Exercise walk-through

Natural and artificial selection ▪ 17.2

eXercise

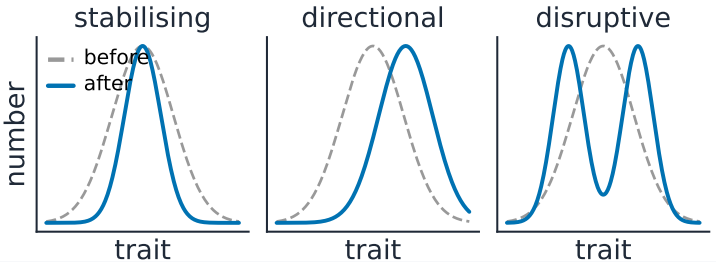
You must be able to

- explain natural selection and how it acts as a stabilising, directional or disruptive force
- explain the founder effect, genetic drift and the bottleneck effect
- use the Hardy–Weinberg principle and describe selective breeding

Method — Natural selection and its forces

Populations make more offspring than can survive, so they **compete** 竞争; the best **adapted** 适应 survive, reproduce and pass on their alleles, so helpful alleles become more common.

Method — Natural selection and its forces

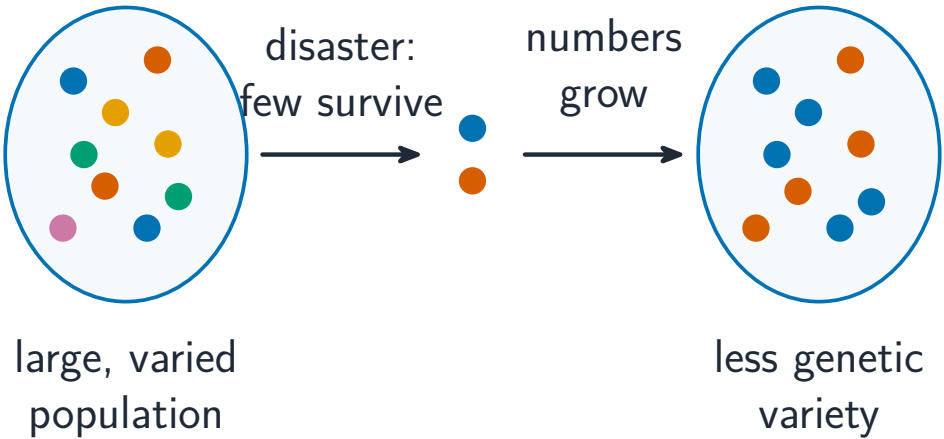


directional: favors one extreme · stabilising: favors mean · disruptive: favors both extremes

Method — Changing allele frequencies

Antibiotic resistance is natural selection: a chance mutation makes some bacteria resistant; the antibiotic kills the rest; the resistant survivors reproduce.

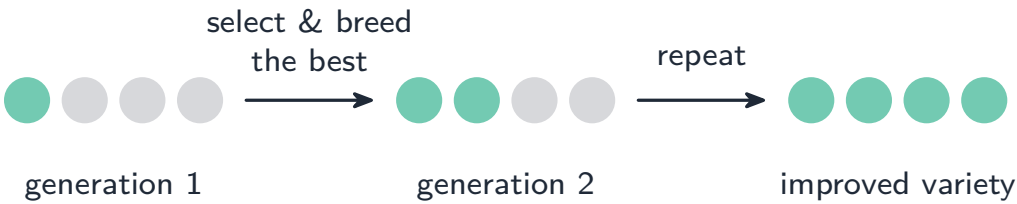
Method — Changing allele frequencies



Method — Hardy–Weinberg

With $p + q = 1$ and $p^2 + 2pq + q^2 = 1$, you can find allele and genotype frequencies (when the population is large, mating random, and there is no mutation, migration or selection).

Method — Selective breeding



Practice 2.1 ▪ 1 mark

Name the type of selection that favours the average and removes the extremes.

Solution 2.1

Method: Natural selection and its forces

Worked steps

stabilising selection B1.

Practice 2.2 ▪ 2 marks

State **two** conditions under which the Hardy–Weinberg principle holds.

Solution 2.2

Method: Hardy–Weinberg

Worked steps

any two: large population; random mating; no mutation; no migration; no natural selection B1 *each, max 2.*

Exam-style 3.1 ▪ 1 mark

A change that favours one extreme of a range, shifting the mean, is:

A stabilising selection

B directional selection

C disruptive selection

D genetic drift

Solution 3.1

Method: Natural selection and its forces

A stabilising selection

B directional selection ✓

C disruptive selection

D genetic drift

Worked steps

B. Directional selection shifts the mean towards one extreme.

Exam-style 3.2 ▪ 1 mark

The bottleneck effect reduces a population's:

A mutation rate

B genetic variety (allele variety)

C birth rate

D number of chromosomes

Solution 3.2

Method: Changing allele frequencies

A mutation rate

B genetic variety (allele variety) ✓

C birth rate

D number of chromosomes

Worked steps

B. A bottleneck leaves few survivors, reducing allele variety.

Exam-style 3.3 ▪ 2 marks

In a population, the recessive phenotype (genotype q^2) occurs in 16% of individuals.
(a) Calculate the frequency of the recessive allele, q.
(b) Calculate the frequency of heterozygotes ($2pq$).

Solution 3.3

Method: Hardy–Weinberg

Worked steps

(a) $q^2 = 0.16$, so $q = \sqrt{0.16} = 0.4$ M1 A1.
(b) $p = 1 - q = 0.6$ M1; $2pq = 2(0.6)(0.4) = 0.48$ A1.

Exam-style 3.4 ▪ 3 marks

Explain how the overuse of antibiotics leads to a resistant bacterial population, using the idea of natural selection.

Solution 3.4

Method: Changing allele frequencies

Worked steps

a chance mutation makes some bacteria resistant B1; using the antibiotic kills the non-resistant bacteria B1; the resistant ones survive and reproduce, so the resistant allele becomes more common B1.