A-Level
BIOLOGY
Genetics, Populations, Control of Gene Expression

Total number of marks: 48

0 8 . 2 Scientists investigated the genetic diversity between several species of sweet potato. They studied non-coding multiple repeats of base sequences.

Define 'non-coding base sequences' and describe where the non-coding multiple repeats are positioned in the genome.

[2 marks]

The percentage similarities in the non-coding multiple repeats of base sequences of four species of sweet potato are shown in **Table 3**.

Table 3

Species of sweet potato	Percentage similarity between non-coding multiple repeat base sequences			
	C	L	R	T
C		53.5	25.7	59.7
L	53.5		33.4	53.7
R	25.7	33.4		36.6
T	59.7	53.7	36.6	

0 8 . 3 Use the information in **Table 3** to complete the phylogenetic tree shown in **Figure 8**.

Write the letter that represents the correct species into each box.

[1 mark]

Figure 8
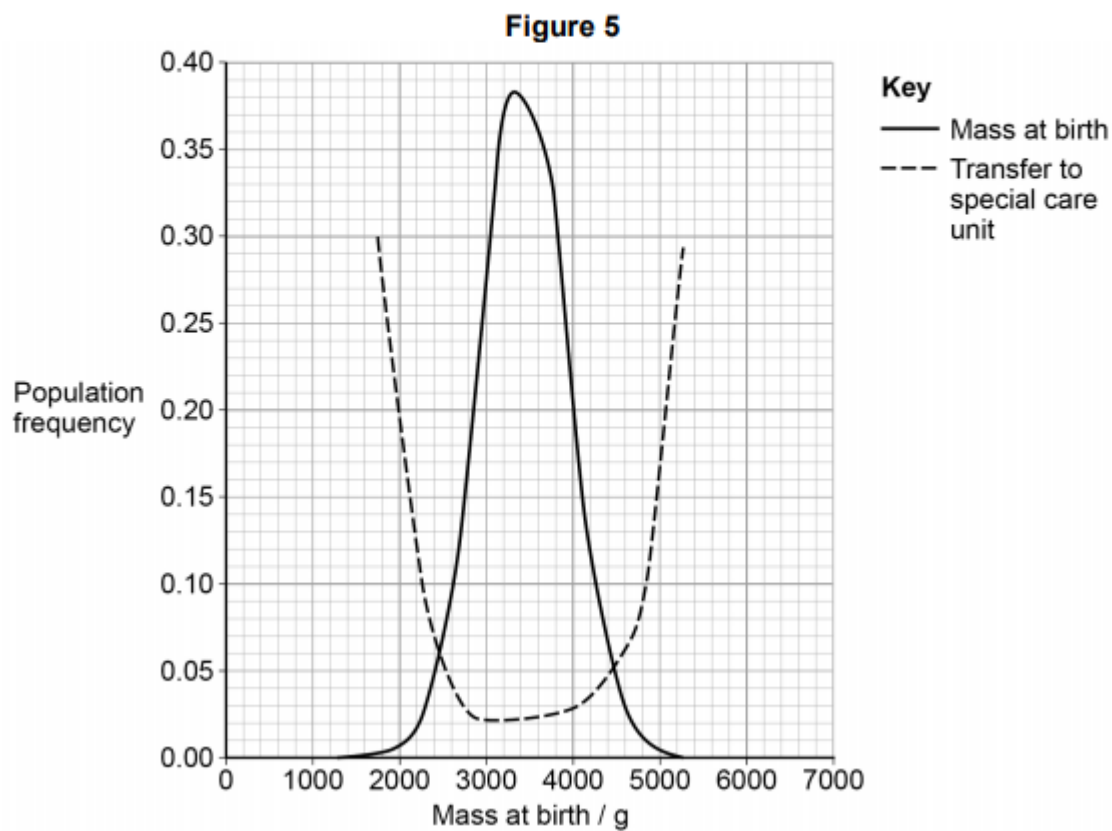

Historical time,
years before present
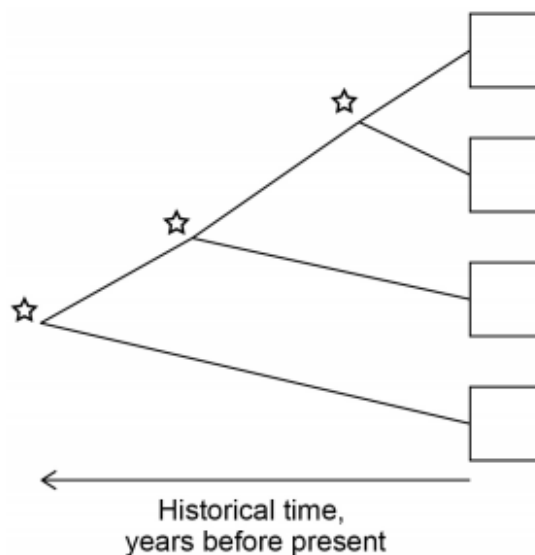
Key

☆ Common ancestor of the species to the right

Scientists collected data on 800 000 human births. The data showed the mass of each baby at birth and whether the baby needed to be transferred to a special care unit for very ill babies.

Their results are shown in **Figure 5**.

Figure 5

0 4 . 1 Use **Figure 5** to explain how human mass at birth is affected by stabilising selection.

[3 marks]

0 4 . 2 The scientists studied the effect of one form, *KIR2DS1*, of the human *KIR* gene on mass at birth.

In the following passage the numbered spaces can be filled with biological terms.

KIR2DS1 is an _____(1)_____ of the *KIR* gene, found at a _____(2)_____ on chromosome 19. *KIR2DS1* is 14 021 bases long and is _____(3)_____ into mRNA that is 1101 bases long. This mRNA is then _____(4)_____ into a polypeptide 304 amino acids long. The polypeptide is then modified in the organelle,_____(5)_____, before forming its functional _____(6)_____ protein structure.

Write the correct biological term beside each number below, that matches the space in the passage.

[3 marks]

(1) _____

(2) _____

(3) _____

(4) _____

(5) _____

(6) _____

Table 1 shows mRNA codons and the amino acids coded for by each codon. It also shows some properties of the R group of each amino acid.

Table 1

1st base	2nd base				3rd base
	U	C	A	G	
U	Phe	Ser	Tyr	Cys	U
					C
	Leu		Stop	Stop	A
				Trp	G
C	Leu	Pro	His	Arg	U
					C
			Gln		A
					G
A	Ile	Thr	Asn	Ser	U
					C
			Lys	Arg	A
	Met				G
G	Val	Ala	Asp	Gly	U
					C
			Glu		A
					G

Key to the properties of the R group of each amino acid

☐ No overall charge   ☐ Positively charged   ☐ Negatively charged

0 5 . 2   The genetic code is described as degenerate.

What is meant by this? Use an example from **Table 1** to illustrate your answer.
[2 marks]

1 0 . 1   Describe how mRNA is formed by transcription in eukaryotes.
[5 marks]

1 0 . 3   Define 'gene mutation' and explain how a gene mutation can have:

- no effect on an individual
- a positive effect on an individual.

[4 marks]

In women, the first division of meiosis produces one daughter cell that has almost all of the cytoplasm. The other daughter cell consists of a nucleus surrounded by a very small amount of cytoplasm and a cell-surface membrane. This very small daughter cell is called a polar body. Polar bodies do not usually divide. The same process occurs in the second division of meiosis, resulting in one egg cell and two polar bodies.

The diagram in **Figure 3** shows the formation of an egg cell and two polar bodies during meiosis. It also shows what happens to one pair of homologous chromosomes. This pair carries two alleles of gene A.

Figure 3
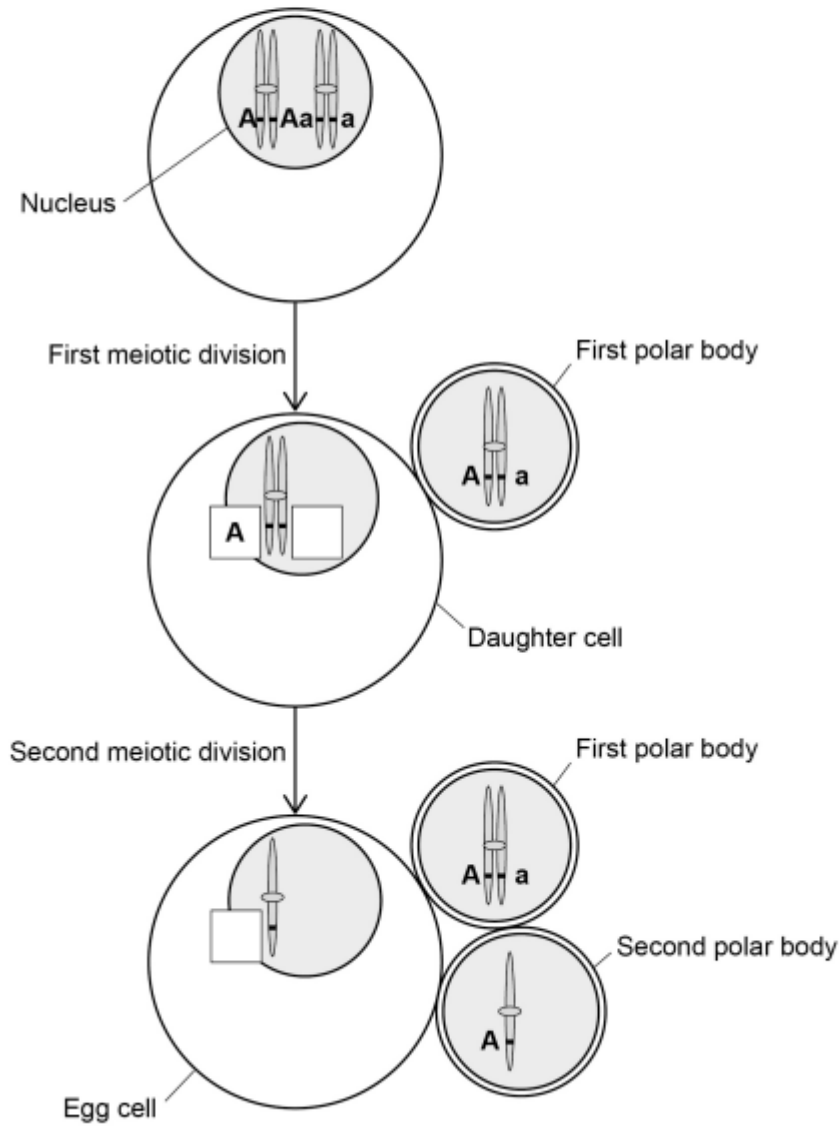
Not to scale

0 3 . 1 Complete **Figure 3** by putting **A** or **a** in the boxes. One box has been completed for you with **A**.

[1 mark]

0 3 . 2 Put a tick (✔) in the box next to the name of the process that produced the combination of alleles on the chromosome in the first polar body in **Figure 3**.
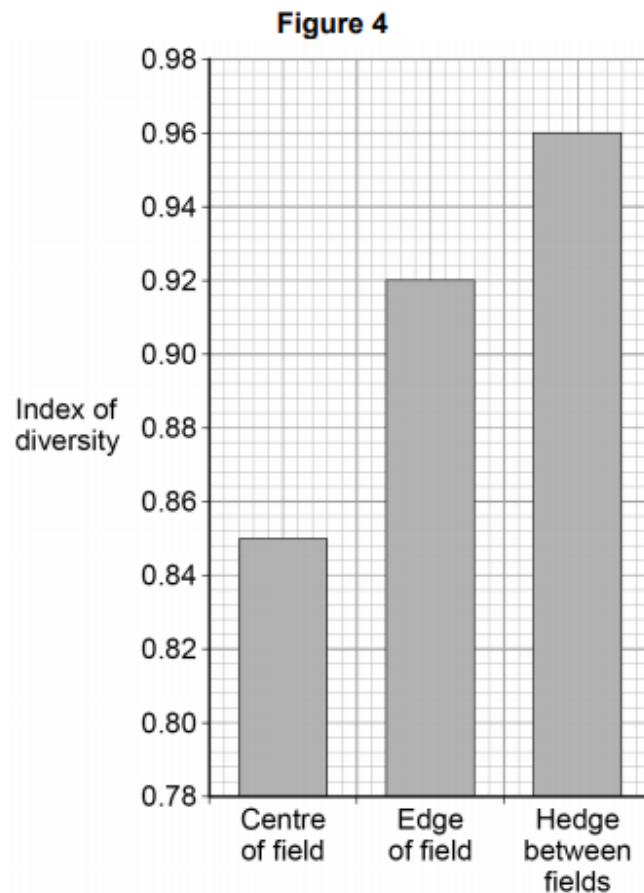
[1 mark]

Anaphase ☐

Crossing over ☐

Independent assortment ☐

Semi-conservative replication ☐

0 3   A group of students investigated biodiversity of different areas of farmland.
They collected data in each of these habitats:

- the centre of a field
- the edge of a field
- a hedge between fields.

Their results are shown in **Figure 4**.

Figure 4

0 3 . 1   What data would the students need to collect to calculate their index of diversity in each habitat?

Do **not** include apparatus used for species sampling in your answer.

[1 mark]

0 3 . 2   Give **two** ways the students would have ensured their index of diversity was representative of each habitat.

[2 marks]

0 3 . 3   Modern farming techniques have led to larger fields and the removal of hedges between fields.

Use **Figure 4** to suggest why biodiversity decreases when farmers use larger fields.

[1 mark]

| 0 | 3 |.| 4 | Farmers are now being encouraged to replant hedges on their land.

Suggest and explain **one** advantage and **one** disadvantage to a farmer of replanting hedges on her farmland.
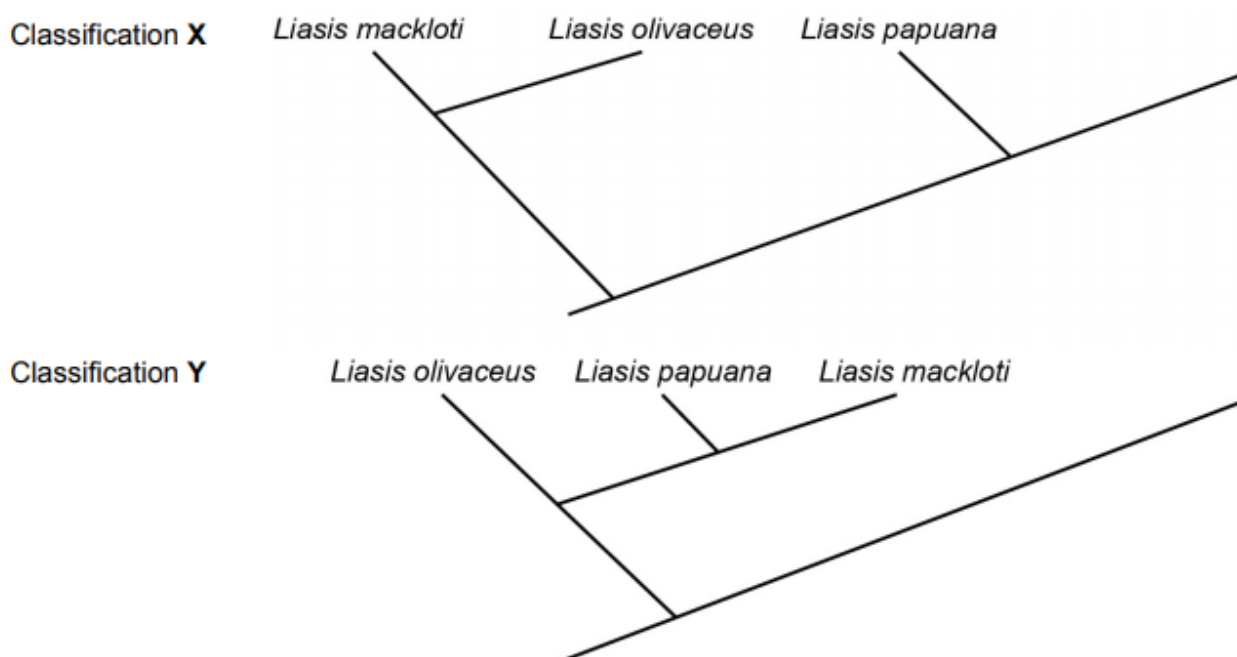
[2 marks]

| 0 | 8 | **Figure 3** shows two different ways of classifying the same three species of snake.

- Classification **X** is based on the frequency of observable characteristics
- Classification **Y** is based on other comparisons of genetic characteristics.

All three species of snake belong to the Python family.

Figure 3

Classification **X**   *Liasis mackloti*   *Liasis olivaceus*   *Liasis papuana*

Classification **Y**   *Liasis olivaceus*   *Liasis papuana*   *Liasis mackloti*

| 0 | 8 | . | 1 | What do these classifications suggest about the evolutionary relationships between these species of snake?

[2 marks]

| 0 | 8 | . | 2 | Complete **Table 4** below to show the missing names of the taxa when classifying these snakes.

[1 mark]

Table 4

Taxon (hierarchical order)	Name
	Eukaryote
	Animal
	Chordata
	Reptilia
	Squamata
Family	Python

| 0 | 8 | . | 3 | There is a debate about the name of one of these species of snake. Some scientists name it *Liasis papuana* and other scientists name it *Apodora papuana*.

Give the name of the taxon about which the scientists disagree.

[1 mark]

| 0 | 6 | . | 2 | Name the relationship between the two alleles that code for flower colour.

[1 mark]

0 6 . 3 A dwarf, pink-flowered plant was crossed with a heterozygous tall, white-flowered plant.

Complete the genetic diagram to show all the possible genotypes and the ratio of phenotypes expected in the offspring of this cross.

[3 marks]

Phenotypes of parents: Dwarf, pink-flowered   ×   Tall, white-flowered

Genotypes of parents: _____   _____

Genotypes of offspring: _____

Phenotypes of offspring: _____

_____

Ratio of phenotypes: _____

0 1 . 1 Describe how a **non-competitive** inhibitor can reduce the rate of an enzyme-controlled reaction.

[3 marks]

0 9 A scientist produced transgenic zebrafish.

She obtained a gene from silverside fish. The gene codes for a growth hormone (GH).

She inserted copies of this *GH* gene into plasmids. She then microinjected these recombinant plasmids into fertilised egg cells of zebrafish.

0 9 . 1 Describe how enzymes could be used to insert the *GH* gene into a plasmid.

[2 marks]

0 9 . 2 Microinjection of DNA into fertilised egg cells is a frequent method of producing transgenic fish. However, the insertion of the transferred gene into nuclear DNA may be delayed. Consequently, the offspring of transgenic fish may not possess the desired characteristic.

Suggest and explain how delayed insertion of the *GH* gene could produce offspring of transgenic fish without the desired characteristic.

[2 marks]

The scientist investigated whether the transferred *GH* gene increased the growth of transgenic zebrafish. She microinjected 2000 fertilised egg cells with the *GH* plasmid and left 2000 fertilised egg cells untreated. After 12 months, she determined the mean mass of the transgenic and non-transgenic fish.

The results the scientist obtained are shown in **Table 3**.

Table 3

A value of ±2 × SD from the mean includes over 95% of the data.

Type of zebrafish	Mean mass of zebrafish / g (± 2 × SD)
Transgenic	1.79 (± 0.37)
Non-transgenic	0.68 (± 0.13)

0 9 . 3 Using **Table 3**, what can you conclude about the effectiveness of the *GH* gene on the growth of zebrafish?

[2 marks]

_____

_____

_____

_____

_____

_____

0 9 . 4 Explain how **two** features of the design of this investigation helped to ensure the validity of any conclusions obtained.

Do **not** include calculating the mean or SD in your answer.

[2 marks]