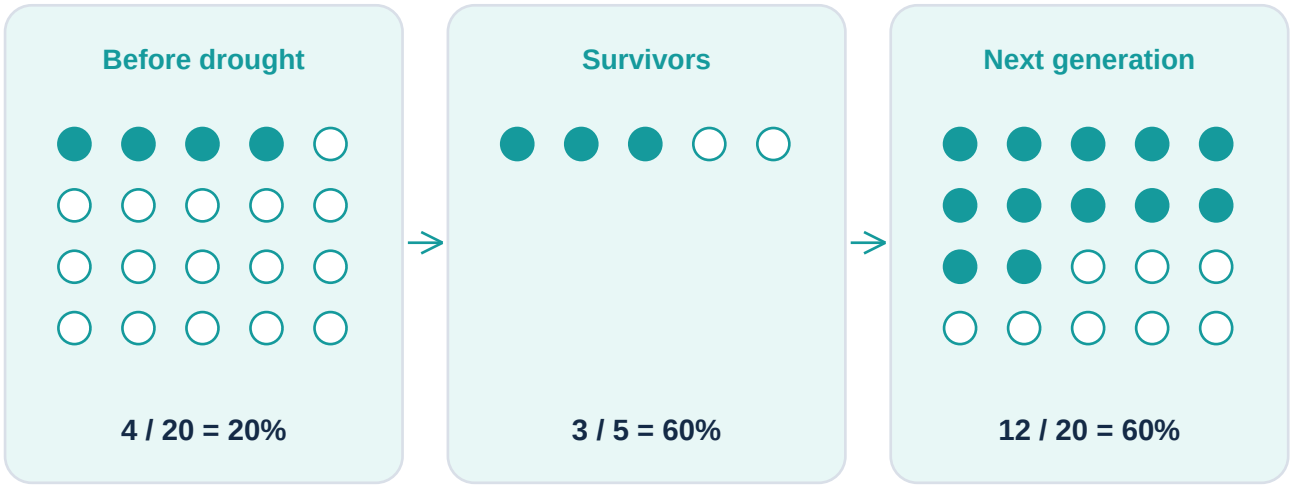
Natural selection and adaptation: OpenStax, Biology 2e 18.1.
Fitness and inherited variation: OpenStax, Biology 2e 19.2-19.3.
Sources of genetic variation: OpenStax, Biology 2e 19.2.

Scope: College Board AP Environmental Science CED, Topic 2.6, p. 57.

# Selection changes trait frequencies

Illustrative scenario, not real field data: a beetle population contains an inherited trait that reduces water loss. Drier conditions favor beetles with this trait.

## 1. TRACK INDIVIDUALS AND PROPORTIONS




Each circle = one beetle. Filled circles carry the lower-water-loss trait; open circles do not.

## 2. EXPLAIN THE MECHANISM

In this example, 3 of 4 trait-bearing beetles survive, compared with 2 of 16 others. The trait therefore becomes more frequent among survivors even though its absolute count falls. Survivors reproduce and pass on the trait; the diagram assumes the shown offspring composition.

## 3. KNOW WHAT THE NUMBERS DO AND DO NOT SHOW

The share with the trait rises from 20% to 60%, an increase of 40 percentage points. No beetle changes from an open to a filled circle during the drought. These are trait frequencies, not a complete genetic model. Real evidence must establish inheritance and differences in reproductive success.

Selection and relative fitness: OpenStax, Biology 2e 19.3.
Population-level change versus individual change: OpenStax, Concepts 11.5.

Scope: College Board AP Environmental Science CED, Topic 2.6, p. 57.

# Immediate responses are not evolution

Sudden or gradual environmental change can force individuals to change behavior, move or die. Some responses help an individual now; genetic adaptation changes populations over generations.

## 1. DISTINGUISH THE LEVEL AND TIMESCALE

### BEHAVIOR: AN INDIVIDUAL RESPONDS

A lizard moves into shade as the day warms. Its location changes; this observation alone does not show genetic evolution.

### ACCLIMATION: PHYSIOLOGY ADJUSTS

An individual may adjust its physiology after exposure to new conditions. Such a within-lifetime adjustment is not, by itself, a change in inherited traits across generations.

### ADAPTATION: A POPULATION CHANGES

If inherited heat-tolerant traits lead to greater reproductive success, their frequency may increase over generations. That requires inheritance, not just exposure to heat.

## 2. ADAPTATIONS CAN TAKE DIFFERENT FORMS

Structural features, physiological processes and inherited behavioral tendencies can all affect fitness. Camouflage can reduce detection by predators; water-conserving physiology can help in dry habitats. A behavior can have an evolved basis even though performing it once is not evolution.

## 3. THERE IS NO UNIVERSALLY BEST TRAIT

A trait useful in one environment may carry costs in another. Thick insulation can conserve heat in the cold but make cooling harder in hot conditions. Environmental change may outpace reproduction and selection. Adaptation is not guaranteed, and evolution has no planned destination.

Environmental change and individual responses: College Board, ERT-2.H.
Adaptation and misconceptions: OpenStax, Concepts of Biology 11.5.

Scope: College Board AP Environmental Science CED, Topic 2.6, p. 57.