

17.2 Natural and artificial selection

Name: _____ Class: _____ Date: _____

Total: 12 marks

KEY WORDS natural selection 自然选择 • selective breeding 选择育种 • genetic drift 遗传漂变 • founder effect 奠基者效应 • hardy–weinberg principle 哈迪

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.

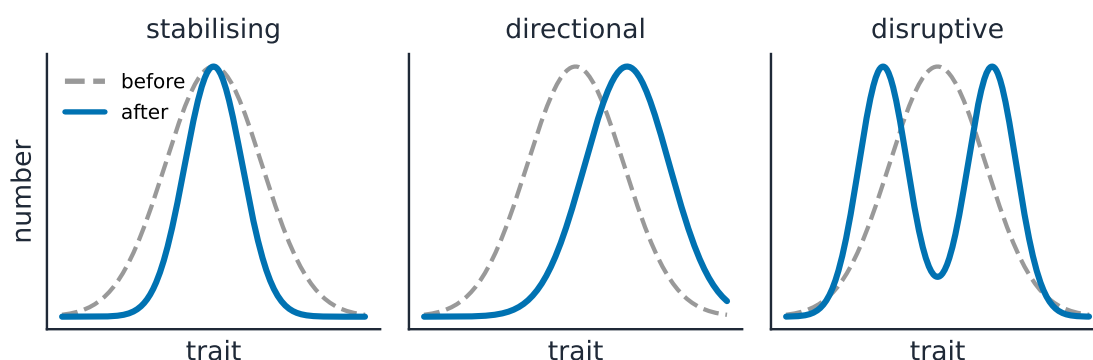
You must be able to:

- 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

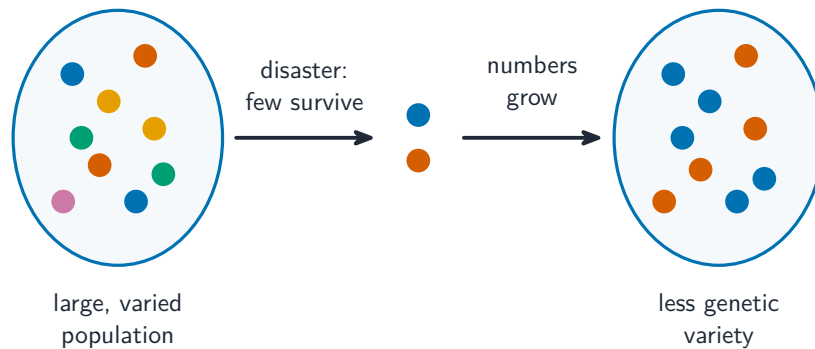
Populations make more offspring than can survive, so they **compete** 竞争; the best **adapted** 适应 survive, reproduce and pass on their alleles, so helpful alleles become more common.



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

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
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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
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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]

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.