A-LEVEL BIOLOGY • EXERCISE SHEET

17.2 Natural and artificial selection

Name: _____ Class: _____ Date: _____ **Total: 12 marks**

Objective

Build the skills to answer exam questions on **natural and artificial selection** —**natural selection** 自然选择, types of selection, the **founder effect** 奠基者效应 and **genetic drift** 遗传漂变, the **Hardy–Weinberg principle** 哈迪-温伯格原理, and **selective breeding** 选择育种.

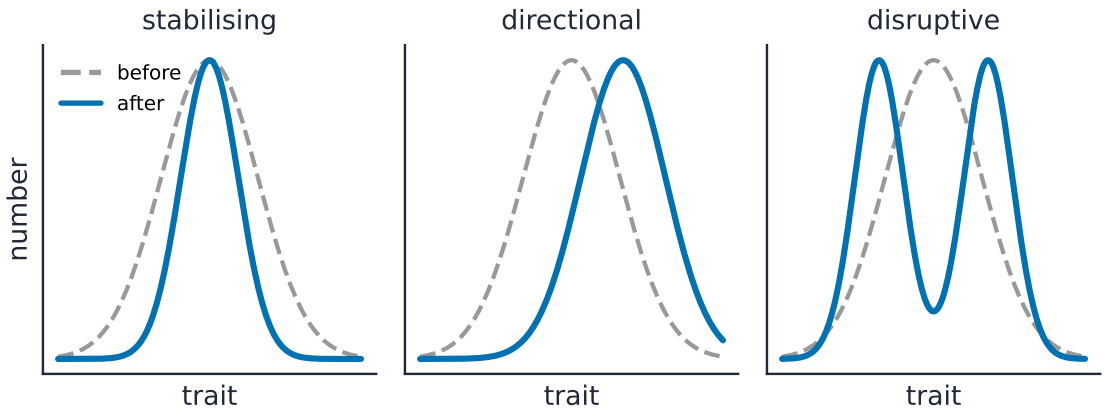
You must be able to:

- 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

1 Worked examples

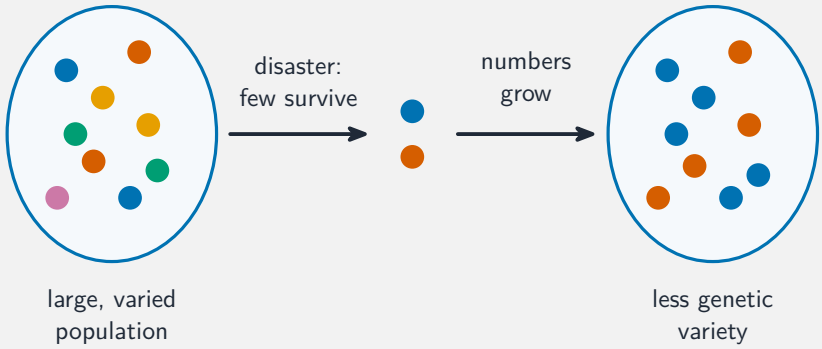
Natural selection and its forces

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.



Stabilising favours the average; directional favours one extreme; disruptive favours both extremes

Changing allele frequencies



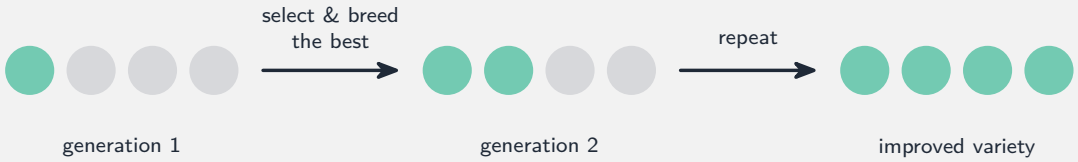
A bottleneck (or founder effect) leaves few alleles; genetic drift changes frequencies by chance

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

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).

Selective breeding



Humans choose which organisms breed, so useful features (e.g. disease resistance, milk yield) increase

2 Practice

2.1 Name the type of selection that favours the average and removes the extremes. [1]

2.2 State **two** conditions under which the Hardy–Weinberg principle holds. [2]

3 Exam-style questions

3.1 A change that favours one extreme of a range, shifting the mean, is: [1]

- **A** stabilising selection
- **B** directional selection
- **C** disruptive selection
- **D** genetic drift

3.2 The bottleneck effect reduces a population's: [1]

- **A** mutation rate
- **B** genetic variety (allele variety)
- **C** birth rate
- **D** number of chromosomes

3.3 In a population, the recessive phenotype (genotype q^2) occurs in 16% of individuals.

(a) Calculate the frequency of the recessive allele, q. [2]

(b) Calculate the frequency of heterozygotes ($2pq$). [2]

3.4 Explain how the overuse of antibiotics leads to a resistant bacterial population, using the idea of natural selection. [3]

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4 Go further

You are now ready for the real exam questions on this subtopic. Open the **17.2 Natural and artificial selection** past-paper sheet in the Library, or try these in **Practice mode**:

- 9700/41 N25 —Q4 (selection, calculation)
- 9700/42 N25 —Q4 (natural selection)
- 9700/41 J25 —Q5 (Hardy–Weinberg, calculation)

Solutions

2.1 stabilising selection.

2.2 any two: large population; random mating; no mutation; no migration; no natural selection.

3.1 B. Directional selection shifts the mean towards one extreme.

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

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

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