Variation becomes evolutionary change

Natural selection is unequal reproductive success associated with heritable phenotypic differences. Its outcome depends on the environment, not on what an organism needs or wants.

1. HERITABLE VARIATION EXISTS

Mutation creates new alleles; sexual reproduction reshuffles them. Some resulting phenotypes affect survival or reproduction.

2. MORE OFFSPRING THAN CAN ALL SUCCEED

Many offspring compete for limited resources. Predators, disease and climate can also impose selection pressures.

3. REPRODUCTIVE SUCCESS DIFFERS

Individuals with advantageous phenotypes tend to leave more surviving offspring. Survival can contribute to reproductive success.

4. ALLELES ARE PASSED TO OFFSPRING

When the advantage has a genetic basis, offspring can inherit the relevant alleles. The successful phenotype is more likely to recur.

5. THE POPULATION CHANGES OVER GENERATIONS

Alleles linked to greater reproductive success can become more frequent. The population may become better adapted to those conditions.

FITNESS MEANS REPRODUCTIVE CONTRIBUTION

Fitness compares contribution to the next generation, not strength or lifespan alone. Selection acts on phenotypes; populations evolve as allele frequencies change. Individuals do not change their alleles through effort.

The selection process: University of California, Berkeley, Understanding Evolution.
Relative fitness and adaptation: OpenStax, Biology 2e 19.3.

Scope: Cambridge 9700, 17.2.1-2, selection in 17.2.3, and 17.2.4, p. 43.

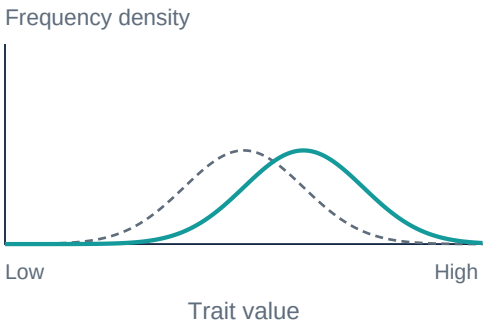
Three patterns of selection

The same process can shift the centre of a distribution, narrow its spread or favour two extremes. Identify which phenotypes have higher reproductive success.

------ Before ——— After selection

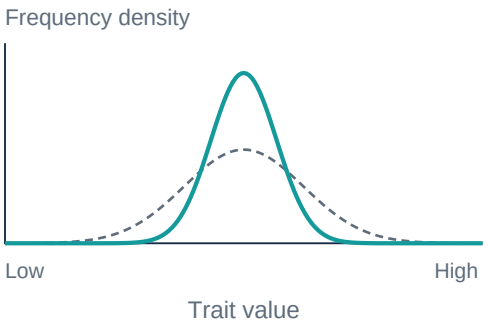
1. DIRECTIONAL

One extreme is favoured, shifting the mean toward that end. Example: where large, hard seeds dominate, birds able to crack them may have a reproductive advantage.



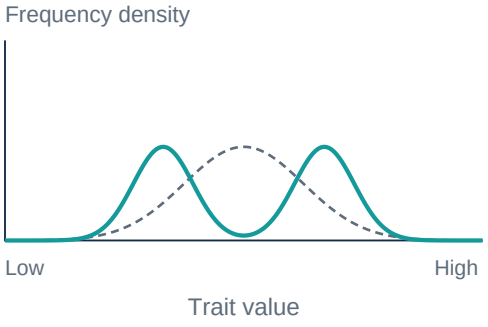
2. STABILISING

Intermediate phenotypes are favoured over both extremes. Variation around the centre tends to decrease; the mean may remain similar. Example: an intermediate clutch size can balance offspring number and parental care.



3. DISRUPTIVE

Both extremes are favoured over intermediates. The distribution may develop two peaks. Example: habitats offering mainly small and large seeds may favour small- and large-beaked birds over intermediates.



Curves and examples are schematic, not measured results. Disruptive selection alone does not establish reproductive isolation or prove that new species have formed.

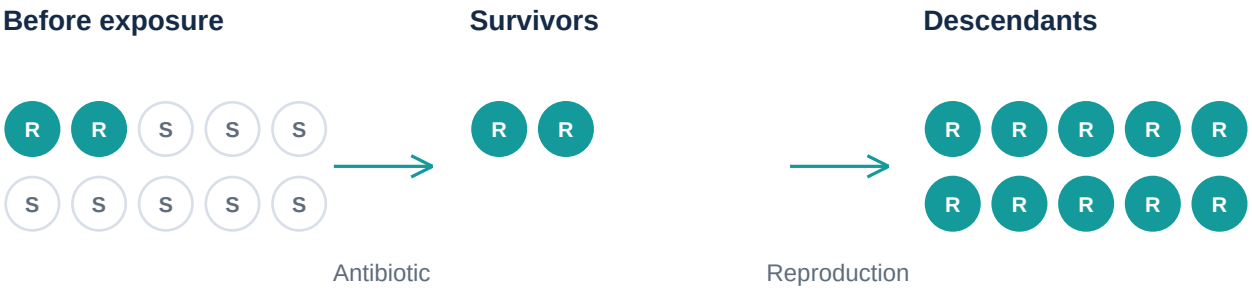
Selection patterns and effects on distributions: OpenStax, Biology 2e 19.3.
Environmental forces of selection: Cambridge 9700, 17.2.2.

Scope: Cambridge 9700, 17.2.1-2, selection in 17.2.3, and 17.2.4, p. 43.

Antibiotics change the odds

Resistance is a property of bacteria, not of the person taking an antibiotic. Antibiotic exposure creates selection pressure when resistant bacteria survive or reproduce better than susceptible bacteria.

1. FOLLOW THE RESISTANT LINEAGE



R = resistant; S = susceptible. In this simplified example, 8 susceptible cells die, 2 resistant cells survive, and the resistant lineage multiplies. Resistance rises from 2/10 to all surviving cells; exposure has not converted S cells into R cells.

Simplified counts; real survival and reproduction need not match this all-or-none example.

2. EXPLAIN THE GENETIC BASIS

Resistance can originate through mutation or be acquired by gene transfer, including transfer of resistance genes on plasmids. These sources generate or introduce genetic differences; antibiotic selection changes their representation in the population. Surviving bacteria can pass resistance genes to descendants.

3. USE THE CORRECT CAUSAL EXPLANATION

Do not say bacteria develop resistance because they try to survive. Mutation is not directed toward the change they need. Selection favours existing or newly arising heritable variants that perform better under exposure. Without that antibiotic, resistance may have a cost; its advantage is context-dependent.

A change in allele frequency is not automatically evidence of selection: genetic drift can also change frequencies through chance.

Resistance, selection and genetic spread: CDC, About Antimicrobial Resistance.
Heritable differences and differential reproduction: UC Berkeley, Natural Selection.

Scope: Cambridge 9700, 17.2.1-2, selection in 17.2.3, and 17.2.4, p. 43.