

## Variation exam questions 192 mins 174 marks

### Q1.

The diagram shows a short sequence of DNA bases.

**T T T G T A T A C T A G T C T A C T T C G T T A A T A**

- (a) (i) What is the maximum number of amino acids for which this sequence of DNA bases could code?

(1)

- (ii) The number of amino acids coded for could be fewer than your answer to part (a)(i).

Give **one** reason why.

(1)

- (b) Explain how a change in the DNA base sequence for a protein may result in a change in the structure of the protein.

(3)

- (c) A piece of DNA consisted of 74 base pairs. The two strands of the DNA, strands **A** and **B**, were analysed to find the **number** of bases of each type that were present. Some of the results are shown in the table.

	Number of bases			
	C	G	A	T
Strand <b>A</b>	26			

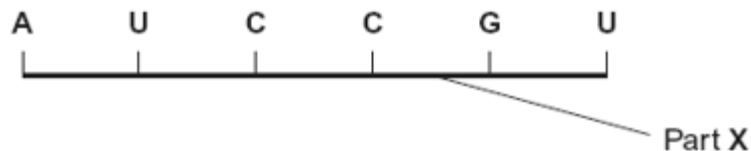
Strand <b>B</b>	19		9	
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Complete the table by writing in the missing values.

(2)  
(Total 7 marks)

## Q2.

The diagram shows part of a pre-mRNA molecule.



- (a) (i) Name the **two** substances that make up part **X**.

\_\_\_\_\_ and \_\_\_\_\_

(1)

- (ii) Give the sequence of bases on the DNA strand from which this pre-mRNA has been transcribed.

\_\_\_\_\_

(1)

- (b) (i) Give one way in which the structure of an mRNA molecule is different from the structure of a tRNA molecule.

\_\_\_\_\_  
\_\_\_\_\_

(1)

- (ii) Explain the difference between pre-mRNA and mRNA.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

(1)

- (c) The table shows the percentage of different bases in two pre-mRNA molecules. The molecules were transcribed from the DNA in different parts of a chromosome.

Part of chromosome	Percentage of base			
	A	G	C	U
Middle	38	20	24	

End	31	22	26	
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- (i) Complete the table by writing the percentage of uracil (U) in the appropriate boxes.

(1)

- (ii) Explain why the percentages of bases from the middle part of the chromosome and the end part are different.

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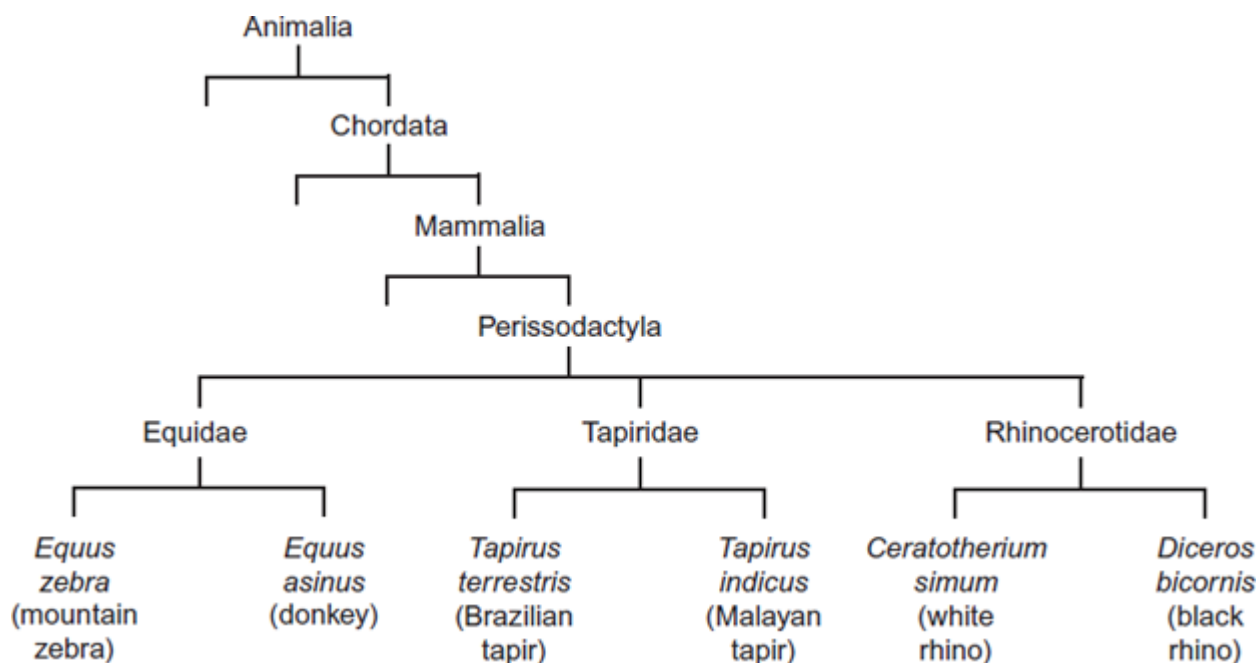
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(2)

(Total 7 marks)

### Q3.

The following figure shows how some animals with hooves are classified.



- (a) This type of classification can be described as a phylogenetic hierarchy.

- (i) What is meant by a **hierarchy**?

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\_\_\_\_\_ (2)

(ii) How many different families are shown in the figure?



(1)

(iii) To which phylum does the white rhino belong?

\_\_\_\_\_ (1)

(b) (i) Explain the role of independent segregation in meiosis.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ (2)

(ii) A zedonk is the offspring produced from breeding a mountain zebra with a donkey.

- The body cells of a mountain zebra contain 32 chromosomes.
- The body cells of a donkey contain 62 chromosomes.

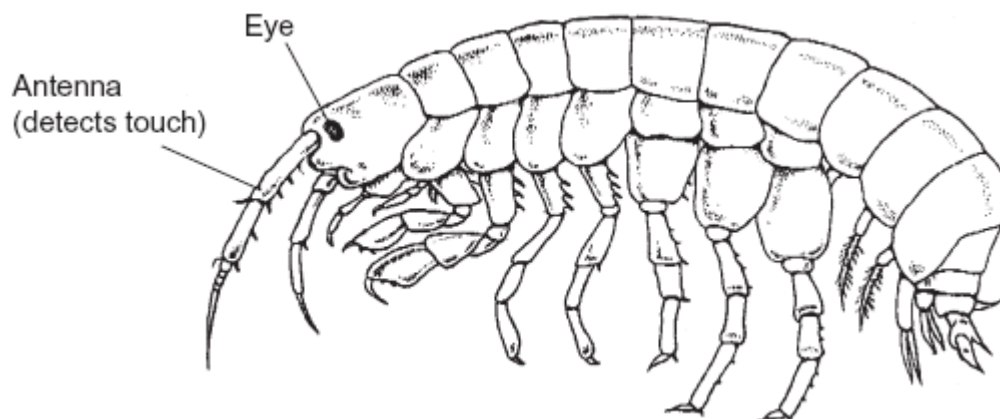
Use this information to suggest why zedonks are usually infertile.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ (2)  
(Total 8 marks)

**Q4.**

**Figure 1** shows a fresh-water shrimp.

**Figure 1**



Biologists collected shrimps from a stream inside a cave and from the same stream when it was in the open.

They measured the maximum diameter of each shrimp's eye. They also measured the length of its antenna. From these measurements they calculated the mean values for each site. **Figure 2** shows their results.

**Figure 2**

	Shrimps from the stream	
	Inside the cave	In the open
Mean diameter of eye /mm	0.09	0.24
Mean length of antenna /mm	8.46	5.81

- (a) The biologists measured the maximum diameter of each shrimp's eye.

Explain why they measured the **maximum** diameter.

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(1)

- (b) A scientist working many years earlier suggested that animals which live in caves had similar adaptations. These adaptations included

- smaller eyes
- greater use of sense organs such as those involved in detecting touch.

- (i) Do the data in **Figure 2** support this scientist's suggestion? Explain your answer.

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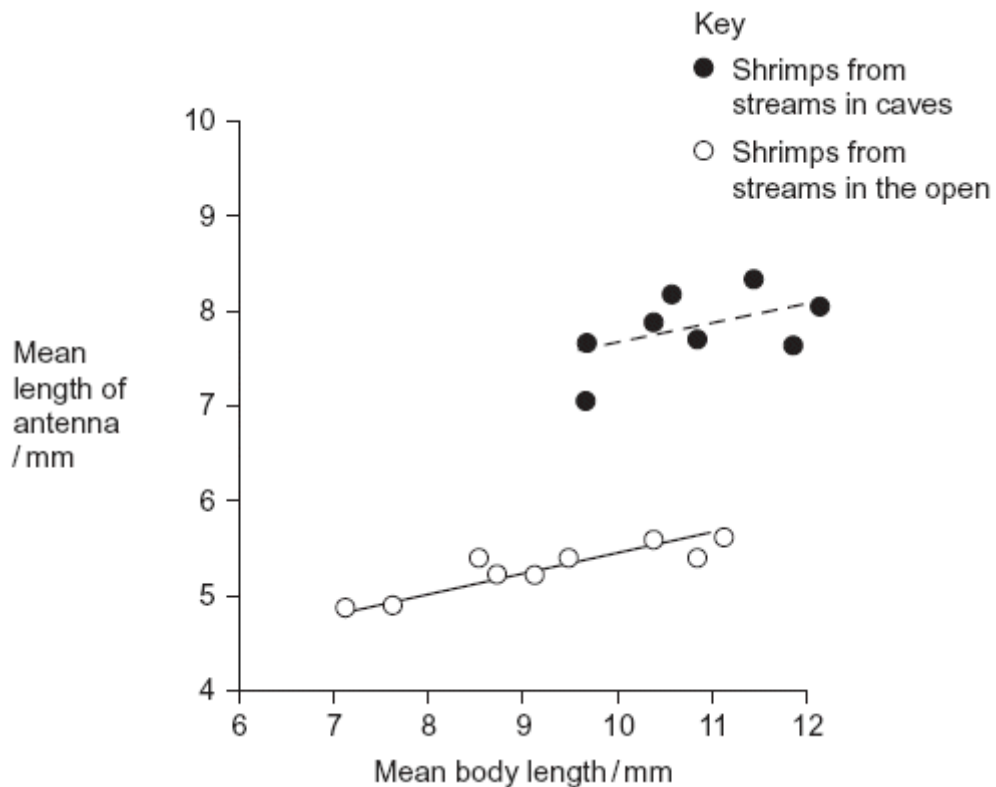
(2)

- (ii) The data in **Figure 2** are mean values. Explain how standard deviations of these mean values would help you to interpret the data in **Figure 2**.

(2)

- (c) The biologists investigated shrimps living in other streams. They measured the length of the antennae of these shrimps. They also measured their body length. **Figure 3** shows the mean antenna length plotted against mean body length for each site.

**Figure 3**



- (i) What does the information in the graph suggest about the body lengths of shrimps living in caves and living in the open?

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(2)

- (ii) Do the data in the graph support the conclusion that shrimps with longer bodies have longer antennae? Give the reason for your answer.

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(1)

Other biologists investigated the genetic diversity of these shrimps. **Figure 4** shows some of the data they collected.

**Figure 4**

Gene	Allele	Percentage of shrimps with this allele in steam	
		Inside a cave	In the open
PGI	A	0.9	2.5
	B	0.0	3.3
	C	98.2	66.4
	D	0.9	6.6
	E	0.0	21.3
ACO2	J	0.0	5.6
	K	0.0	76.7
	L	100.0	17.8

- (d) The biologists concluded that the shrimps in the open had a higher genetic diversity than those in the cave. Explain how the data in **Figure 4** support this conclusion.

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(1)

- (e) The percentage of shrimps with allele **L** in the cave is different from the percentage of shrimps with allele **L** in the open. Use your knowledge of the founder effect to suggest a reason for this difference.

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(3)

- (f) The biologists who studied these shrimps wanted to know if the shrimps living in the cave were the same species as those living in the open. They used breeding experiments to investigate this.

- (i) Describe how the biologists should carry out these breeding experiments.

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- (ii) The results of breeding experiments would help the biologists to decide whether the shrimps were the same species. Explain how.

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(3)

(Total 15 marks)

**Q5.**

The table shows some differences between three varieties of banana plant.

	Variety <b>A</b>	Variety <b>B</b>	Variety <b>C</b>
Number of chromosomes in a leaf cell	22	33	44
Growth rate of fruit / cm <sup>3</sup> week <sup>-1</sup>	2.9	6.9	7.2
Breaking strength of leaf / arbitrary units	10.8	9.4	7.8

- (a) (i) How many chromosomes are there in a male gamete from variety **C**?

(1)

- (ii) Variety **B** cannot produce fertile gametes. Use information in the table to explain why.

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(2)

In some countries very strong winds may occur. Banana growers in these countries choose to grow variety **B**.

- (b) (i) Use the data in the table to explain why banana growers in these countries choose to grow variety **B** rather than variety **A**.

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(1)

- (ii) Use the data in the table to explain why banana growers in these countries choose to grow variety **B** rather than variety **C**.

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(1)

- (c) Banana growers can only grow new variety **B** plants from suckers. Suckers grow from cells at the base of the stem of the parent plant.

Use your knowledge of cell division to explain how growing variety **B** on a large scale will affect the genetic diversity of bananas.

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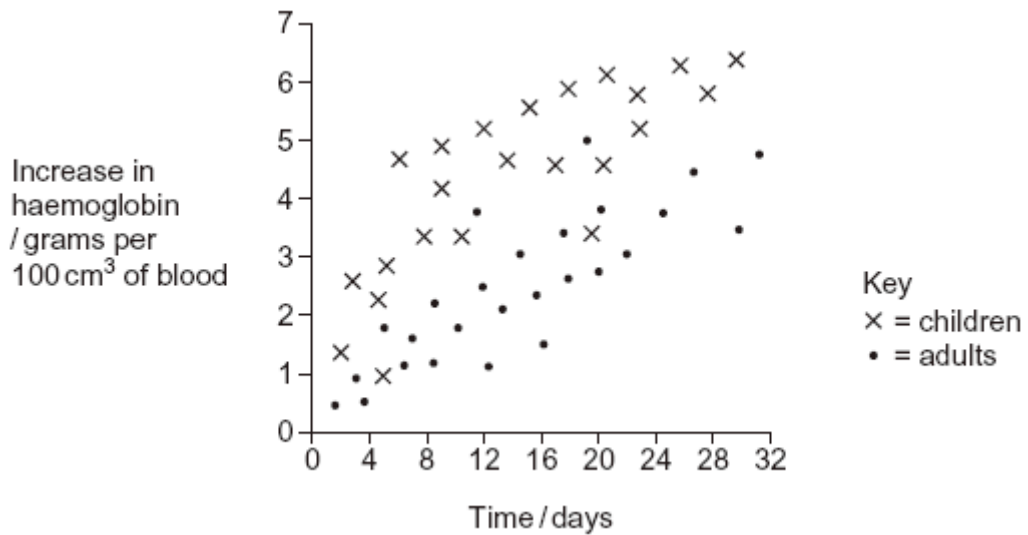
(2)

(Total 7 marks)

**Q6.**

- (a) Haemoglobin contains iron. One type of anaemia is caused by a lack of iron. This type of anaemia can be treated by taking tablets containing iron. A number of patients were given a daily dose of 120 mg of iron. **Figure 1** shows the effect of this treatment on the increase in the concentration of haemoglobin in their red blood cells.

**Figure 1**



- (i) Give **one** difference in the response of adults and children to this treatment.

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(1)

- (ii) You could use the graph to predict the effect of this treatment on the increase in haemoglobin content of an adult after 40 days. Explain how.

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(2)

- (iii) Haemoglobin has a quaternary structure. Explain what is meant by a quaternary structure.

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(1)

- (b) (i) Pernicious anaemia is another type of anaemia. One method of identifying pernicious anaemia is to measure the diameter of the red blood cells in a sample of blood that has been diluted with an isotonic salt solution. Explain why an isotonic salt solution is used to dilute the blood sample.

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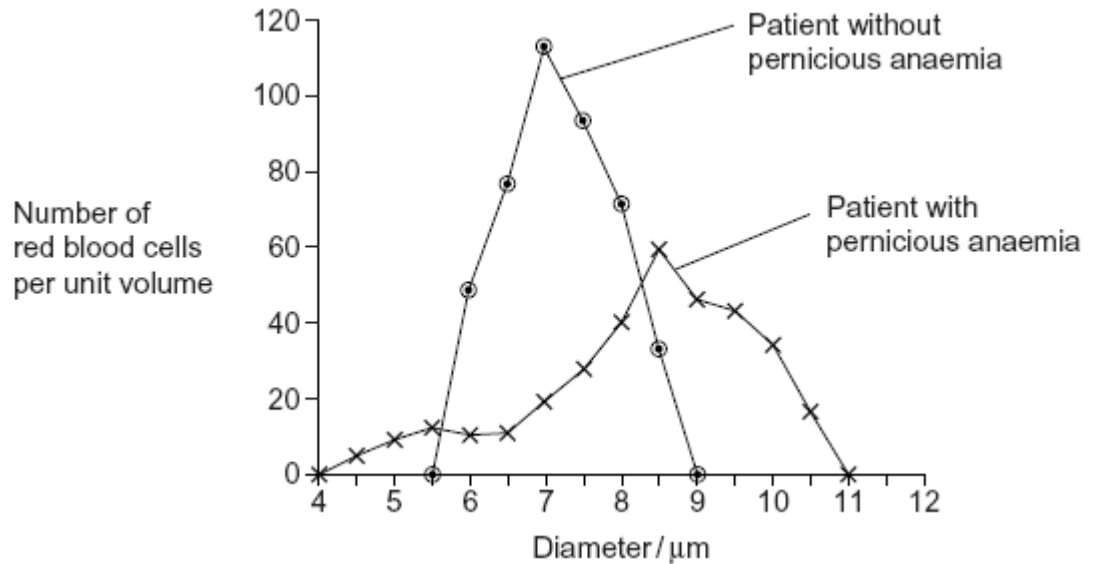


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(3)

- (ii) A technician compared the red blood cells in two blood samples of equal volume. One sample was from a patient with pernicious anaemia, the other was from a patient who did not have pernicious anaemia. **Figure 2** shows some of the results she obtained.

**Figure 2**



Describe **two** differences between the blood samples.

1. \_\_\_\_\_
2. \_\_\_\_\_

(2)

(Total 9 marks)

**Q7.**

- (a) The number of patients infected with the bacterium MRSA has increased in some hospitals. Scientists have suggested ways to reduce the transmission of MRSA in hospitals. Suggest **two** ways to reduce the transmission of MRSA in hospitals.

1. \_\_\_\_\_
2. \_\_\_\_\_

(2)

- (b) The minimum inhibitory concentration (MIC) is the lowest concentration of a

substance that prevents the growth of a microorganism.

When antibiotics are prescribed for treating patients, higher doses than the MIC are recommended. Suggest **two** reasons why.

1. \_\_\_\_\_

\_\_\_\_\_

2. \_\_\_\_\_

\_\_\_\_\_

(2)

Scientists tested a new group of drugs for their effectiveness against four species of bacteria. The scientists used MICs to compare the effectiveness of four drugs. The results are shown in the table.

Drug	Minimum inhibitory concentration / $\mu\text{g cm}^{-3}$			
	<i>Escherichia coli</i>	<i>Staphylococcus aureus</i>	<i>Enterococcus faecalis</i>	<i>Pseudomonas aeruginosa</i>
<b>P</b>	0.39	0.049	0.049	3.13
<b>Q</b>	1.54	0.049	0.195	3.13
<b>R</b>	0.39	0.049	0.195	1.56
<b>S</b>	1.56	0.098	0.390	12.50

(c) Which of the four drugs is

(i) most effective against *Enterococcus faecalis*?

(1)

(ii) least effective against all the species of bacteria used?

(1)

(d) The effectiveness of these drugs was tested in double-blind trials using human volunteers. In a double-blind trial neither the volunteers nor the scientists know which treatment a particular volunteer is receiving.

(i) Suggest **two** ways in which a double-blind trial improves reliability.

1. \_\_\_\_\_

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2. \_\_\_\_\_  
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(2)

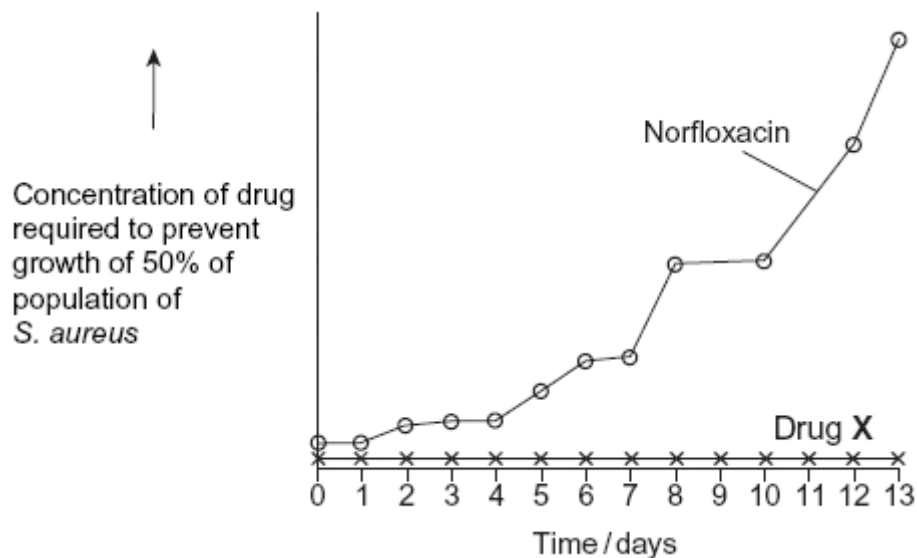
- (ii) Suggest **two** factors the scientists should have considered when selecting adult volunteers for this trial.

1. \_\_\_\_\_

2. \_\_\_\_\_

(2)

- (e) Scientists investigated resistance of the bacterium, *S. aureus* to the antibiotic Norfloxacin. They grew the bacteria in a medium containing a low concentration of Norfloxacin. The concentration of Norfloxacin that they added killed some of the bacteria. It did not kill all of them. Every 24 hours, they removed a sample of the bacteria from the culture. They tested the sample to find the concentration of Norfloxacin that prevented the growth of 50 % of the bacteria in the sample. The scientists then used the same method to investigate the resistance of *S. aureus* to a new drug, drug X. The results of both investigations are shown in the graph.



Describe the results obtained with Norfloxacin.

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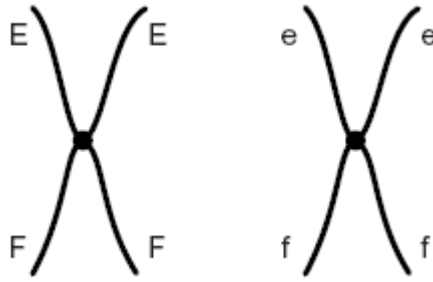
(1)

(Total 11 marks)

**Q8.**

**Figure 1** shows a pair of chromosomes at the start of meiosis. The letters represent alleles.

**Figure 1**



- (a) What is an allele?

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(1)

- (b) Explain the appearance of one of the chromosomes in **Figure 1**.

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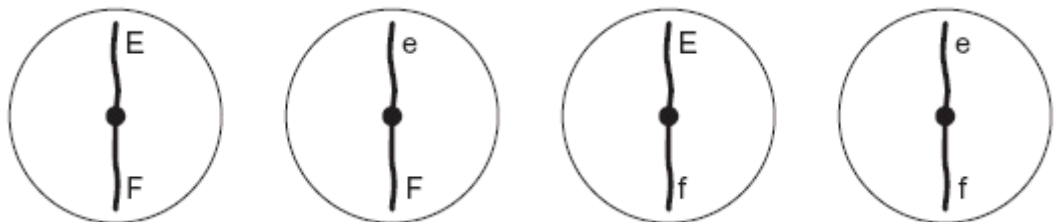


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(2)

- (c) The cell containing this pair of chromosomes divided by meiosis. **Figure 2** shows the distribution of chromosomes from this pair in four of the gametes produced.

**Figure 2**



- (i) Some of the gametes formed during meiosis have new combinations of alleles.

Explain how the gametes with the combinations of alleles  $Ef$  and  $eF$  have been produced.

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(2)

- (ii) Only a few gametes have the new combination of alleles  $Ef$  and  $eF$ . Most gametes have the combination of alleles  $EF$  and  $ef$ . Suggest why only a few

gametes have the new combination of alleles, Ef and eF.

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(1)

- (d) **Figure 3** shows a cell with six chromosomes.

**Figure 3**



- (i) This cell produces gametes by meiosis. Draw a diagram to show the chromosomes in one of the gametes.

(2)

- (ii) How many different types of gametes could be produced from this cell as a result of different combinations of maternal and paternal chromosomes?

(1)

**(Total 9 marks)**

### Q9.

Phenylketonuria is a disease caused by mutations of the gene coding for the enzyme PAH. The table shows part of the DNA base sequence coding for PAH. It also shows a mutation of this sequence which leads to the production of non-functioning PAH.

DNA base sequence coding for PAH	C	A	G	T	T	C	G	C	T	A	C	G
DNA base sequence coding for non-functioning PAH	C	A	G	T	T	C	C	C	T	A	C	G

- (a) (i) What is the maximum number of amino acids for which this base sequence could code?



(1)

- (ii) Explain how this mutation leads to the formation of non-functioning PAH.

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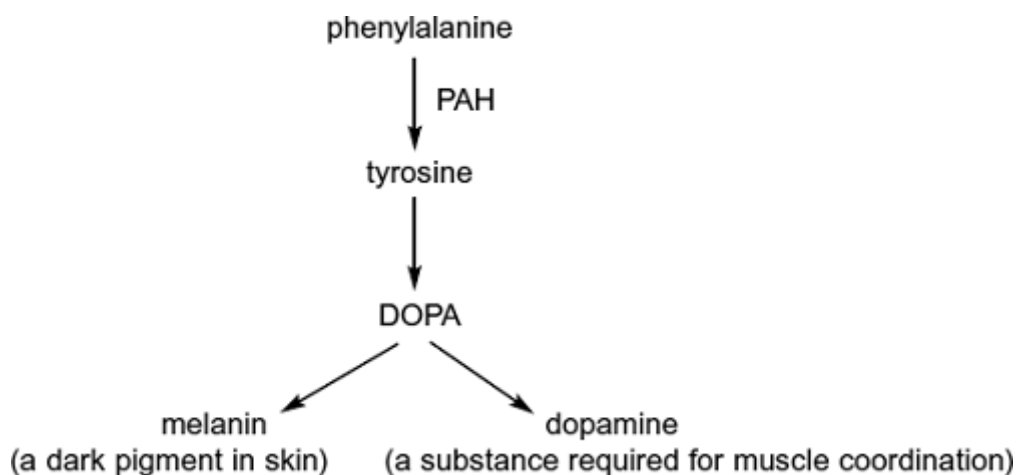
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(3)

PAH catalyses a reaction at the start of two enzyme-controlled pathways. The diagram shows these pathways.



- (b) Use the information in the diagram to give **two** symptoms you might expect to be visible in a person who produces non-functioning PAH.

1. \_\_\_\_\_

2. \_\_\_\_\_

(2)

- (c) One mutation causing phenylketonuria was originally only found in one population in central Asia. It is now found in many different populations across Asia. Suggest how the spread of this mutation may have occurred.

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(1)

(Total 7 marks)



**Q10.**

- (a) What name is used for the non-coding sections of a gene?

(1)

**Figure 1** shows a DNA base sequence. It also shows the effect of two mutations on this base sequence. **Figure 2** shows DNA triplets that code for different amino acids.

**Figure 1**

Original DNA base sequence	A	T	T	G	G	C	G	T	G	T	C	T
Amino acid sequence												
Mutation 1 DNA base sequence	A	T	T	G	G	A	G	T	G	T	C	T
Mutation 2 DNA base sequence	A	T	T	G	G	C	C	T	G	T	C	T

**Figure 2**

DNA triplets	Amino acid
GGT, GGC, GGA, GGG	Gly
GTT, GTA, GTG, GTC	Val
ATC, ATT, ATA	Ile
TCC, TCT, TCA, TCG	Ser
CTC, CTT, CTA, CTG	Leu

- (b) Complete **Figure 1** to show the sequence of amino acids coded for by the original DNA base sequence.
- (c) Some gene mutations affect the amino acid sequence. Some mutations do not. Use the information from **Figure 1** and **Figure 2** to explain

(1)

- (i) whether mutation 1 affects the amino acid sequence

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(2)

- (ii) how mutation 2 could lead to the formation of a non-functional enzyme.

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(3)

(d) Gene mutations occur spontaneously.

(i) During which part of the cell cycle are gene mutations most likely to occur?

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(1)

(ii) Suggest an explanation for your answer.

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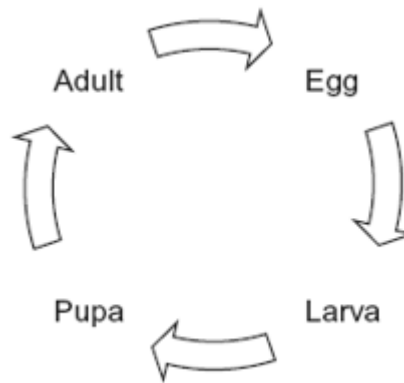
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(1)

(Total 9 marks)

**Q11.**

The diagram shows the life cycle of a fly.



When the larva is fully grown, it changes into a pupa. The pupa does not feed. In the pupa, the tissues that made up the body of the larva are broken down. New adult tissues are formed from substances obtained from these broken-down tissues and from substances that were stored in the body of the larva.

(a) Hydrolysis and condensation are important in the formation of new adult proteins. Explain how.

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(2)

- (b) Most of the protein stored in the body of a fly larva is a protein called calliphorin. Explain why different adult proteins can be made using calliphorin.

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(1)

The table shows the mean concentration of RNA in fly pupae at different ages.

Age of pupa as percentage of total time spent as a pupa	Mean concentration of RNA / $\mu\text{g}$ per pupa
0	20
20	15
40	12
60	17
80	33
100	20

- (c) Describe how the concentration of RNA changes during the time spent as a pupa.

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(2)

- (d) (i) Describe how you would expect the number of lysosomes in a pupa to change with the age of the pupa. Give a reason for your answer.

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(2)

- (ii) Suggest an explanation for the change in RNA concentration in the first 40% of the time spent as a pupa.

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(2)

- (e) Suggest an explanation for the change in RNA concentration between 60 and 80% of the time spent as a pupa.

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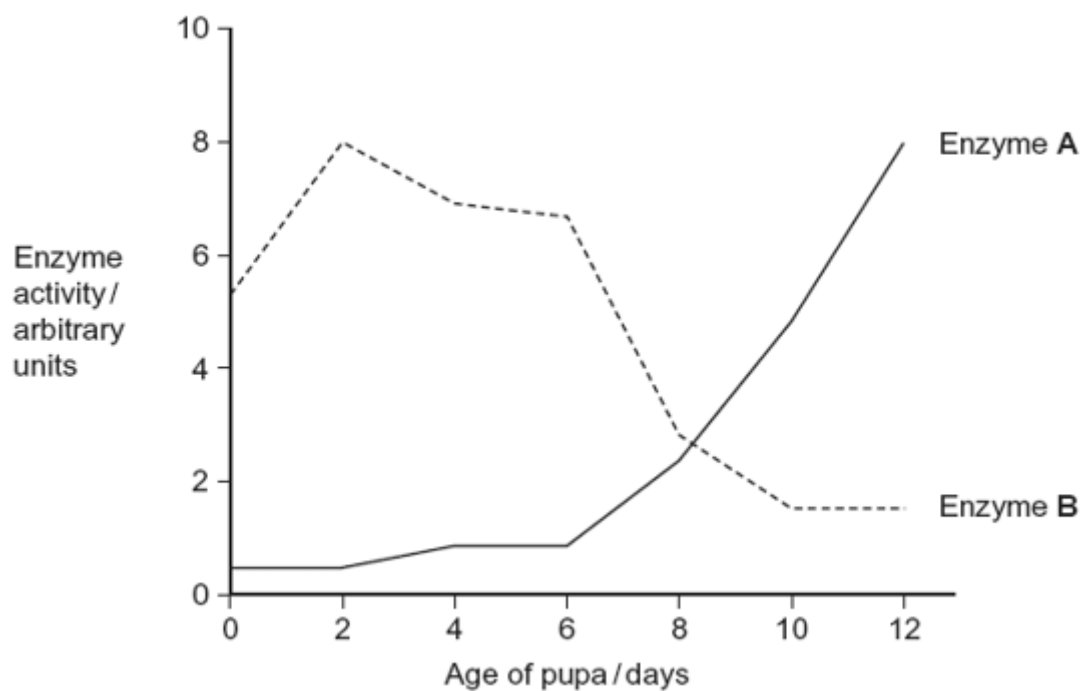
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(2)

- (f) The graph shows changes in the activity of two respiratory enzymes in a fly pupa.

- Enzyme **A** catalyses a reaction in the Krebs cycle
- Enzyme **B** catalyses the formation of lactate from pyruvate



During the first 6 days as a pupa, the tracheae break down. New tracheae are formed after 6 days. Use this information to explain the change in activity of the two enzymes.

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(4)  
(Total 15 marks)

**Q12.**

- (a) Give **three** ways in which courtship behaviour increases the probability of successful mating.

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_

(3)

Male field crickets produce a courtship song by vibrating their wings. The natural song contains seven low-pitched 'chirps' followed by two high-pitched 'ticks'.

Scientists recorded this song and used a computer program to change the number of chirps and ticks. Different versions of the song were then played back continuously to females in the presence of a male. This male had previously had one wing removed so he could not produce a courtship song. The scientists determined the percentage of females that showed courtship behaviour within 5 minutes of hearing each recorded song.

The results of the scientists' playback experiments are shown in the table below.

Version of recorded song played	Number of chirps	Number of ticks	Percentage of females that showed courtship behaviour within 5 minutes
K	No song played		30
L (natural)	7	2	83
M	7	0	70
N	0	2	65
O	7	1	83
P	7	4	82

- (b) The scientists wanted to know if the recorded natural song was less effective than the natural song in stimulating courtship behaviour.

Suggest how the scientists could determine if the recorded natural song (L) was less effective than the natural song.

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(2)

- (c) A student concluded from the data in the table above that the number of chirps and ticks is essential for successfully stimulating courtship behaviour.

Do these data support this conclusion? Explain your answer.

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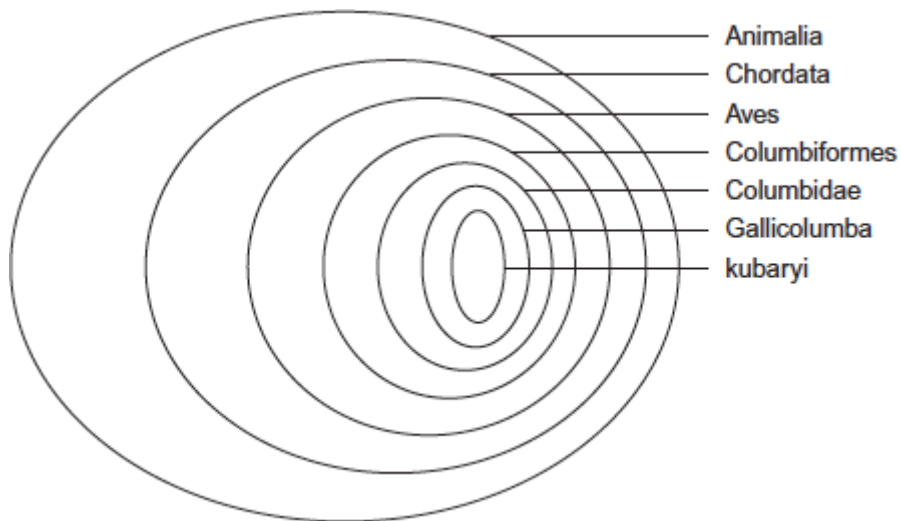
(4)

(Total 9 marks)

**Q13.**

Micronesia is a group of islands in the Pacific Ocean. The white-fronted ground dove is a bird found on these islands.

The diagram below shows how the white-fronted ground dove is classified.



- (a) To which class does the white-fronted ground dove belong?

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(1)

- (b) Give the scientific name for the white-fronted ground dove.

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(1)

- (c) This classification system consists of a hierarchy as there are small groups within larger groups.

Give **one** other feature of a hierarchy that is shown in the diagram.

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(1)

(Total 3 marks)

#### Q14.

- (a) (i) A mutation of a tumour suppressor gene can result in the formation of a tumour.

Explain how.

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(2)

- (ii) Not all mutations result in a change to the amino acid sequence of the encoded polypeptide.

Explain why.

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(1)

- (b) Some cancer cells have a receptor protein in their cell-surface membrane that binds to a hormone called **growth factor**. This stimulates the cancer cells to divide.

Scientists have produced a monoclonal antibody that stops this stimulation.

Use your knowledge of monoclonal antibodies to suggest how this antibody stops the growth of a tumour.

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(3)

(Total 6 marks)

### Q15.

- (a) Scientists can use protein structure to investigate the evolutionary relationships between different species. Explain why.

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(2)

- (b) Comparing the base sequence of genes provides more evolutionary information than comparing the structure of proteins. Explain why.

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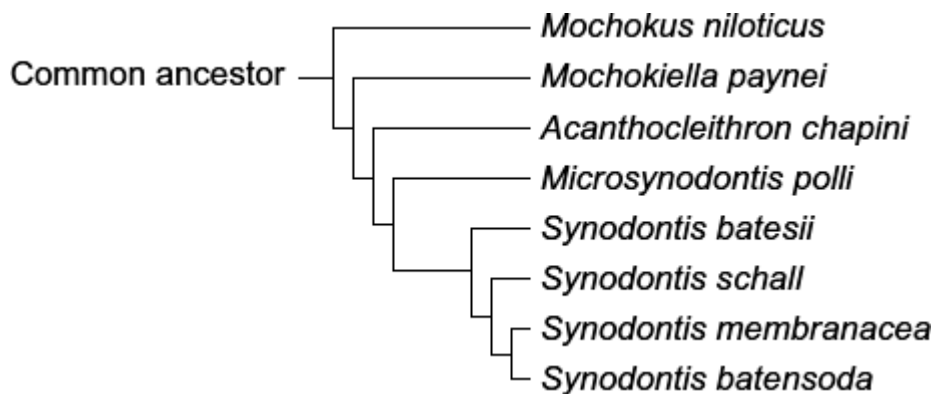
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**Q16.**

There are over 200 species of catfish. All catfish evolved from a common ancestor. The diagram shows how some species of catfish are classified. This diagram is based on the evolutionary links between these species.



- (a) (i) Which species of catfish is most closely related to *Synodontis membranacea*?

\_\_\_\_\_

(1)

- (ii) Which species of catfish is most distantly related to *Synodontis membranacea*?

\_\_\_\_\_

(1)

- (b) How many different genera are shown in this diagram?

(1)

- (c) (i) A scientist carried out breeding experiments with catfish from different populations.  
Describe how the results could show that the catfish belong to the same species.

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\_\_\_\_\_

\_\_\_\_\_

(1)

- (ii) The variety of colours displayed by catfish is important in courtship. Give **two** ways in which courtship increases the probability of successful mating.

1. \_\_\_\_\_

2. \_\_\_\_\_  
 \_\_\_\_\_

(2)  
 (Total 6 marks)

**Q17.**

Hummingbirds belong to the order Apodiformes. One genus in this order is *Topaza*.

- (a) (i) Name **one** other taxonomic group to which all members of the Apodiformes belong.

\_\_\_\_\_  
 (1)

- (ii) Name the taxonomic group between order and genus.

\_\_\_\_\_  
 (1)

The crimson topaz and the fiery topaz are hummingbirds.

Biologists investigated whether the crimson topaz and the fiery topaz are different species of hummingbird, or different forms of the same species.

They caught large numbers of each type of hummingbird. For each bird they

- recorded its sex
- recorded its mass
- recorded the colour of its throat feathers
- took a sample of a blood protein.

The table shows some of their results.

	Crimson topaz		Fiery topaz	
	Male	Female	Male	Female
Mean mass / g ( $\pm$ standard deviation)	13.6 ( $\pm 1.9$ )	10.8 ( $\pm 1.3$ )	14.2 ( $\pm 1.6$ )	11.6 ( $\pm 0.63$ )
Colour of throat feathers	Green	Grey edges	Yellowish green	No grey edges

- (b) Explain how the standard deviation helps in the interpretation of these data.

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 \_\_\_\_\_  
 \_\_\_\_\_

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(2)

- (c) The biologists analysed the amino acid sequences of the blood protein samples from these hummingbirds.

Explain how these sequences could provide evidence as to whether the crimson topaz and the fiery topaz are different species.

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(2)

(Total 6 marks)

**Q18.**

The Amazonian forest today contains a very high diversity of bird species.

- Over the last 2 000 000 years, long periods of dry climate caused this forest to separate into a number of smaller forests.
  - Different plant communities developed in each of these smaller forests.
  - Each time the climate became wetter again, the smaller forests grew in size and merged to reform the Amazonian forest.
- (a) Use the information provided to explain how a very high diversity of bird species has developed in the Amazonian forest.

(5)

- (b) Speciation is far less frequent in the reformed Amazonian forest. Suggest one reason for this.

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(1)

(Total 6 marks)

**Q19.**

- (a) There are ethical and economic arguments for maintaining biodiversity.

- (i) Suggest **one** ethical argument for maintaining biodiversity.

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(1)

- (ii) Suggest **one** economic argument for maintaining biodiversity.

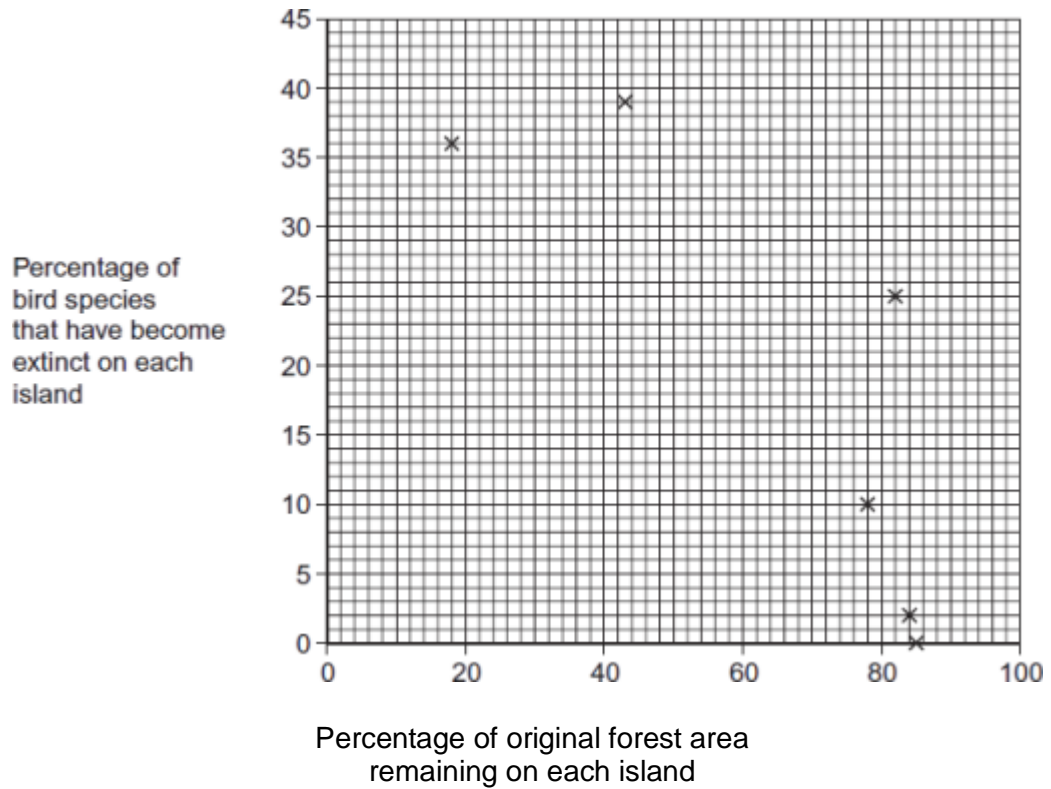
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(1)

Ecologists calculated the percentage of bird species that have become extinct on six islands in the last one hundred years. They also calculated the percentage of original forest area remaining on each island after the same time period. The graph shows their results.



- (b) Explain the relationship between the percentage of original forest area remaining and the percentage of bird species that have become extinct.

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(2)

- (c) What **two** measurements would the ecologists have needed to obtain to calculate the index of diversity of birds on each island?

1. 

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2. 

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(2)

- (d) The ecologists noted that the species of birds surviving on the coldest islands had a larger body size than those surviving on warmer islands.

Explain how a larger body size is an adaptation to a colder climate

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(2)  
(Total 8 marks)

**Q20.**

Organisms can be classified using a hierarchy of phylogenetic groups.

(a) Explain what is meant by:

(i) a hierarchy

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(2)

(ii) a phylogenetic group.

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(1)

(b) Cytochrome c is a protein involved in respiration. Scientists determined the amino acid sequence of human cytochrome c. They then:

- determined the amino acid sequences in cytochrome c from five other animals
- compared these amino acid sequences with that of human cytochrome c
- recorded the number of differences in the amino acid sequence compared with human cytochrome c.

The table shows their results.

Animal	Number of differences in the amino acid sequence compared with human cytochrome c
A	1
B	12

<b>C</b>	12
<b>D</b>	15
<b>E</b>	21

- (i) Explain how these results suggest that animal **A** is the most closely related to humans.

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(2)

- (ii) A student who looked at these results concluded that animals **B** and **C** are more closely related to each other than to any of the other animals.

Suggest **one** reason why this might **not** be a valid conclusion.

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(1)

- (iii) Cytochrome c is more useful than haemoglobin for studying how closely related different organisms are. Suggest **one** reason why.

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(1)

(Total 7 marks)

## Q21.

- (a) What is a *species*?

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(2)

- (b) Scientists investigated the diversity of plants in a small area within a forest. The table shows their results.

Plant species	Number of individuals
Himalayan raspberry	20
Heartwing sorrel	15
Shala tree	9
Tussock grass	10
Red cedar	4
Asan tree	6
Spanish needle	8
Feverfew	8

The index of diversity can be calculated by the formula

$$d = \frac{N(N-1)}{\sum n(n-1)}$$

where

$d$  = index of diversity

$N$  = total number of organisms of all species

$n$  = total number of organisms of each species

- (i) Use the formula to calculate the index of diversity of plants in the forest. Show your working.

Answer = \_\_\_\_\_

(2)

- (ii) The forest was cleared to make more land available for agriculture.

After the forest was cleared the species diversity of insects in the area decreased. Explain why.

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(3)

(Total 7 marks)

**Q22.**

- (a) What **two** measurements are needed to calculate an index of diversity?

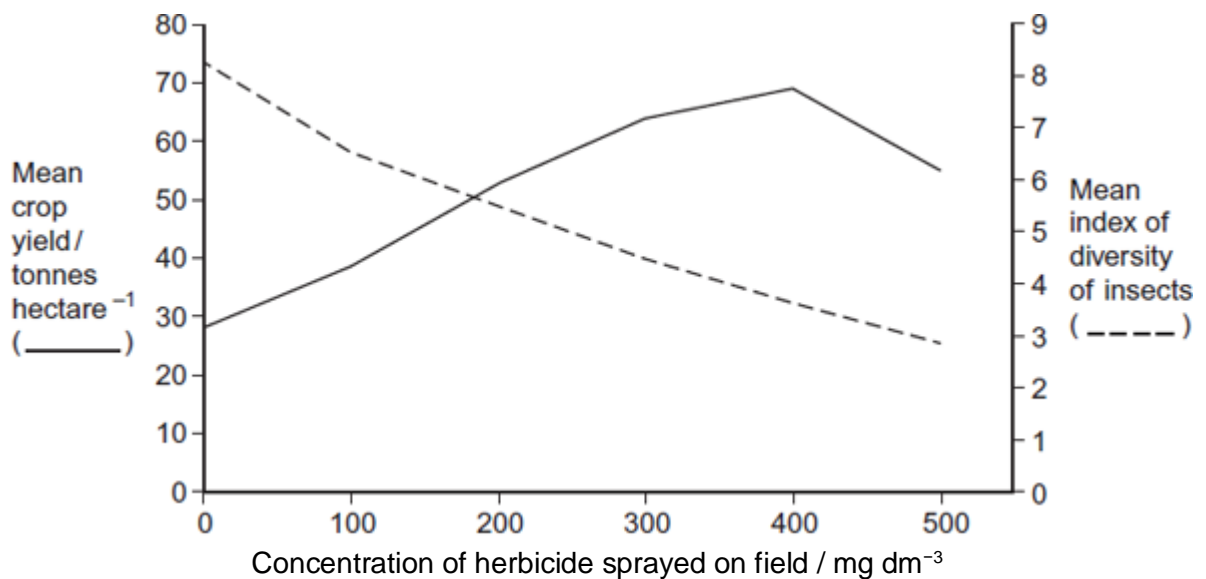
1. \_\_\_\_\_

2. \_\_\_\_\_

(2)

- (b) A herbicide is a chemical used to kill weeds. Ecologists investigated the effect of a herbicide on crop yield and the diversity of insects. They sprayed different fields with the same volume of different concentrations of the herbicide. At harvest, the ecologists determined the mean crop yield and the mean index of diversity of insects for fields that had received the same concentration of the herbicide.

The figure below shows their results.



- (i) Some fields acted as controls. They were sprayed with a solution that did not contain the herbicide. Explain the purpose of these control fields.

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(1)

- (ii) Suggest an explanation for the relationship between the concentration of herbicide and the mean crop yield.

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(2)

- (iii) Explain the relationship between the concentration of herbicide and the mean index of diversity of insects.

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(3)

(Total 8 marks)

## Mark schemes

### Q1.

- (a) (i) 9;

*Accept: nine*

1

- (ii) Introns / non-coding DNA / junk DNA;

Start / stop code / triplet;

*Neutral: Repeats.*

*Accept: 'Introns and exons present'.*

*Reject: 'Due to exons'.*

1 max

- (b) Change in amino acid / s / primary structure;

Change in hydrogen / ionic / disulfide bonds;

Alters tertiary structure;

*Reject: 'Different amino acid is formed' – negates first marking point.*

*Neutral: Reference to active site.*

3

- (c) Number of bases

	Number of bases			
	C	G	A	T
Strand A	26	<b>19</b>	<b>20</b>	<b>9</b>
Strand B	19	<b>26</b>	9	<b>20</b>

Second column correct;

Columns three and four correct;

2

[7]

### Q2.

- (a) (i) Phosphate and ribose;

*Accept in either order. Both correct for one mark.*

*For phosphate accept  $PO_4$  /  $Pi$  /  $\textcircled{P}$  but not  $P$ .*

*Do not accept phosphorus.*

*Ignore references to pentose / sugar.*

1

- (ii) TAGGCA; 1
- (b) (i) Does not contain hydrogen bonds / base pairs / contains codons / does not contain anticodon / straight / not folded / no amino acid binding site / longer;  
*Assume that "it" refers to mRNA.*  
*Do not accept double stranded.* 1
- (ii) (pre-mRNA) contains introns / mRNA contains only exons;  
*Assume that "it" refers to pre-mRNA.*  
*Accept non-coding as equivalent to intron.* 1
- (c) (i)
- | Part of chromosome | U  |
|--------------------|----|
| Middle             | 18 |
| End                | 21 |
- One mark for both figures correct* 1
- (ii) 1. Have different (base) sequences / combinations of (bases);  
 2. (Pre-mRNA) transcribed from different DNA / codes for different proteins; 2

[7]

### Q3.

- (a) (i) 1. Groups within groups;  
*Accept: idea of larger groups at the top **or** smaller groups at the bottom*  
 2. No overlap (between groups); 2
- (ii) 3; 1
- (iii) Chordata;  
*Accept: if phonetically correct eg 'Cordata'* 1
- (b) (i) 1. (To provide) genetic variation;  
*Genetic variation must be directly stated and not implied*  
 2. (Allows) different combinations of maternal and paternal chromosomes / alleles;  
*Accept: any allele of one gene can combine with any allele of another gene* 2

- (ii) 1. (Zedonk has) 47 / odd / uneven number of chromosomes;  
*Accept: diploid number would be odd*  
*Reject: if wrong number of chromosomes is given*
2. Chromosomes cannot pair / are not homologous / chromosome number cannot be halved / meiosis cannot occur / sex cells / haploid cells are not produced;  
*Accept: cannot have half a chromosome*  
*Q Reject: meiosis cannot occur **in** sex cells*

2

[8]

#### Q4.

- (a) (So results) can be compared / so measurement is the same each time / because eye is not perfectly round / uniform;  
*Accept eye opens to different amounts*

1

- (b) (i) 1. Eye (diameter) is smaller and antennae longer;  
 2. Antennae detecting touch;  
 3. Data only refers to shrimps / data may not apply to all animals / only in one area;  
*The principle here is that candidate has recognised that both features confirm suggestion. Exact wording does not matter.*

2 max

- (ii) 1. Standard deviation gives a measure of spread / variation;  
 2. More standard deviations overlap, the less likely it is that differences are real / significant / the more likely they are caused by chance;  
*Do not accept range*  
*Accept converse.*  
*Although we are looking for the idea of significance, we cannot require this term.*

2

- (c) (i) Qualitative statement about  
 difference in size /  
 difference in variation /  
 overlap in size;  
 Quantitative statement about  
 difference in size /  
 difference in variation /  
 overlap in size;

Supported by relevant two sets of figures from graph;;

*Note simplistic answer involving a quantitative statement gains 1 mark.*

*More specific answer involving quantitative information gains 2 marks.*

2

- (ii) (No) for same body length, antenna are longer / antenna are shorter / some with longer body have short antennae / some with shorter body length have longer antennae;

**OR**

(Yes) positive correlation in open / in cave;

*Habitat not critical as a term.*

*Must refer to idea of same habitat*

*Accept description*

1

- (d) More alleles of each gene / shrimps in open have all the alleles;

*Candidates are required to use the information from the table. Must therefore refer to alleles.*

1

- (e) 1. A small number of shrimps were / went into the cave;

2. All / high proportion of shrimps had allele L;

3. Cave population descended from these / these reproduce;

3

- (f) (i) 1. Cross shrimps from two sites / watch courtship;

2. Breed young together / observe mating;

3. Allow 1 mark for any method of improving quality of results e.g. carry out reciprocal crosses / large number of crosses / isolate beforehand;

*Other valid equivalent suggestions should be accepted.*

- (ii) If same species the shrimps would breed, producing fertile young / courtship species specific;

*Accept any form of evidence – mating / laying eggs / giving birth to young.*

3

[15]

## Q5.

- (a) (i) 22;

1

- (ii) 1. Odd number of chromosomes / 33 chromosomes (in leaf cell);

2. Chromosomes cannot pair / cannot undergo meiosis / would result in half chromosomes / cannot form haploid cells;

2

- (b) (i) Fast growth / produces crop fast / produces large crop;  
*Do not insist on relative statement.*  
*Accept similar terms for fast. E.g. "better" growth*  
*Do not accept unqualified references to profit.* 1

- (ii) Leaves less likely to break / higher breaking strength; 1

- (c) Low genetic diversity because they are produced by mitosis;  
 Will all have the same DNA / genes / alleles / will be genetically identical / will be clones;

**OR**

Low genetic diversity because they are not produced by meiosis;

No crossing over / independent segregation / will not be genetically different;  
*Independent segregation is the specification term. Accept other such as random assortment.*

2

[7]

## Q6.

- (a) (i) Faster / greater / more effective response in children;  
*Do not accept children have more haemoglobin* 1

- (ii) Use line of best fit; 1

Extrapolate / extend line (and read from graph);  
*Allow calculation using rate of increase per day = one mark.*  
*However for both marks this must be linked to line of best fit.*

1

- (iii) More than one polypeptide chain;  
*Allow many polypeptide chains.*  
*'Haemoglobin has four polypeptide chains' must be in correct context to gain mark.*

1

- (b) (i) Has same water potential;  
*Allow converse for effect of using distilled water or a concentrated solution.* 1

No (net) water movement / osmosis; 1

Cells will not swell / burst / change size;  
*No osmotic lysis = two marks* 1

- (ii) Pernicious anaemia (cells) greater range / spread / variation of diameters

/ widths;

Some pernicious anaemia (cells) wider than 9 ( $\mu\text{m}$ ) / some less than 5.5 ( $\mu\text{m}$ ) / without pernicious anaemia none more than 9 ( $\mu\text{m}$ ) / none less than 5.5 ( $\mu\text{m}$ );

Pernicious anaemia (cells) peak / most frequent at 8.5 ( $\mu\text{m}$ ) / peak / most frequent at higher diameter / / without pernicious anaemia peak / most frequent at 7 ( $\mu\text{m}$ ) / peaks at lower diameter;

*There are several alternatives for marking points 2 and 3*

2 max

[9]

**Q7.**

- (a) Isolation / quarantine / 'kept separate';

Screening / testing (of patients / doctors etc);

Sterilisation of wards / equipment / method to improve hygiene;

*Do not allow improve 'hygiene' or 'cleanliness' without named example such as 'washing hands' use of gloves etc.*

2 max

- (b) May not all be absorbed;

May be broken down / metabolised / excreted quickly;

To kill the microorganisms / bacteria;

Reference to antibiotic resistance;

*Reference to becoming 'immune' negates last marking point.*

2 max

- (c) (i) P;

1

- (ii) S;

1

- (d) (i) Prevents bias;

Vested interest (of scientists);

Prevents 'placebo' / positive / negative / psychological effects / 'demand characteristics' (in volunteers);

2 max

- (ii) Age;

Ethnicity;

Lifestyle;

Body mass;

Health;



Sex of person;  
*Ignore references to same or different*

2 max

- (e) Gradual / slight increase followed by rapid / greater increase;  
*Allow more detailed descriptions which describe similar trend of gradual increase followed by rapid increase.*

1

[11]

### Q8.

- (a) (Different) form / type / version of a gene / different base sequence of a gene;

1

- (b) Two / sister chromatids joined by a centromere;

Due to DNA replication;

2

- (c) (i) Crossing over;

1

Exchange (of alleles) between chromatids / chromosomes;

*Negate first marking point for answers which refer to independent segregation.*

*Chiasma / chiasmata = first marking point*

1

- (ii) Is infrequent / rare;

*References to it being 'random', 'occurs by chance' or 'doesn't always occur' should not be credited without a clear idea that it is rare or infrequent.*

1

- (d) (i) Three chromosomes shown;

1

One from each homologous pair;

*For first mark point allow drawings showing three chromosomes as single or double structures.*

1

- (ii) 8;

1

[9]

### Q9.

- (a) (i) 4;

1

- (ii) 1. Change in amino acid / (sequence of) amino acids / primary structure;

*1. Reject = different amino acids are 'formed'*

2. Change in hydrogen / ionic / disulphide bonds alters tertiary

structure / active site (of enzyme);  
 2. Alters 3D structure on its own is not enough for this marking point.

3. Substrate not complementary / cannot bind (to enzyme / active site) / no enzyme- substrate complexes form;

3

- (b) 1. Lack of skin pigment / pale / light skin / albino;  
 2. Lack of coordination / muscles action affected;

2 max

- (c) Founder effect / colonies split off / migration / interbreeding;  
*Allow description of interbreeding e.g. reproduction between individuals from different populations*

1

[7]

### Q10.

- (a) Introns;

1

- (b) Ile Gly Val Ser;

1

- (c) (i) Has no effect / same amino acid (sequence) / same primary structure;  
*Q Reject same amino acid formed or produced.*

1

Glycine named as same amino acid;

1

*It still codes for glycine = two marks.*

- (ii) Leu replaces Val / change in amino acid (sequence) / primary structure;

Change in hydrogen / ionic bonds which alters tertiary structure / active site;

*Q Different amino acid formed or produced negates first marking point.*

Substrate cannot bind / no longer complementary / no enzyme-substrate complexes form;

*Active site changed must be clear for third marking point but does not need reference to shape.*

3

- (d) (i) Interphase / S / synthesis (phase);

1

- (ii) DNA / gene replication / synthesis occurs / longest stage;  
*Allow 'genetic information' = DNA.*  
*Allow 'copied' or 'formed' = replication / synthesis*

1

[9]

**Q11.**

- (a) 1. Hydrolysis breaks proteins / hydrolyses proteins / produces amino acids (from proteins);  
2. Protein synthesis involves condensation; 2
- (b) Amino acids (from calliphorin) can be joined in different sequences / rearranged; 1
- (c) 1. Fall, rise and fall;  
2. Rise after 40 and fall after 80;  
*Ignore concentration values.* 2
- (d) (i) Fall / increase then fall;  
Lysosomes associated with tissue breakdown; 2
- (ii) 1. Tissues / cells are being broken down;  
2. RNA is digested / hydrolysed / broken down;  
3. By enzymes from lysosomes;  
4. New proteins not made / no new RNA made; 2 max
- (e) 1. (RNA) associated with making protein;  
2. New / adult tissues are forming; 2
- (f) 1. In the first 6 days no / little oxygen supplied / with breakdown of tracheae, no / little oxygen supplied;  
2. (Without tracheae) respire anaerobically;  
3. Anaerobic respiration involves reactions catalysed by enzyme **B** / conversion of pyruvate to lactate / involves lactate production;  
4. Enzyme **A** / Krebs cycle is part of aerobic respiration;  
*Or, with emphasis on aerobic respiration:*  
*1. Tracheae supply oxygen / after 6 days oxygen supplied;*  
*2. (With tracheae) tissues can respire aerobically.* 4

**[15]****Q12.**

- (a) 1. Recognise / identify / attract same species;  
*Ignore: references to letting them produce fertile offspring*  
2. Stimulates / synchronises mating / production / release of gametes;

3. Recognition / attraction of mate / opposite sex;  
*Accept finding a mate*  
*Accept: gender*
4. Indication of (sexual) maturity / fertility / receptivity / readiness to mate;
5. Formation of a pair bond / bond between two organisms (to have / raise young).

3 max

- (b) 1. Use a (real) male (with intact wings / no wing removed);  
*Mark ignoring reference to birds / or other types of animals*  
*Accept: use a real cricket, since only males sing*
2. Determine (percentage) response (of females compared with L).  
*Accept: compare results with L*

2

- (c) 1. Lowest / only 30% courtship with no song / K / (or) courtship still occurred when no song played / K;  
*Note: throughout, for courtship accept response / stimulation / reaction*  
*Neutral: references to methodology*  
*Answer must make clear there is no song / version K*
2. Reduced courtship when no ticks / M / there is some courtship when no ticks / M;
3. Reduced courtship when no chirps / N / there is some courtship when no chirps / N;  
*Accept: use of figures from the table in an explanation*
4. (So) courtship must involve a visual stimulus / other factor involved;
5. Chirps more important as lowest courtship when none / N / ticks less important as similar courtship when changed / M;  
*Must make comparison to gain mark*
6. Data only show presence and absence of chirps / 0 and 7 chirps.  
*Note: 'courtship still occurred when no sound played so a visual stimulus / other factor / something else (e.g. pheromone?) must be involved'*  
*= 2 marks*

4 max

[9]

### Q13.

- (a) Aves;

1

- (b) Gallicolumba kubaryi;  
*Must have both words and in this order*  
*Must be capital G*  
*If starts with k, award mark as impossible to recognise*

*difference*  
*Ignore: underlining*  
*Accept: phonetic spelling*  
*Accept: G kubaryi (must be a capital / upper case G)*

1

(c) No overlap.

1

[3]

#### Q14.

- (a) (i) 1. (Tumour suppressor) gene inactivated / not able to control / slow down cell division;

*Ignore: references to growth*

2. Rate of cell division too fast / out of control.

*1 and 2 Accept: mitosis*

*1 and 2 Reject: meiosis*

2

- (ii) 1. (Genetic) code degenerate;

*Accept: codon for triplet*

*Accept description of degenerate code, e.g. another triplet codes for the same amino acid*

2. Mutation in intron.

*Accept: mutation in non-coding DNA*

1 max

- (b) 1. Antibody has specific tertiary structure / binding site / variable region;

*Do not accept explanations involving undefined antigen*

2. Complementary (shape / fit) to receptor protein / GF / binds to receptor protein / to GF;

*Ignore: same shape as receptor protein / GF*

3. Prevents GF binding (to receptor).

3

[6]

#### Q15.

- (a) 1. Closer the (amino acid) sequence the closer the relationship;

2. (Protein structure) related to (DNA) base / triplet sequence;

*Amino acid sequence is related to (DNA) base / triplet sequence = two marks;*

2

- (b) 1. Reference to base triplets / triplet code / more bases than amino acids / longer base sequence than amino acid sequence;

*Different (base) triplets code for same amino acids = 2 marks;*

*Degeneracy of triplet code = 2 marks*

2. Introns / non-coding DNA / degeneracy of code / more than one code for each amino acid;

*Ignore reference to codon.*

2

[4]

### Q16.

- (a) (i) *Synodontis batensoda* / *S. batensoda*;

*Ignore spellings*

1

- (ii) *Mochokus niloticus*;

*Ignore spellings*

1

- (b) 5;

1

- (c) (i) Fertile offspring produced;

*Allow suitable description of offspring being fertile.*

1

- (ii) 1. Attracts / recognises same species;  
*Attracts mate of the same species = two marks.*

2. Attracts / recognises mate / opposite sex;

3. Indication of sexual maturity / fertility / synchronises mating;  
*Allow 'ready to mate'.*

4. Stimulates release of gametes;

5. Form pair bond;

2 max

[6]

### Q17.

- (a) (i) Kingdom / phylum / class;

*Accept Animalia / animal kingdom / Chordata / Chordates / Aves*

*Allow phonetic spelling*

1

- (ii) Family;

1

- (b) 1. Shows the spread of the data / how data varies;

*1. Reject range.*

*Accept varies from the mean*

2. Overlap = no difference / due to chance / not significant;

*2. Allow converse*

2

- (c) 1. Different species would have different amino acid sequences;  
*Accept more closely related = more similar sequence*
2. Amino acid sequence is the result of DNA / alleles / base sequence;  
*References to incorrect statements about coding negates second mark*

2

[6]

### Q18.

- (a) 1. No interbreeding / gene pools are separate / geographic(al) isolation;  
*Accept: all marks if answer written in context of producing increased diversity of plants*  
*1 Do not award this mark in context of new species being formed and then not interbreeding*  
*1 Accept reproductive isolation as an alternative to no interbreeding*
2. Mutation;  
*2 Accept: genetic variation*
3. Different selection pressures / different foods / niches / habitats;  
*3 Accept: different environment / biotic / abiotic conditions or named condition*  
*3 Neutral: different climates*
4. Adapted organisms survive and breed / differential reproductive success;
5. Change / increase in allele frequency / frequencies;

5

- (b) Similar / same environmental / abiotic / biotic factors / similar / same selection pressures / no isolation / gene flow can occur (within a species);  
*Accept: same environment*

1

[6]

### Q19.

- (a) (i) (We should maintain biodiversity to)  
*Prevent extinction / loss of populations / reduction in populations / loss of habitats / save organisms for future generations (idea of);*  
*Neutral: references to 'playing God' / animal rights*
- (ii) A suitable example of how some species may be important financially e.g.
1. medical / pharmaceutical uses;
  2. commercial products / example given;
  3. tourism;

1

4. agriculture;
5. saving local forest communities;
- 1 max
- (b) 1. Fewer plant species / decrease in plant diversity;  
*Accept: converse arguments for islands with a high percentage of forest remaining*  
 1. *Neutral: fewer plants*
2. Fewer habitats nesting sites / niches / food sources / varieties / less protection from predators / hunters / environment;  
 2. *Neutral: fewer homes*  
 2. *Neutral: less food*
- 2
- (c) 1. Number of (individuals / birds of) each species;  
 1. *Neutral: number of species*
2. Total number of individuals / birds of all species;  
 2. *Accept: 'total number of birds' as given context for 'all species' in the investigation*
- 2
- (d) 1. (Larger birds have) a low(er) SA:VOL;  
*Neutral: reference to fat / feathers*
2. (So) less heat loss / more heat retained;  
*MP2 is independent of MP1*
- 2

[8]

**Q20.**

- (a) (i) 1. Groups within groups;  
 1. *accept idea of larger groups at the top / smaller groups at the bottom*
2. No overlap (between groups);
- 2
- (ii) (Grouped according to) evolutionary links / history / relationships / common ancestry;  
*Neutral: closely related*  
*Neutral: genetically similar*
- 1
- (b) (i) 1. (Only) one amino acid different / least differences / similar amino acid sequence / similar primary structure;
2. (So) similar DNA sequence / base sequence;
- 2
- (ii) 1. Compared with humans / not compared with each other;  
*Accept: degenerate code / more than one triplet (codes) for an amino acid*



2. Differences may be at different positions / different amino acids affected / does not show where the differences are (in the sequence);

1 max

- (iii) 1. All organisms respire / have cytochrome c;  
*Accept: converse arguments for haemoglobin*  
 1. *Accept 'more' instead of 'all'*  
 1. *Accept 'animals' instead of organisms?*
2. (Cytochrome c structure) is more conserved / less varied (between organisms);  
 2. *Neutral: cytochrome c is conserved*

1 max

[7]

### Q21.

- (a) 1. Group of similar organisms / organisms with similar features / organisms with same genes / chromosomes;  
 1. *Accept: same number of chromosomes*  
 1. *Accept: smallest taxonomic group*  
 1. *Reject: genetically identical. Only allow 1 max if mentioned*  
 1. **Q** *Neutral: similar genes / chromosomes*
2. Reproduce / produce offspring;  
 2. *Accept: breed / mate*
3. That are fertile;  
 3. *Neutral: that are 'viable'*  
*'Produce fertile offspring' = 2 marks*

2 max

- (b) (i) Correct answer of 6.97 to 7 = 2 marks;  
 One mark for 6320 as numerator or 906 as denominator;

2

- (ii) 1. Decrease in variety of plants / fewer plant species;  
 1. *Accept: reference to monoculture or description*  
 1. *Neutral: fewer plants*
2. Fewer habitats / niches;  
 2. *Neutral: fewer homes / less shelter*
3. Decrease in variety of food / fewer food sources;  
 3. *Neutral: less food*  
 3. *Accept: less variety of prey*

3

[7]

### Q22.

- (a) 1. Number of (individuals of) each species;  
*Accept: 'population' for 'number'*
2. Total number of individuals / number of species;  
*Accept: 'species richness'*  
*MP2 allows for other types of diversity index*
- 2
- (b) (i) (Shows) results are due to the herbicide / are not due to another factor /  
(to) compare the effect of using and not using the herbicide / shows the  
effect of adding the herbicide;  
*Neutral: allows a comparison*  
*Neutral: ensures results are due to the independent variable*  
*Reject: 'insecticide'*  
*Accept: 'pesticide'*
- 1
- (ii) 1. (More) weeds killed **so** more crops / plants survive / higher yield /  
less competition;
2. High concentrations (of herbicide) harm / damage / kill / are toxic to  
crops / plants;  
*Accept: 'pesticide'*  
*Neutral: 'insecticide'*  
*Accept: use of figures (eg 400+)*
- 2
- (iii) 1. Reduced plant diversity / fewer plant species / fewer varieties of  
plant;  
*Accept: 'weed' for 'plant'*  
*Neutral: fewer plants*  
*Accept: only one crop species remains*
2. Fewer habitats / niches;  
**Q** *Neutral: fewer homes / shelters*
3. Fewer food sources / varieties of food;  
*Neutral: less food*
- 3

[8]