

Natural selection and genetic modification practice questions

29 questions • 79 marks • mark scheme at the back

For Edexcel GCSE Biology 1BI0 and Combined Science 1SC0. **Triple only** is not in Combined Science. **Higher tier** is only on the Higher paper.

Name

Total / 79

Darwin, natural selection and antibiotic resistance Spec 4.1B-4.3

1 Which statement describes how natural selection leads to evolution? [1 mark]

- A. ☐ Individuals change their characteristics to suit the environment during their lives.
- B. ☐ Individuals with advantageous alleles are more likely to survive and reproduce, so the alleles become more common.
- C. ☐ The strongest individuals always live longest and produce the most offspring.
- D. ☐ Mutations only happen when the environment changes.

2 Triple only [2 marks]

Describe the contribution of Alfred Wallace to the theory of evolution by natural selection.

3 Triple only [3 marks]

Explain the impact of the ideas of Darwin and Wallace on modern biology.

- 4** A population of beetles lives on pale sand. Most beetles are pale. A mutation produces a few dark beetles. Birds eat the beetles. After many generations, most beetles on the sand are pale and very few are dark. Explain how natural selection causes this. **[4 marks]**

[illegible]

- 5** In a practice data set, 250 samples of bacteria were tested. In year 1, 20 samples were resistant to an antibiotic. In year 5, 85 samples were resistant. Calculate the percentage of resistant samples in each year and the increase in percentage points. **[3 marks]**

Answer =

[illegible]

- 6** Explain how antibiotic-resistant bacteria emerge in a population of bacteria, and how this supports Darwin's theory of evolution by natural selection. **[6 marks]**

[illegible]

Evidence for evolution and classification Spec 4.4-4.7

- 7 Which fossil is dated at about 3.2 million years old? [1 mark]
- A. ☐ Ardi
 - B. ☐ Lucy
 - C. ☐ The fossils found by Richard Leakey
 - D. ☐ None of these

- 8 Ardi is 4.4 million years old and the fossils found by Richard Leakey are 1.6 million years old. Calculate the difference in age. Give your answer in standard form. [2 marks]

Answer =

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- 9 Fossils provide evidence for human evolution. Explain why scientists sometimes disagree about what fossils show. [3 marks]

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- 10 Describe how stone tools provide evidence for human evolution. [2 marks]

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- 11 A stone tool is found in a layer of rock. Explain how scientists can find out its age from its environment. [2 marks]

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The arm of a human, the wing of a bat and the flipper of a whale all have the same basic arrangement of bones, but are used for different jobs. Explain what this suggests about the evolution of these animals.

- 13 Describe how genetic analysis has led to the suggestion of three domains rather than five kingdoms. [3 marks]

Selective breeding and tissue culture Spec 4.8–4.9B

- 14 Which is a possible disadvantage of selective breeding? [1 mark]

- A. ☐ It increases genetic variation.
- B. ☐ It reduces genetic variation.
- C. ☐ It only takes one generation.
- D. ☐ It involves inserting genes from other species.

- 15 Describe how a farmer could use selective breeding to produce cattle that give more milk. [4 marks]

- 16** In a plant, resistance to a disease is controlled by a dominant allele R. Susceptibility is controlled by the recessive allele r. Two plants with the genotype Rr are crossed. Use a genetic diagram to find the probability that an offspring is susceptible. **[3 marks]**

Answer =

- 17** **Triple only** **[3 marks]**
Describe how tissue culture can be used to produce new plants.

- 18** **Triple only** **[2 marks]**
Give two advantages of using tissue culture in plant breeding programmes.

- 19** **Triple only** **[2 marks]**
Explain how tissue culture is useful in medical research.

Genetic engineering **Spec 4.10–4.12B**

- 20** What is genetic engineering? **[1 mark]**

- A. ☐ Choosing parents with desired characteristics to breed together.
- B. ☐ Growing many identical plants from small pieces of tissue.
- C. ☐ Modifying the genome of an organism to introduce desirable characteristics.
- D. ☐ Using living organisms to control pests.

21 Bacteria can be genetically engineered to make human insulin. Describe what is done to the bacteria and the result. **[2 marks]**

22 **Higher tier** **[3 marks]**
Describe the roles of restriction enzymes and ligase in genetic engineering.

23 **Higher tier** **[4 marks]**
Describe the main stages in inserting a gene into a bacterial plasmid vector.

24 **Triple only** **[3 marks]**
Crop plants can be genetically engineered with a gene from *Bacillus thuringiensis*. Explain how this benefits a farmer.

25 **Triple only** **[2 marks]**
Give two disadvantages of growing GM crops.

Spec 4.13B-4.14

Triple only

[3 marks]

[illegible]

Triple only

[3 marks]

[illegible]

In a practice data set, a non-GM crop yields 5.0 tonnes per hectare. A GM crop yields 6.5 tonnes per hectare. Calculate the percentage increase in yield.

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Evaluate the use of genetic engineering and selective breeding in modern agriculture. Include practical and ethical implications in your answer.

[illegible]

Mark scheme

One mark for each point unless a maximum is given. Words in brackets are not needed for the mark.

1. [1]

B B (1)

2. [2] Triple only

- he independently developed a theory of evolution by natural selection (1)
- his ideas were based on his own observations of plants and animals in different places (1)
- his work encouraged Darwin to publish / ideas presented together with Darwin's (1)
- Max 2

3. [3] Triple only

- gives a unifying explanation of the diversity of living things / how species are related (1)
- when combined with genetics, explains variation (from mutation) and inheritance (1)
- helps explain the emergence of resistant organisms, for example antibiotic-resistant bacteria (1)
- allows organisms to be classified by how they are related (1)
- Max 3

4. [4]

- variation / dark beetles are more visible (to birds) than pale beetles (1)
- dark beetles are more likely to be eaten / pale beetles are more likely to survive (1)
- pale beetles reproduce more / have more offspring (1)
- they pass on the allele for pale colour (1)
- proportion of pale beetles increases over generations (1)
- Max 4

5. [3]

- year 1: $20 \div 250 \times 100 = 8\%$ (1)
- year 5: $85 \div 250 \times 100 = 34\%$ (1)
- increase = 26 percentage points (1)
- allow ecf for the final mark

6. [6]

Level 3 5-6	A detailed and coherent explanation which covers the sequence from mutation to a resistant population, with the antibiotic identified as the selection pressure, and links this clearly to Darwin's theory.
Level 2 3-4	A partly detailed explanation that covers most of the sequence, with some links to Darwin's theory. There may be some gaps in the logic.
Level 1 1-2	A basic explanation with one or two relevant points, but little or no link to natural selection.

Indicative content

- variation in the population: a mutation gives some bacteria an allele for resistance
- antibiotic kills the non-resistant bacteria / is the selection pressure
- resistant bacteria survive and reproduce
- they pass the resistance allele to their offspring
- the proportion of resistant bacteria increases over generations
- bacteria reproduce rapidly, so this can be observed within a short time
- this shows variation, selection, survival and reproduction, and inheritance, as in Darwin's theory

7. [1]

B B (1)

8. [2]

- $4.4 - 1.6 = 2.8$ million years (1)
- 2.8×10^6 years (1)
- allow 1 mark for 2 800 000 or 2.8 million

9. [3]

- few fossils are found / most organisms decay before they can become fossils (1)
- fossils are often incomplete / only fragments are found (1)
- so there are gaps in the evidence / it is hard to know how they are related (1)
- new discoveries can change ideas (1)
- Max 3

10. [2]

- older tools are simple, newer tools are more complex / better made (1)
- suggests early humans developed greater skill / intelligence over time (1)

11. [2]

- the age of the rock layer / materials in the layer (for example volcanic ash) can be found (1)
- the tool is the same age as the layer it was found in (1)
- allow deeper layers are older, so the depth of the layer gives its relative age (1)
- Max 2

12. [3] Triple only

- same basic bone structure / pentadactyl limb (1)
- suggests they have a common ancestor (1)
- limbs have become adapted for different functions by natural selection (1)

13. [3]

- five kingdoms was based on structure / observed features (1)
- genetic analysis showed the prokaryotes are not one closely related group (1)
- Archaea and Bacteria are genetically very different, so three domains: Archaea, Bacteria and Eukarya (1) allow Eukaryota / eukaryotes

14. [1]

B B (1)

15. [4]

- select a bull and cows that produce a lot of milk / with high milk yield (1)
- breed them together (1)
- select offspring that produce the most milk and breed them (1)
- repeat over many generations (1)

16. [3]

- gametes R and r from each parent (1)
- offspring RR, Rr, Rr, rr (1)
- probability of rr = 1/4 or 25% (1)

17. [3] Triple only

- take small pieces of tissue / cells from the parent plant (1)
- use aseptic technique / sterile conditions to prevent contamination (1)
- grow on a nutrient medium (agar) with nutrients and growth hormones (1)
- cells divide to form new plants that are identical to the parent (1)
- Max 3

18. [2] Triple only

- many identical plants produced quickly (1)
- from a small amount of tissue (1)
- desirable characteristics are kept / plants are genetically identical (1)
- can be done all year / in a small space (1)
- rare / endangered plants can be reproduced (1)
- Max 2

19. [2] Triple only

- large numbers of identical cells can be grown (1)
- so new drugs can be tested on them / disease can be studied, with reliable results (1)

20. [1]

C C (1)

21. [2]

- the human gene for insulin is inserted into the genome / DNA of the bacteria (1)
- the bacteria can make human insulin (1)

22. [3] Higher tier

- restriction enzyme cuts DNA at a specific base sequence (1)
- leaving sticky ends (1)
- ligase joins the DNA / gene into the vector (1)

23. [4] Higher tier

- cut the gene out using a restriction enzyme (1)
- cut the plasmid with the same restriction enzyme, so sticky ends match (1)
- mix the gene and plasmid, and use ligase to join them (1)
- insert the plasmid (vector) into the bacterium (1)

24. [3] Triple only

- the gene codes for a toxin that kills insect pests (1)
- so less of the crop is eaten / damaged, giving a higher yield (1)
- less insecticide needs to be used (1)

25. [2] Triple only

- possible risk to human health (1)
- genes may spread to wild plants / the toxin may harm other insects (1)
- seeds are expensive / farmers must buy new seeds (1)
- some people think it is wrong (1)
- Max 2

26. [3] Triple only

- advantage: supply mineral ions / nitrates that plants need for growth (1)
- so crop yield increases (1)
- disadvantage: can be washed into rivers / lakes (1)
- causing water pollution / harm to wildlife (1)
- allow disadvantage: costly (1) so increases the farmer's costs (1)
- Max 3

27. [3] Triple only

- advantage: no chemical residue on the food / chemical pesticides not needed (1)
- so less harm to people or other organisms / the ladybirds target only the pest / keep working over a long time (1)
- disadvantage: slower / may not remove all the pests (1)
- allow disadvantage: the control organism may become a pest / eat other organisms (1)
- Max 3

28. [2]

- $(6.5 - 5.0) \div 5.0 \times 100$ (1)
- 30% (1)

29. [6]

Level 3 5-6	A balanced evaluation which covers benefits and risks of both methods, includes practical and ethical implications, and reaches a justified conclusion.
Level 2 3-4	A partly balanced evaluation covering benefits and risks of both methods, or giving more detail for one method. Some practical or ethical implications are given.
Level 1 1-2	A basic answer with one or two valid points. There is little or no evaluation.

Indicative content

- selective breeding: higher yield, disease resistance, better quality food
- selective breeding: takes many generations, reduces genetic variation, so risk of disease affecting all
- genetic engineering: new characteristics such as insect resistance or higher nutritional value
- genetic engineering: quicker and more precise than selective breeding
- genetic engineering: costly, unknown effects on the environment or health, genes may spread to wild species
- ethical: some people think it is wrong to alter genes / interfere with nature
- ethical: concerns about animal welfare
- a justified conclusion, for example weighing increased food production against risks