

Natural selection and genetic modification practice questions

19 questions • 53 marks • mark scheme at the back

For Edexcel GCSE Combined Science 1SC0. **Higher tier** is only on the Higher paper.

Name

Total / 53

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 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]

3 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 =

- 4** 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

- 5** 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

- 6** 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 =

[illegible]

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

[illegible]

8 Describe how stone tools provide evidence for human evolution.

[2 marks]

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

10 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

11 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.

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

- 13** 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 =

Genetic engineering Spec 4.10–4.12B

- 14** 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.

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

- 16** Higher tier **[3 marks]**

Describe the roles of restriction enzymes and ligase in genetic engineering.

- 17** Higher tier **[4 marks]**

Describe the main stages in inserting a gene into a bacterial plasmid vector.

Spec 4.13B-4.14

- [2 marks]**

[illegible]

- [6 marks]**

[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. [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

3. [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

4. [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

5. [1]

B B (1)

6. [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

7. [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

8. [2]

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

9. [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

10. [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

11. [1]

B B (1)

12. [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)

13. [3]

- gametes R and r from each parent (1)
- offspring RR, Rr, Rr, rr (1)
- probability of rr = $\frac{1}{4}$ or 25% (1)

14. [1]

C C (1)

15. [2]

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

16. [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)

17. [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)

18. [2]

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

19. [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