

D4.1 Natural selection

Questions

[D4.1.1—Natural selection as the mechanism driving evolutionary change](#)

[D4.1.2—Roles of mutation and sexual reproduction in generating the variation on which natural selection acts](#)

[D4.1.3—Overproduction of offspring and competition for resources as factors that promote natural selection](#)

[D4.1.4—Abiotic factors as selection pressures](#)

[D4.1.5—Differences between individuals in adaptation, survival and reproduction as the basis for natural selection](#)

[D4.1.6—Requirement that traits are heritable for evolutionary change to occur](#)

[D4.1.7—Sexual selection as a selection pressure in animal species](#)

[D4.1.8—Modelling of sexual and natural selection based on experimental control of selection pressures](#)

[D4.1.9—Concept of the gene pool](#)

[D4.1.10—Allele frequencies of geographically isolated populations](#)

[D4.1.11—Changes in allele frequency in the gene pool as a consequence of natural selection between individuals according to differences in their heritable traits](#)

[D4.1.12—Differences between directional, disruptive and stabilizing selection](#)

[D4.1.13—Hardy–Weinberg equation and calculations of allele or genotype frequencies](#)
(Total for question = 4 marks)

[D4.1.14—Hardy–Weinberg conditions that must be maintained for a population to be in genetic equilibrium](#)

[D4.1.15—Artificial selection by deliberate choice of traits](#)

Answers

[D4.1.1—Natural selection as the mechanism driving evolutionary change](#)

[D4.1.2—Roles of mutation and sexual reproduction in generating the variation on which natural selection acts](#)

[D4.1.3—Overproduction of offspring and competition for resources as factors that promote natural selection](#)

[D4.1.4—Abiotic factors as selection pressures](#)

[D4.1.5—Differences between individuals in adaptation, survival and reproduction as the basis for natural selection](#)

[D4.1.6—Requirement that traits are heritable for evolutionary change to occur](#)

[D4.1.7—Sexual selection as a selection pressure in animal species](#)

[D4.1.8—Modelling of sexual and natural selection based on experimental control of selection pressures](#)

[D4.1.9—Concept of the gene pool](#)

[D4.1.10—Allele frequencies of geographically isolated populations](#)

[D4.1.11—Changes in allele frequency in the gene pool as a consequence of natural selection between individuals according to differences in their heritable traits](#)

[D4.1.12—Differences between directional, disruptive and stabilizing selection](#)

[D4.1.13—Hardy–Weinberg equation and calculations of allele or genotype frequencies](#)

[D4.1.14—Hardy–Weinberg conditions that must be maintained for a population to be in](#)

genetic equilibrium

D4.1.15—Artificial selection by deliberate choice of traits

Questions

D4.1.1—Natural selection as the mechanism driving evolutionary change

10. [1 mark]

Which is an example of natural selection?

- A. A giraffe stretching its neck to reach higher leaves
- B. A juvenile bird learning to sing
- C. Development of antibiotic resistance in bacteria
- D. Selective breeding of tail-less cats

11. [1 mark]

What is required for natural selection to occur?

- I. Acquired characteristics
 - II. Advantageous characteristics
 - III. Genetic variation
- A. I only
 - B. I and III only
 - C. II and III only
 - D. I, II and III

2. [1 mark]

Which factor(s) would favour evolution by natural selection?

- I. Long lifespans
 - II. Favourable characteristics acquired by individuals during their lifetime
 - III. Variation within a species
- A. II only
 - B. III only
 - C. I and II
 - D. I and III

4b. [7 marks]

Explain how natural selection can cause traits such as drought resistance to develop in wild plants.

7. [1 mark]

Which process results in decreased variation?

- A. Meiosis
- B. Mutation
- C. Sexual reproduction
- D. Natural selection

D4.1.2—Roles of mutation and sexual reproduction in generating the variation on which natural selection acts

10b. [7 marks]

Explain how genetic variation between the individuals in a species can be generated.

12c. [4 marks]

Explain how evolution by natural selection depends on mutations.

.....

.....

.....

.....

.....

.....

.....

.....

13b. [3 marks]

Outline how variation in organisms of the same species could lead to natural selection.

.....

.....

.....

.....

.....

.....

.....

.....

24. [1 mark]

What causes variation within a population?

- A. Fertilization and change in the environment
- B. Fertilization and mutation
- C. Mutation and evolution
- D. Evolution and adaptive radiation

37a. *[2 marks]*

List **two** causes of variation within a gene pool.

.....

.....

.....

37b. *[3 marks]*

Describe how variation contributes to evolution by natural selection.

.....

.....

.....

.....

.....

.....

.....

.....

.....

D4.1.3—Overproduction of offspring and competition for resources as factors that promote natural selection

27. *[1 mark]*

What is a direct consequence of the overproduction of offspring?

- A. Individuals become more adapted to the environment.
- B. They will be subject to intraspecific competition.
- C. They will diverge to produce different species.
- D. They will suffer mutations.

D4.1.4—Abiotic factors as selection pressures

D4.1.5—Differences between individuals in adaptation, survival and reproduction as the basis for natural selection

D4.1.6—Requirement that traits are heritable for evolutionary change to occur

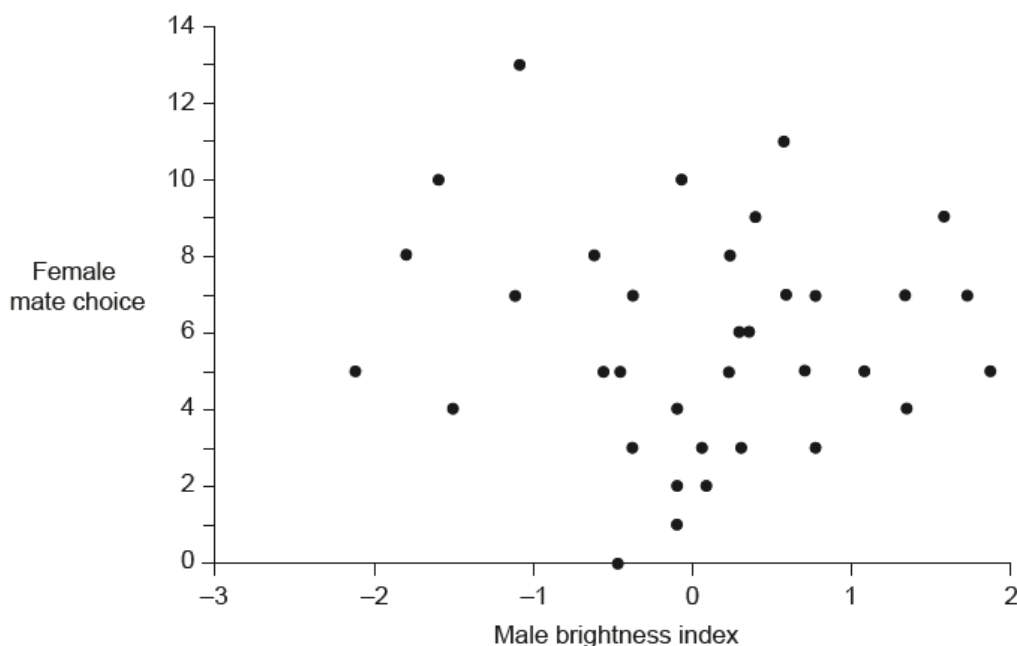
D4.1.7—Sexual selection as a selection pressure in animal species

1a. [2 marks]

Male eastern bluebirds (*Sialia sialis*) display brilliant UV-blue feathers on their heads, backs, wings and tails. The brightness index of the male was calculated; the larger the score, the brighter the blue feathers. A brightness value of 0 indicates normal male brightness, so birds with negative scores are less bright than normal.

In an experiment to see the mating behaviour of bluebirds, scientists separated pairs of males and females and then allowed females to choose new partners.

The graph shows the relationship between male brightness index and choice of mate by females in eastern bluebirds.



[Source: Reprinted from *Animal Behaviour*, 78, Liu, M., Siefferman, L., Mays, H., Steffen, J.E. and Hill, G.E., A field test of female mate preference for male plumage coloration in eastern bluebirds. pp.879–885. 2009 with permission from Elsevier and The Association for the Study of Animal Behaviour.
<https://www.sciencedirect.com/journal/animal-behaviour>.]

Evaluate the hypothesis that females prefer to mate with males whose feathers are a brighter blue.

.....

.....

.....

.....

.....

.....

1b. [3 marks]

Explain how natural selection can cause mate selection behaviour patterns to develop in a species such as eastern bluebirds.

.....

.....

.....

.....

.....

.....

2a. [3 marks]

Many animals have a unique technique for courting their mate. The male peacocks (*Pavo cristatus*) spread their brightly-coloured tails to impress the females (peahens).



[Source: cocoparisienne/Pixabay]

Explain the implications of courtship behaviour in natural selection.

.....

.....

.....

.....

.....

.....

D4.1.8—Modelling of sexual and natural selection based on experimental control of selection pressures

D4.1.9—Concept of the gene pool

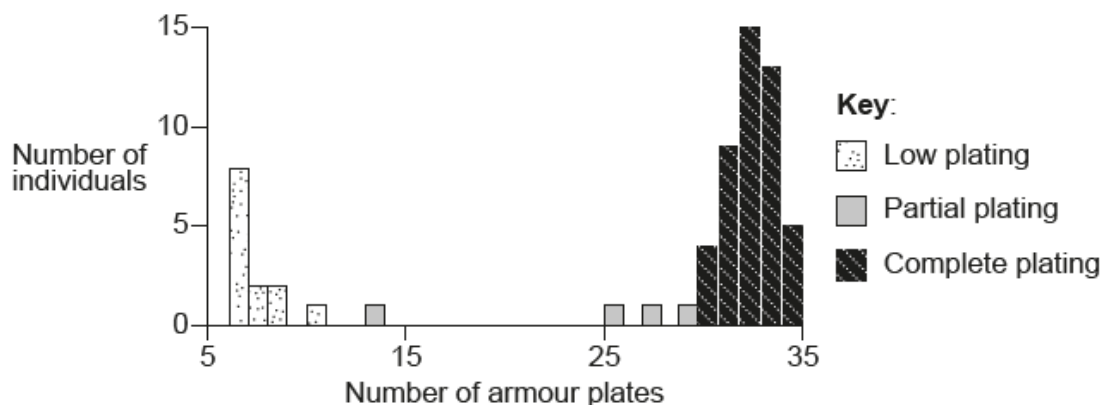
D4.1.10—Allele frequencies of geographically isolated populations

D4.1.11—Changes in allele frequency in the gene pool as a consequence of natural selection between individuals according to differences in their heritable traits

D4.1.12—Differences between directional, disruptive and stabilizing selection

2. [1 mark]

Three-spined stickleback fish (*Gasterosteus aculeatus*) vary in the number of armour plates. The graph shows the frequency of individuals with low, partial or complete plating in a three-spined stickleback population living in Kennedy Lake, Vancouver Island, Canada.



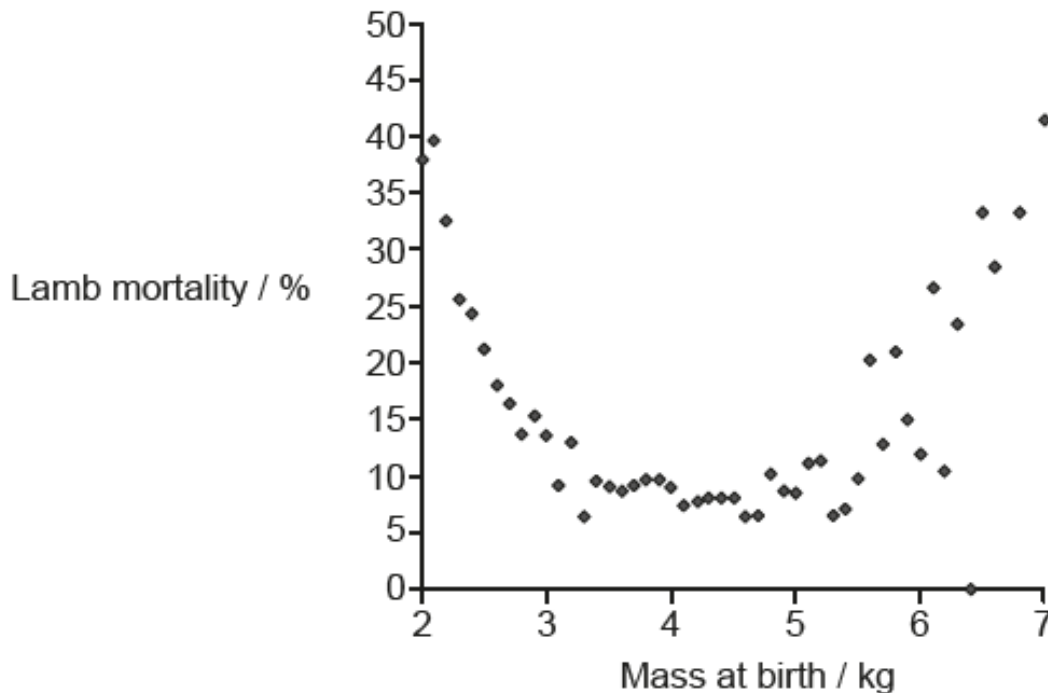
[Source: Reprinted from *Current Biology*, 24, Marchinko, K.B., Matthews, B., Arnegard, M.E., Rogers, S.M. and Schluter, D., Maintenance of a Genetic Polymorphism with Disruptive Natural Selection in Stickleback. 2014. pp.1289–1292 with permission from Elsevier.]

Which type of natural selection could result in this pattern of variation in the population?

- A. Disruptive
- B. Directional
- C. Stabilizing
- D. Convergent

4. [1 mark]

The graph shows the relationship between mass at birth and the percentage that die shortly after birth for Scottish Blackface lambs.



[Source: Dwyer, C.M., Conington, J., Corbiere, F., Holmoy, I.H., Muri, K., Nowak, R., Rooke, J., Vipond, J. and Gautier, J.-M., 2016. Invited review: Improving neonatal survival in small ruminants: science into practice. *Animal*, 10(3), pp. 449–459.]

What type of selection for the lambs is shown in the graph?

- A. Disruptive selection, as there is a drop in mortality at intermediate birth masses
- B. Stabilizing selection, as lambs with low or high birth mass are less likely to survive
- C. Directional selection, as lambs with a high birth mass have high mortality
- D. There is no evidence in the graph of selection, as survival frequency is not shown

7. [1 mark]

A hunter tends to kill the bigger individuals of a population for their meat or for large ornamental trophies. Therefore, the population tends to have more individuals who are smaller. What is this an example of?

- A. Directional selection
- B. Disruptive selection
- C. Natural selection
- D. Stabilizing selection

8. [1 mark]

Natural selection can operate in different ways. What is the effect of disruptive selection?

- A. It eliminates individuals with intermediate forms of a characteristic.
- B. It eliminates individuals at random regardless of their characteristics.
- C. It favours individuals with intermediate forms of a characteristic.
- D. It favours individuals at one extreme of the range of variation in a characteristic.

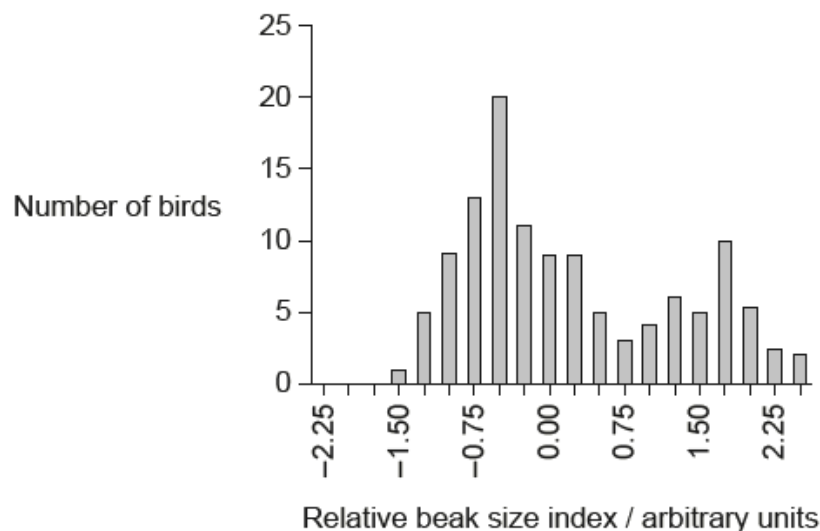
13. [1 mark]

Which example shows disruptive selection?

- A. Giraffe necks have become longer over time.
- B. Medium-sized beaks in hummingbirds have decreased in frequency over time.
- C. The peppered moth became less common in polluted environments.
- D. Human babies with a very high or a very low birth mass have a higher mortality rate.

18. [1 mark]

The graph shows variations in beak size for the bird *Geospiza fortis* on an island in the Galápagos archipelago.



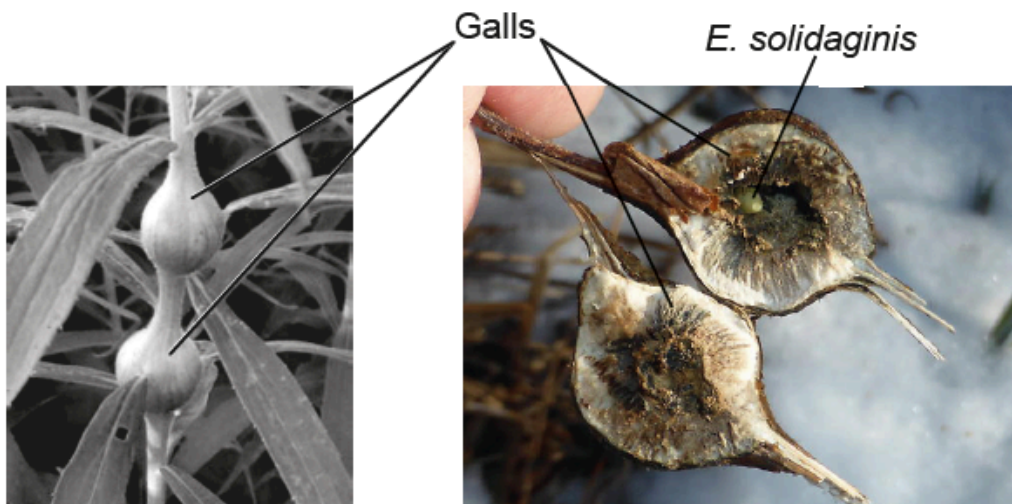
[Source: adapted from A P Hendry et al. (2006) *Proceedings of the Royal Society B*, 273, page 1890, by permission of the Royal Society.]

What evidence from the graph indicates that disruptive selection is occurring?

- A. An intermediate beak size is less common.
- B. Median beak size is the most common.
- C. Smaller beaks are favoured.
- D. Larger beaks are favoured.

21a. [2 marks]

The larval stage of the fly *Eurosta solidaginis* develops in the plant *Solidago altissima*. The larva secretes a chemical which causes plant tissue to grow around it forming a swelling called a gall. The gall provides the developing insect with protection from predators.



[Source: <https://nhgardensolutions.files.wordpress.com>]

[Source: Masumi Palhof]

The *E. solidaginis* fly is preyed upon by the parasitic wasp *Eurytoma gigantea*. The graph shows the relationship between gall diameter and the percentage of flies that avoid predation by *E. gigantea*.

Explain the concept of directional selection with respect to this example.

.....

.....

.....

.....

.....

.....

22. [1 mark]

Fossil records show that black bears increased in size during the Ice Age and decreased in size with warmer temperatures. What type of selection do these changes in size represent?

- A. Allopatric
- B. Directional
- C. Disruptive
- D. Stabilizing

D4.1.13—Hardy–Weinberg equation and calculations of allele or genotype frequencies

Q1.

The ability to taste phenylthiocarbamide (PTC) depends on a single gene.

This gene has two alleles. One is a dominant, tasting allele (T), and the other is a recessive, non-tasting allele (t).

In a survey, it was found that 64% of people could taste PTC.

(a) The Hardy-Weinberg equation is

$$(p + q)^2 = 1$$

Use this equation to calculate the proportion of the population who would be TT, Tt and

(b) There is no known selective advantage for being able to taste PTC.

(i) Describe two conditions under which these proportions remain the same over many generations.

(2)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(ii) In native American populations 98% of individuals can taste PTC.

In native Australian population 58% of individuals can taste PTC.

State why these two populations have different frequencies of the T allele. (3)

.....

.....

.....

.....

.....

.....

.....

.....

Q2.

The genetic condition Hers disease is caused by a recessive allele of the glycogen phosphorylase gene.

In an isolated population of 1400 people in the USA, 15 people have

Hers disease. (i) Calculate the number of heterozygous individuals in this population.

Use the Hardy-Weinberg equation

(4)

$$p^2 + 2pq + q^2 = 1$$

Answer

- (ii) The frequency of Hers disease in most human populations is 1 in 40 000. Explain why the frequency of Hers disease is higher in the isolated population. (2)

.....

.....

.....

.....

.....

.....

(Total for question = 6 marks)

Q3.

Cystic fibrosis is a recessive inherited condition where the cells in the lungs produce sticky mucus. This mucus builds up in the airways, causing breathlessness and chest infections.

People with cystic fibrosis often need treatments such as physiotherapy and antibiotics. The incidence of babies born with cystic fibrosis in Australia is 1 in 2500.

Use the Hardy Weinberg equation, $p^2 + 2pq + q^2 = 1$, to calculate the percentage of Australians who are carriers of cystic fibrosis.

(4)

Answer %

(Total for question = 4 marks)

D4.1.14—Hardy–Weinberg conditions that must be maintained for a population to be in genetic equilibrium

D4.1.15—Artificial selection by deliberate choice of traits

2. [1 mark]

Humans have been improving crop species for thousands of years by cross-breeding plants with desirable characteristics. The photograph shows the changes in dry cobs of corn (*Zea mays*) over 10 000 years.



[Source: Evolution of Maize Cobs © Robert S. Peabody Institute of Archaeology, Phillips Academy, Andover, Massachusetts. All Rights Reserved.]

What is the name of the process that was used to produce modern corn?

- A. Selective breeding
- B. Adaptive radiation
- C. Discontinuous variation
- D. Natural selection

16c. [3 marks]

Outline the evidence for evolution provided by selective breeding.

.....

.....

.....

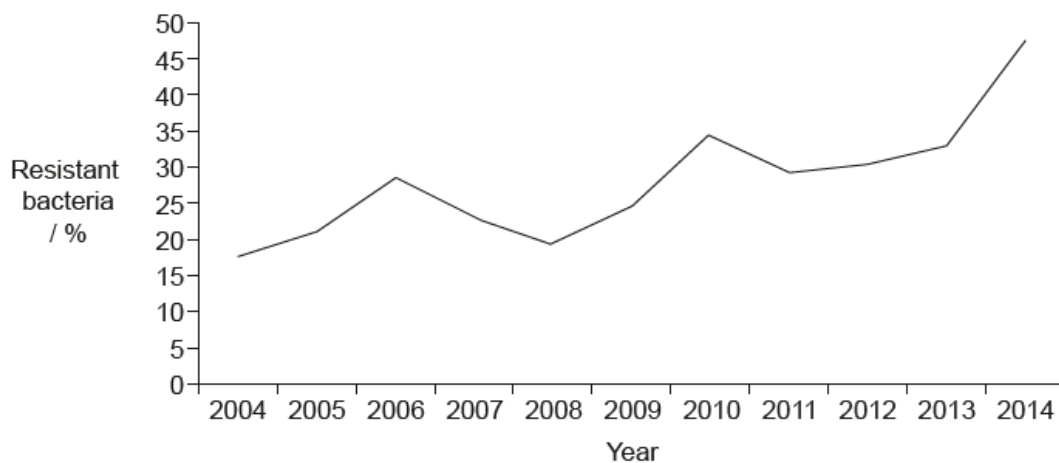
.....

.....

.....

1. [1 mark]

The graph shows the proportion of a bacterial population of *Neisseria gonorrhoeae*, displaying resistance to the antibiotic tetracycline.



[Source: © All rights reserved. *Canadian Antimicrobial Resistance Surveillance System Report, 2016*. Public Health Agency of Canada. Adapted and reproduced with permission from the Minister of Health, 2022.]

What can be deduced from this graph?

- A. Bacteria with beneficial adaptations survive and pass on their genes.
- B. Immunity to tetracycline is triggered by over-use of the antibiotic.
- C. Genetic variation in this bacterial population is increasing.
- D. Use of tetracycline inhibits the growth of antibiotic-resistant *N. gonorrhoeae*.

36. [1 mark]

What is the major contributor to the increase in antibiotic resistance in bacteria?

- A. Sexual reproduction
- B. Mutation
- C. Natural selection
- D. New antibiotics

Answers

D4.1.1—Natural selection as the mechanism driving evolutionary change

10. [1 mark]

C

11. [1 mark]

C

Examiners report

The answers to this question show poor knowledge of the requirements for natural selection, as many candidates believed acquired characteristics are needed.

2. [1 mark]

B

Examiners report

The question did discriminate well. It was commented that the word 'lifespans' may be difficult for non-native English speakers.

4b. [7 marks]

- a. (natural selection occurs if) there is variation in degree of drought resistance among members of a population/same species;
- b. variation is caused by mutations (when changes occur in the DNA/nucleic bases/chromosomes);
- c. variation during meiosis occurs (with separation of chromosomes);
- d. variation occurs during sexual reproduction (as different alleles combine);
- e. some variations make some plants more drought-resistant;
- f. example of variations: deeper roots/more storage tissue for water/thicker cuticles/less opening of stomata/other verifiable variations;
- g. these variations let some survive and reproduce better/have more offspring
OR
(these variations) confer selective advantage;
- h. these variations/characteristics are passed onto offspring which survive better;
- i. natural selection increases the frequency of these characteristics;
- j. eventually leads to changes/evolution in the species / more drought-resistant plants;

Examiners report

The inclusion of 'drought resistance' in the stem of the question should have been a suggestion to include it, but many answers were far too general with a vague attempt to explain Natural Selection in general without explaining how the initial variation in the population came about. There were quite a few 'Lamarckian' answers with claims of individuals adapting to cope with the change. The average for this question was only 2.8, putting it as one of the most poorly answered.

7. [1 mark]

D

Examiners report

There was some concern among teachers that this question might be misinterpreted, but three quarters of candidates answered correctly and the discrimination index was high. Natural selection can decrease variation by eliminating alleles that reduce fitness.

D4.1.2—Roles of mutation and sexual reproduction in generating the variation on which natural selection acts

10b. [7 marks]

- a. mutation (in genes/DNA generates variation)
- b. base substitution / change to base sequence of gene / makes single nucleotide polymorphisms /SNPs ✓
- c. new alleles formed / different alleles of gene / multiple alleles ✓
- d. radiation/mutagenic chemicals/mutagens cause/increase the chance of mutation ✓
- e. meiosis (generates variation) ✓
- f. recombination/new combinations of genes/alleles produced by crossing over ✓
- g. independent assortment/random orientation of (pairs of homologous) chromosomes/bivalents ✓
- h. gametes/chromosomes/DNA/genes from two parents combined (in sexual reproduction)
- i. random fertilization (increases genetic variation) ✓
- j. in reproductively/geographically isolated populations natural selection may differ ✓
- k. in small/isolated populations gene pools change/evolution occurs due to natural selection/genetic drift ✓
- l. disruptive selection can cause different varieties/variants/types/phenotypes to diverge ✓ transfer of genes (between bacteria) in plasmids ✓

For mpf it is not enough just to state 'crossing over'.

Do not accept types of mutation other than substitution for mpb.

Examiners report

More marks were scored here, with most candidates at least mentioning mutation and some of the events of meiosis. As this was an explain question it was not enough merely to name a process, such as crossing over, some indication of how it generates variation was expected. A common misunderstanding was to think that geographic isolation in itself generates variation.

12c. [4 marks]

- a. mutations cause variation among organisms of same species/population;
- b. some variations/mutations make individual more suited to its environment/way of life;
- c. individuals that are better adapted survive and produce offspring;

- d. individuals pass on genetic characteristics/mutation/variation to offspring;
- e. natural selection increases frequency of characteristics/alleles that make individuals better adapted;

13b. [3 marks]

- a. survival of the better adapted/fittest ✓
- b. more reproduction of better adapted/fittest/individuals with favorable variations ✓
- c. genes for favorable variations/adaptations passed on to offspring ✓ *Accept answers in the converse.*
- d. competition for resources/more offspring produced than the environment can support/a struggle for existence ✓ *Accept answers in the converse.*

24. [1 mark]

B

37a. [2 marks]

- a. sexual reproduction / random fertilization / meiosis
- b. mutation

No mark for crossing over unqualified.

Reject natural selection/evolution as causes of variation.

37b. [3 marks]

- a. (variation is) different phenotypes/differences between individuals in a population/species
- b. struggle/competition for survival
- c. some individuals have advantageous characteristics/are better adapted/have greater chance of survival/reproduction (than others)
- d. favourable alleles/genetic variations passed on/inherited by offspring/next generation

Reject "pass on phenotypes".

D4.1.3—Overproduction of offspring and competition for resources as factors that promote natural selection

27. *[1 mark]*

B

D4.1.4—Abiotic factors as selection pressures

D4.1.5—Differences between individuals in adaptation, survival and reproduction as the basis for natural selection

D4.1.6—Requirement that traits are heritable for evolutionary change to occur

D4.1.7—Sexual selection as a selection pressure in animal species

1a. [2 marks]

Strengths:

a. (slight) increase in mate choice at higher male brightness index;

Weaknesses:

b. dots are scattered without a trend/no clear correlation

OR

most females choose mates around normal (brightness);

c. insufficient data/information provided;

Allow any other data-based statement.

Examiners report

Most candidates managed to provide at least one evaluation statement, but it was difficult for many to provide a complete evaluation.

1b. [3 marks]

a. natural selection favours specific types of mate selection/behaviour;

b. (behaviour/mate selection) increases the chances of survival/reproduction;

c. chosen organisms/males will leave more offspring;

d. pass on gene(s) for behavior to offspring;

e. (behaviour/allele) will become more prevalent/frequent in a population;

Examiners report

It was difficult for many to provide focused answers for this question, although most candidates could provide valid partial explanations.

2a. [3 marks]

a. «courtship behaviour» is inherited/innate

OR

variations exist ✓ *OWTTE*

b. fittest animals have the best courtship behaviour ✓

c. «courtship behaviour» allows members of a species to identify each other

OR

«courtship behaviour» results in mate selection ✓ *OWTTE*

d. «courtship behaviour» increases chances of mating/reproductive success ✓

e. «courtship behaviour» also make organisms more vulnerable to predation ✓

f. «allows» best courtship to be passed on to the next generation/offspring ✓

D4.1.8—Modelling of sexual and natural selection based on experimental control of selection pressures

D4.1.9—Concept of the gene pool

D4.1.10—Allele frequencies of geographically isolated populations

D4.1.11—Changes in allele frequency in the gene pool as a consequence of natural selection between individuals according to differences in their heritable traits

D4.1.12—Differences between directional, disruptive and stabilizing selection

2. [1 mark]

A

4. [1 mark]

B

Examiners report

Two thirds of candidates chose the correct answer but the discrimination index was lower than expected. Perhaps some candidates were tiring by this stage of the exam and therefore did not think carefully enough. The shape of the graph looks superficially like disruptive selection, but the y-axis shows mortality, not survival.

7. [1 mark]

A

8. [1 mark]

A

13. [1 mark]

B

18. [1 mark]

A

21a. [2 marks]

a. directional selection is when an extreme phenotype/characteristic is favoured
OWTTE

b. flies that form small galls will be selectively predated *OWTTE – accept vice versa*

c. over time, flies that produce small galls will become rarer

OR

mean gall size will increase

22. *[1 mark]*

B

D4.1.13—Hardy–Weinberg equation and calculations of allele or genotype frequencies

Q1.

Question Number	Acceptable Answer	Additional Guidance	Mark
(a)	An answer that makes reference to the following: • calculation of frequency of homozygous recessives $f(tt)$ (1) • calculation of q (1) • calculation of p (1) • calculation of $f(TT)$ and $f(Tt)$ (1)	<u>Example of calculation</u> Allow ECF for incorrect values $100 - 64\% = 36\% = \mathbf{0.36}$ $q = \sqrt{0.36} = \mathbf{0.6}$ $p = 1 - 0.6 = \mathbf{0.4}$ $p^2 = 0.4^2 = \mathbf{0.16}$ $2pq = 2 \times 0.4 \times 0.6 = \mathbf{0.48}$	(4)

Question Number	Acceptable Answer	Additional Guidance	Mark
(b)(i)	A description that makes reference to any two of the following: • population is large (1) • mating is random (1)		(2)
	• mutation is rare (1) • migration does not alter allele frequency / does not happen / the population is isolated (1)		

Question Number	Acceptable Answer	Additional Guidance	Mark
(b)(ii)	An answer that makes reference to the following: • founder effect (1) • population bottleneck (1) • genetic drift / result of chance (1)		(3)

Q2.

Question Number	Answer	Additional Guidance	Mark
(i)	A calculation that makes reference to three of the following: • calculation of q^2 • calculation of p and q • calculation of 2pq • calculation of the number of heterozygotes in a population of 1400 252 to 260 (4)	<u>Example of calculation</u> $15 \div 1400 = 0.0107$ $p = 0.897 \quad q = 0.103$ $2pq = 2 \times 0.897 \times 0.103 = 0.185$ $0.185 \times 1400 = 259$ Correct answer with no working gains full marks ACCEPT one mark for: $q^2 = 0.01$ to 0.0107 $p = 0.897$ to 0.9 and $q = 0.1$ to 0.103 ACCEPT $2pq = 0.18$ to 0.187 in final answer for 3 marks	4

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to two of the following: • founder effect (1) • therefore genetic bottleneck / therefore small gene pool (1) • more likely to receive two recessive alleles (from parents) / both parents are more likely to be heterozygous / carriers (1)	ACCEPT low genetic diversity / small number of different alleles	2

Q3.

Question Number	Answer	Additional Guidance	Mark
	An answer that makes reference to the following: • calculation of q^2 (1) • calculation of p and q (1) • calculation of 2pq (1) • calculation of percentage of carriers (1)	<u>Example of calculation:</u> $q^2 = 0.0004 / 4 \times 10^{-4}$ $q = 0.02$ and $p = 0.98$ $2pq = 0.0392$ percentage of population who are carriers is 3.92% Correct answer with no working gains full marks	(4)

D4.1.14—Hardy–Weinberg conditions that must be maintained for a population to be in genetic equilibrium

D4.1.15—Artificial selection by deliberate choice of traits

2. [1 mark]

A

16c. [3 marks]

- a. crop plants/domesticated animals/livestock produced by selective breeding
- b. specific example of a domesticated animal/crop plant and the wild species from which it was developed

OR

specific example of a domesticated animal/crop plant and the features in it which have been improved «compared with the wild species»

For example dogs have been developed from wolves

- c. artificial selection/crossing selected varieties/eliminating undesirable varieties
- d. «selective breeding/artificial selection can cause» significant/rapid change over time/from the original wild species
- e. «changes due to selective breeding/artificial selection» shows natural selection can cause change/evolution «in a species»

[Max 3 Marks]

1. [1 mark]

A

Examiners report

This question attracted the most criticism from teachers on G2 forms. The graph showed fluctuating levels of antibiotic resistance, with an overall trend of increasing resistance. Candidates were expected to understand that antibiotic resistance is a heritable trait, so a change in antibiotic resistance levels is evolution. The explanation of increasing resistance levels is therefore based in natural selection: bacteria with genes for resistance have an advantage so survive, reproduce and pass on their genes. After careful scrutiny of the question, it was decided that there was a second acceptable answer. Although the graph does not provide information on antibiotic use, it was not unreasonable to deduce that using the antibiotic causes evolution by acting as a selective agent. Both answers A and D were therefore marked as correct in order to award the benefit of the doubt. The question has been altered for the published version for the examinations CD, with A being the correct option.

36. *[1 mark]*

C