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BIOLOGY

GENETICS, BIODIVERSITY & CLASSIFICATION

Level & Board	AQA (A-LEVEL)
TOPIC:	GENETIC DIVERSITY & ADAPTATION
PAPER TYPE:	QUESTION PAPER - 1
TOTAL QUESTIONS	6
TOTAL MARKS	45

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Genetic Diversity and Adaptation - 1

1.

One kind of little bug is the fruit fly.

One of the fruit fly genes is termed alcohol dehydrogenase (AD), and it codes for an enzyme. When alcohol is present in the insects' diet, AD catalyzes the breakdown of the alcohol.

AD^F and AD^S are the two alleles of the AD gene.

(a) Alcohol is broken down more quickly by the enzyme expressed by the ADF gene than by the enzyme encoded by the ADS allele. Explain why. **(3)**

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A scientist selected adult fruit flies at random from a population. In this sample, he determined the frequency of the generation 0 AD^F allele. He then did the following: fed the insects food containing alcohol; allowed the insects to multiply; picked 100 of these insects at random and kept them in a container; and repeated these actions for 45 generations of fruit fly reproduction.

The frequency of the 45th generation AD^F allele was measured by the scientist.

(b) Explain the scientist's random sample selection method from the population**. (1)**

The scientist findings are shown in the table below.

Generation of fruit fly reproduction	Frequency of AD^F
0	0.20
45	0.74

(c) Fruit flies are poisoned by alcohol. Provide a hypothesis and an explanation for the 45 generations change in the AD^F allele frequency. **(4)**

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(d) Determine the kind of selection that was looked into in the 45 fruit fly generations of reproduction**. (1)**

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Tick (✓) **one** box.

No selection ☐

Directional selection ☐

Random selection ☐

Stabilising selection ☐

2.

A scientist looked at the birth mass of a group of infants. She calculated the babies birth masses (b) and categorized the data into several birth mass ranges.

Her results are displayed in the following table.

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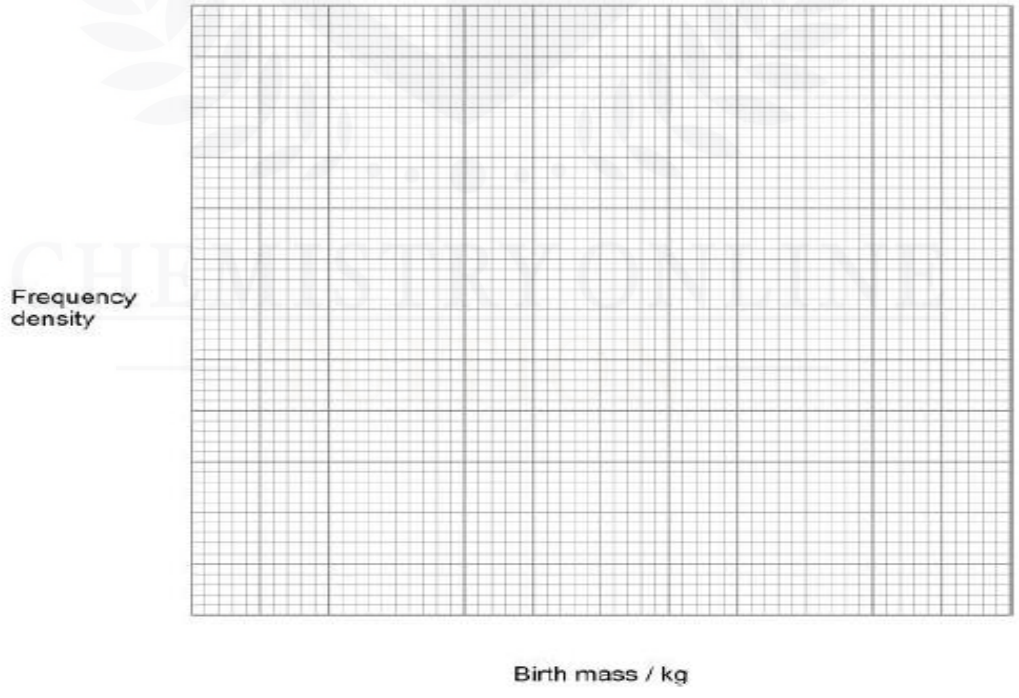
Birth mass *b* / kg	Range of mass / kg	Frequency density
$0.0 < b \leqslant 2.0$	2.0	5 000
$2.0 < b \leqslant 2.5$	0.5	20 000
$2.5 < b \leqslant 3.0$	0.5	90 000
$3.0 < b \leqslant 3.5$	0.5	260 000
$3.5 < b \leqslant 4.5$	1.0	200 000
$4.5 < b \leqslant 5.5$	1.0	20 000

Frequency density is calculated using this equation

$$\text{Frequency density} = \frac{\text{number of babies}}{\text{range of mass}}$$

(a) Create an appropriate chart on Figure 1 that illustrates the birth mass distribution of this baby population**. (4)**

Figure 1



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(b) Low birth mass refers to infants weighing less than 2.5 kg at birth.

To determine the proportion of low birth mass newborns in this population, use the formula and the data in the table above.

Display your work. **(2)**

The correlation between birth mass and newborns that survive for fewer than four weeks was also measured by the scientist. She ascertained whether the pregnant women of these children were cigarette smokers. Figure 2 presents her findings.

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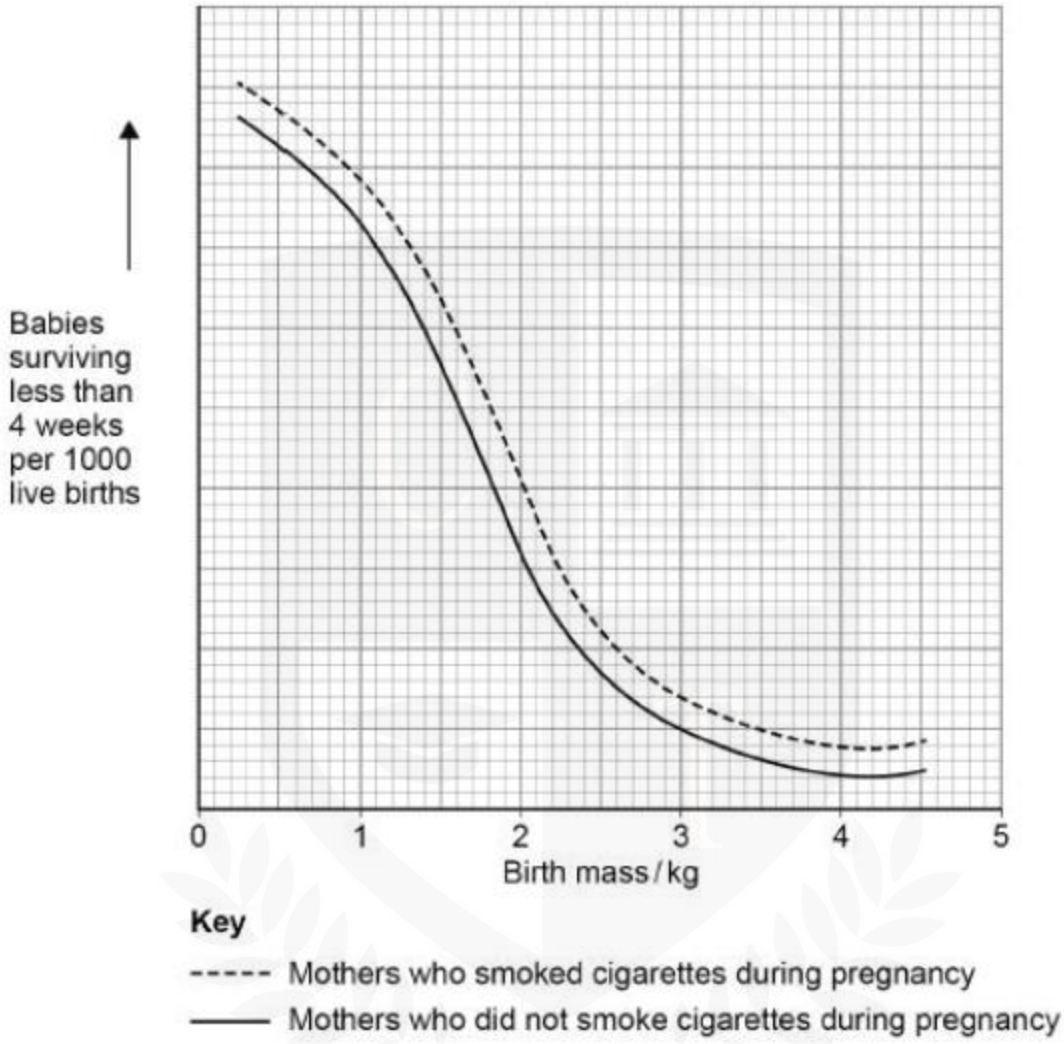
Figure 2



c) List three inferences that can be made based on the information in Figure 2. **(3)**

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3.

Researchers looked into variations in fish mass across three populations of the same species. The fish they used had a year-long life cycle.

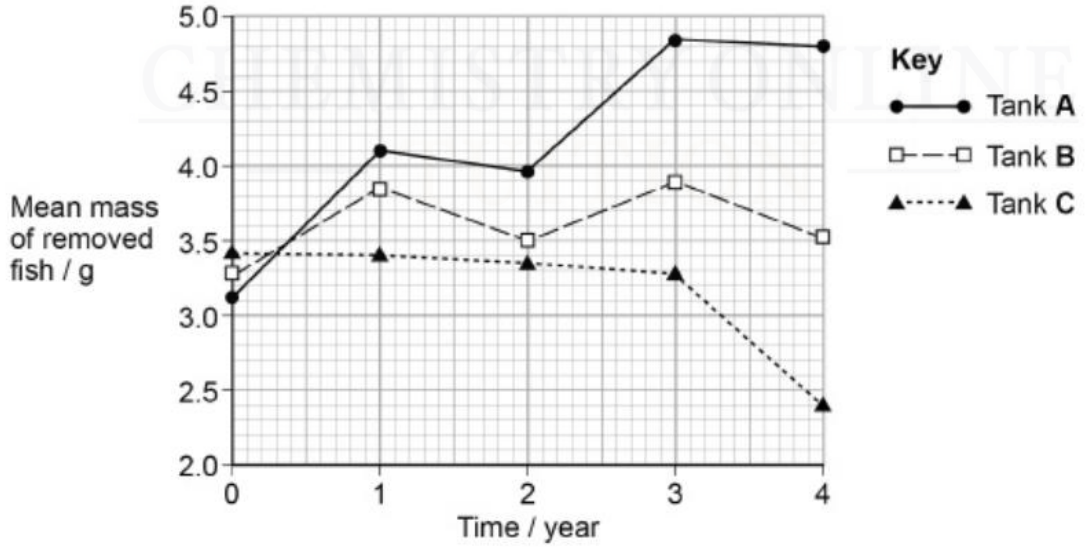
Three fish tanks, each housing a different population, were put up by the scientists.

Every year, the scientists took every fish out of every tank and calculated the average mass of those fish. After that, they returned 10% of each population in the manner described below.

- Return just the largest fish to Tank A.
- Return fish to Tank B at random.
- Return only the tiniest fish to Tank C.

The fish were allowed to mature and procreate throughout each year.

The graph displays the scientists findings.



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(a) By returning just the largest or only the smallest fish to Tanks A and C, what kind of selection were the scientists simulating in this study? Explain your reasoning**. (2)**

(b) Describe the objectives of Tank B. **(2)**

(c) At one year and four years, determine the ratio of the mean mass of fish removed from Tank A to the mean mass of fish removed from Tank C.

To what extent is the ratio higher at 4 years than it was at 1 year? **(2)**

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Ratio at 1 year = _____

Ratio at 4 years = _____

How much greater at 4 years = _____

(c) The law regulates sea fishing. Certain fishing nets have regulated mesh sizes that allow little fish to pass through while capturing larger ones.

The purpose of this legislation is to safeguard wild fish populations.

Determine whether the scientists research justifies the usage of these kinds of nets for sea fishing using all the facts provided in this question**. (3)**

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4.

(a) A student counted the number of cells in a liquid culture of bacteria using a dilution series.

Explain how he diluted the initial liquid culture of bacteria to a 1 in 1000 dilution by first making a 1 in 10 dilution**. (3)**

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(b) The student counted the number of cells in 0.004 mm^3 of the culture 1 in 1000 dilution using an optical microscope.

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Determine how many cells there are in 1 cm^3 of pure liquid culture**. (2)**

Answer = _____ Number of cells

(c) The student's initial effort involved looking at cells in the 1 in 10 dilutions. He made the choice not to count the cells in the undiluted liquid culture using this dilution.

Provide a justification for the student choice**. (2)**

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(d) Antibiotics are frequently fed to animals on certain farms.

Researchers looked into whether the microorganisms in the intestines of these agricultural animals were resistant to antibiotics. They conducted tests to determine whether the germs were resistant to streptomycin and tetracycline.

The table displays their outcomes.

Antibiotic	Percentage of antibiotic-resistant bacteria
Tetracycline	29
Streptomycin	13

Provide a hypothesis and an explanation for the higher prevalence of tetracycline-resistant bacteria compared to streptomycin-resistant bacteria in these farm animals. **(2)**

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5.

(a) Tetracycline has not been fed to these farm animals in recent years. In spite of this, the proportion of tetracycline-resistant bacteria has not changed.

Give one explanation for this. **(1)**

6.

(a) The primary sugar in milk is lactose, which is broken down by the enzyme lactase.

Since milk is a newborn mammal's primary nutritional supply, lactase is vital.

When they begin consuming other foods, the majority of mammals cease to produce lactase. This is not the case for humans, as some of them still manufacture lactase throughout their mature years. Lactase persistence (LP) is the capacity to produce lactase indefinitely and is determined by a dominant allele. To explain LP in humans, several theories based on various selection pressures have been proposed.

(a) A theory on lactation in humans postulates that the selective pressure stemmed from certain human societies raising cattle for milk production.

Explain the process of raising cattle as a source of milk could have led to an increase in LP. **(4)**

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(b) Explain, using the data given, why, after selection for this condition was established, the population exhibiting LP would rise quickly. **(2)**

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(c) Lactase persistence is caused by a genetic mutation. This mutation does not originate from the lactase gene.

Explain your theory on why LP is caused by this mutation. **(2)**

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