

Natural Selection & Evolution

Key ideas

Natural selection: variation → overproduction → competition → the best-adapted survive and reproduce → their alleles become more common. Populations evolve, not individuals.

Other mechanisms: genetic drift (chance; bottleneck and founder effects), gene flow (migration), mutation, non-random (sexual) selection.

Hardy-Weinberg: $p + q = 1$ and $p^2 + 2pq + q^2 = 1$, where $p^2 = AA$, $2pq = Aa$, $q^2 = aa$.

A Darwin's key ideas

3 marks

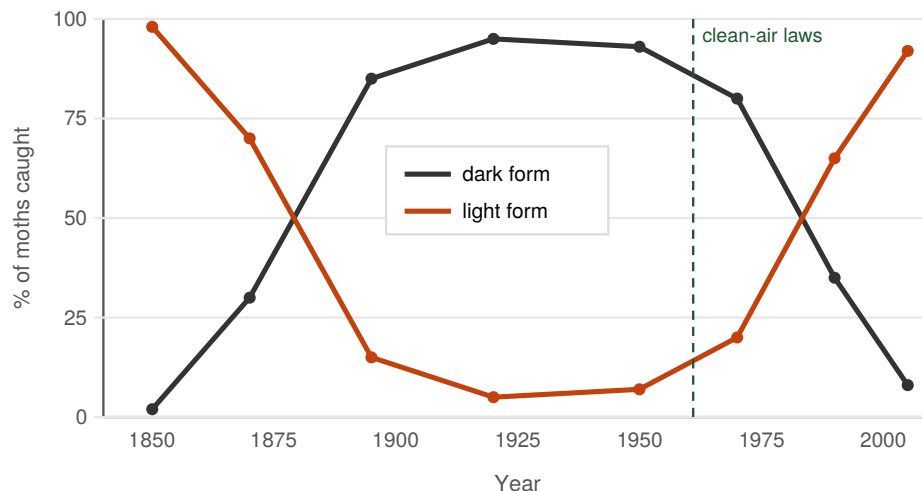
Write the letter of the matching description (½ mark each).

- | | |
|--------------------------------|--|
| 1. _____ Variation | a. Individuals best suited to the environment survive and reproduce more |
| 2. _____ Overproduction | b. Members of a species differ from one another in their traits |
| 3. _____ Competition | c. A trait that helps an organism survive and reproduce in its environment |
| 4. _____ Differential survival | d. Organisms produce more offspring than can possibly survive |
| 5. _____ Inheritance | e. Helpful traits are passed from parents to offspring through genes |
| 6. _____ Adaptation | f. Individuals struggle for limited resources such as food and mates |

B Case study: peppered moths

4 marks

Peppered moths come in a light form and a dark form. The graph shows model data based on moths caught near Manchester, England.

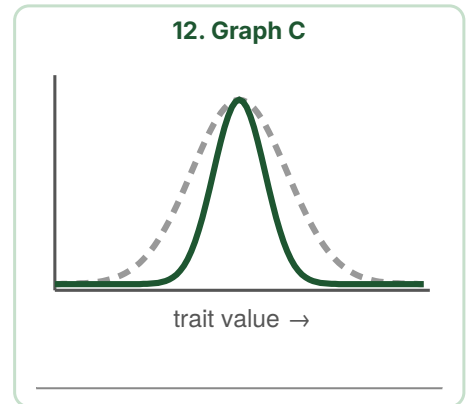
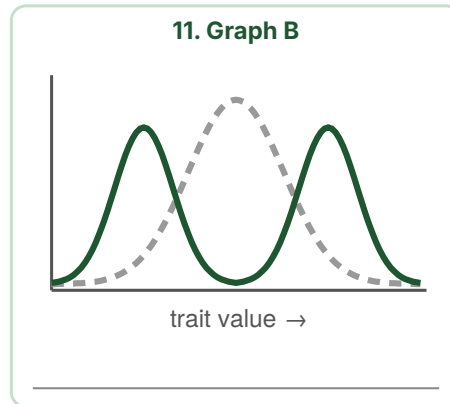
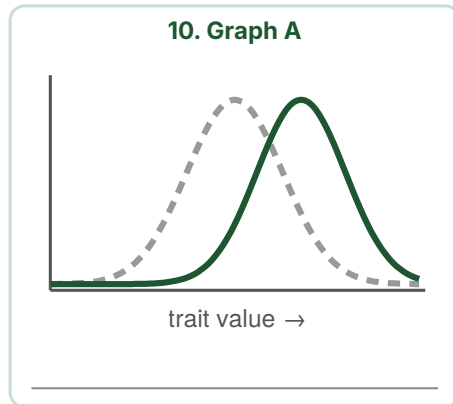


7. Describe how the percentage of dark moths changed between 1850 and 1920.
- _____
8. Factory soot darkened tree trunks during this time. Use natural selection to explain the change. (2 marks)
- _____
9. Explain why the percentage of dark moths fell after clean-air laws were passed.
- _____

C Types of selection

3 marks

Dashed line = before selection; solid line = after. Name each type: stabilizing, directional or disruptive.



D Other mechanisms of evolution

2 marks

Name the mechanism: genetic drift (bottleneck or founder effect), gene flow or sexual selection. ½ mark each.

Scenario	Mechanism
13. A storm randomly kills 90% of a beetle population. By chance, most survivors are green.	
14. A few birds are blown to a remote island and start a new population with different allele frequencies.	
15. Pollen from a neighbouring cornfield fertilizes plants in another field.	
16. Peahens mate mostly with peacocks that have the largest, brightest tails.	

E Hardy-Weinberg calculations

6 marks

17. In a population in Hardy-Weinberg equilibrium, 16% of individuals show the recessive phenotype (aa). Find q.

18. Find p, the frequency of the dominant allele.

19. What percentage of the population is heterozygous (Aa)?

20. A population of 500 flowers has 45 white flowers (the recessive phenotype). How many flowers are expected to be heterozygous? (2 marks)

21. Give two conditions needed for Hardy-Weinberg equilibrium.

F Evidence for evolution

2 marks

Choose: homologous, analogous, vestigial or molecular evidence. ½ mark each.

	Scenario	Type of evidence
22.	A human arm, a whale flipper and a bat wing have the same bone pattern.	
23.	Bird wings and insect wings both allow flight but are built very differently.	
24.	Whales have small pelvis bones that do not support legs.	
25.	Humans and chimpanzees share about 98% of their DNA sequence.	

G Spot the mistake

2 marks

26. A student writes: "Giraffes stretched their necks to reach high leaves, so their babies were born with longer necks." Explain the error and correct it.

27. A student writes: "Antibiotics cause bacteria to mutate so they become resistant." Explain the error and correct it.

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ANSWER KEY**Key ideas**

Natural selection: variation → overproduction → competition → the best-adapted survive and reproduce → their alleles become more common. Populations evolve, not individuals.

Other mechanisms: genetic drift (chance; bottleneck and founder effects), gene flow (migration), mutation, non-random (sexual) selection.

Hardy-Weinberg: $p + q = 1$ and $p^2 + 2pq + q^2 = 1$, where $p^2 = AA$, $2pq = Aa$, $q^2 = aa$.

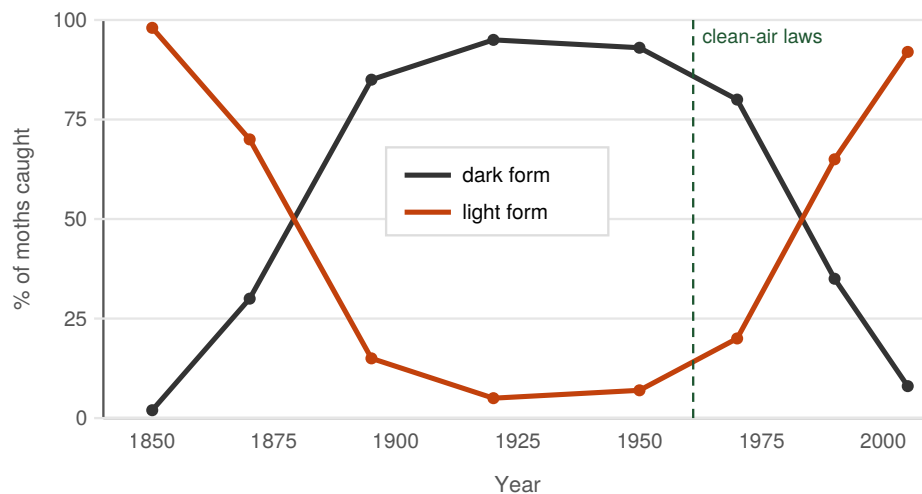
A Darwin's key ideas**3 marks**

Write the letter of the matching description (½ mark each).

- | | |
|---------------------------------------|--|
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| 3. <u> f </u> Competition | c. A trait that helps an organism survive and reproduce in its environment |
| 4. <u> a </u> Differential survival | d. Organisms produce more offspring than can possibly survive |
| 5. <u> e </u> Inheritance | e. Helpful traits are passed from parents to offspring through genes |
| 6. <u> c </u> Adaptation | f. Individuals struggle for limited resources such as food and mates |

B Case study: peppered moths**4 marks**

Peppered moths come in a light form and a dark form. The graph shows model data based on moths caught near Manchester, England.

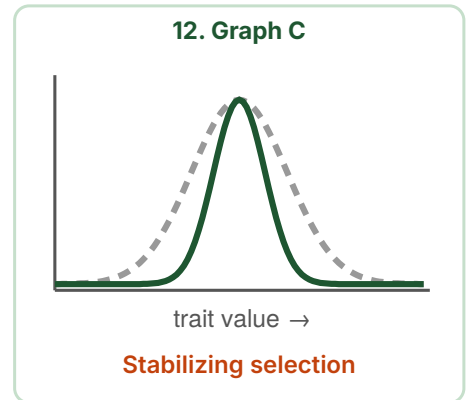
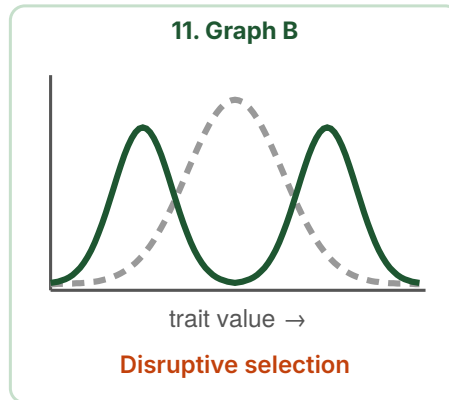
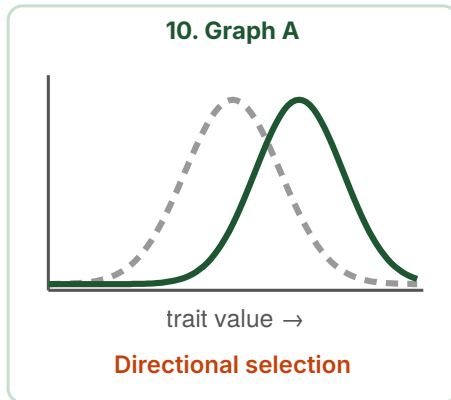


- Describe how the percentage of dark moths changed between 1850 and 1920.
It rose from about 2% to about 95%.
- Factory soot darkened tree trunks during this time. Use natural selection to explain the change. (2 marks)
Dark moths were better camouflaged on sooty trunks, so birds ate fewer of them. They survived and reproduced more, passing on the dark allele, so its frequency increased.
- Explain why the percentage of dark moths fell after clean-air laws were passed.
Trunks became lighter again, so light moths were now better camouflaged and selection favoured them.

C Types of selection

3 marks

Dashed line = before selection; solid line = after. Name each type: stabilizing, directional or disruptive.



D Other mechanisms of evolution

2 marks

Name the mechanism: genetic drift (bottleneck or founder effect), gene flow or sexual selection. ½ mark each.

Scenario	Mechanism
13. A storm randomly kills 90% of a beetle population. By chance, most survivors are green.	Genetic drift (bottleneck effect)
14. A few birds are blown to a remote island and start a new population with different allele frequencies.	Genetic drift (founder effect)
15. Pollen from a neighbouring cornfield fertilizes plants in another field.	Gene flow
16. Peahens mate mostly with peacocks that have the largest, brightest tails.	Sexual selection (non-random mating)

E Hardy-Weinberg calculations

6 marks

17. In a population in Hardy-Weinberg equilibrium, 16% of individuals show the recessive phenotype (aa). Find q.

$$q^2 = 0.16, \text{ so } q = \sqrt{0.16} = 0.4$$

18. Find p, the frequency of the dominant allele.

$$p = 1 - q = 0.6$$

19. What percentage of the population is heterozygous (Aa)?

$$2pq = 2 \times 0.6 \times 0.4 = 0.48 = 48\%$$

20. A population of 500 flowers has 45 white flowers (the recessive phenotype). How many flowers are expected to be heterozygous? (2 marks)

$$q^2 = 45/500 = 0.09, q = 0.3, p = 0.7; 2pq \times 500 = 2 \times 0.7 \times 0.3 \times 500 = 210 \text{ flowers}$$

21. Give two conditions needed for Hardy-Weinberg equilibrium.

Any two: very large population; random mating; no mutation; no migration (gene flow); no natural selection.

F Evidence for evolution

2 marks

Choose: homologous, analogous, vestigial or molecular evidence. ½ mark each.

	Scenario	Type of evidence
22.	A human arm, a whale flipper and a bat wing have the same bone pattern.	Homologous structures
23.	Bird wings and insect wings both allow flight but are built very differently.	Analogous structures
24.	Whales have small pelvis bones that do not support legs.	Vestigial structures
25.	Humans and chimpanzees share about 98% of their DNA sequence.	Molecular (DNA) evidence

G Spot the mistake

2 marks

26. A student writes: "Giraffes stretched their necks to reach high leaves, so their babies were born with longer necks." Explain the error and correct it.

That is Lamarck's idea. Traits gained during a lifetime are not inherited. Giraffes that were born with longer necks survived and reproduced more, passing on the genes.

27. A student writes: "Antibiotics cause bacteria to mutate so they become resistant." Explain the error and correct it.

Mutations happen randomly before the antibiotic is used. The antibiotic only selects the bacteria that already carry resistance.