AQA, OCR, Edexcel

A Level

A Level Biology

DNA, Translation, Transcription and Classification Questions

Name:

M M E

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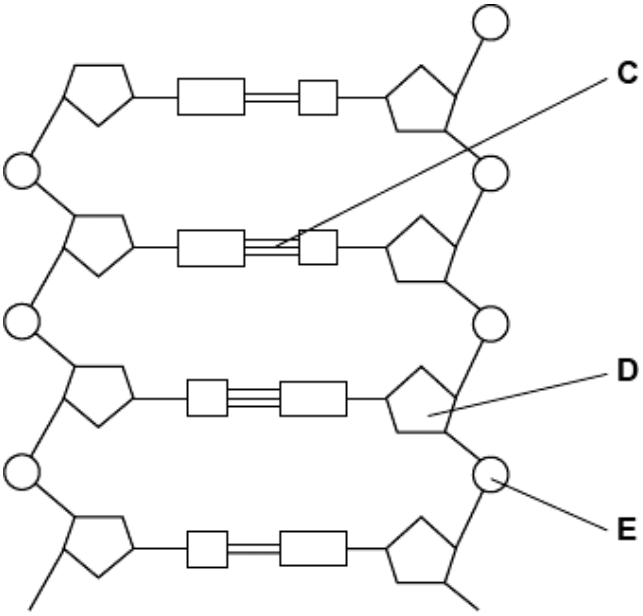
Total Marks:

Q1. The diagram shows part of a DNA molecule.



(a) (i) DNA is a polymer. What is the evidence from the diagram that DNA is a polymer?

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(ii) Name the parts of the diagram labelled **C**, **D** and **E**.

Part **C** .....

Part **D** .....

Part **E** .....

(3)

(iii) In a piece of DNA, 34% of the bases were thymine.

Complete the table to show the names and percentages of the other bases.

Name of base	Percentage
Thymine	34
	34

(2)

(b) A polypeptide has 51 amino acids in its primary structure.

(i) What is the minimum number of DNA bases required to code for the amino acids in this polypeptide?

(1)

(ii) The gene for this polypeptide contains more than this number of bases.

Explain why

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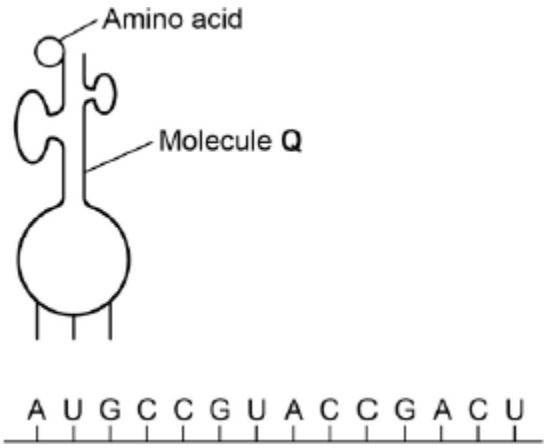
(Total 8 marks)

Q2. The diagram below represents one process that occurs during protein synthesis.



(a) Name the process shown.

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(b) Identify the molecule labelled **Q**.

.....**(1)**

(c) In the diagram above, the first codon is AUG. Give the base sequence of:

the complementary DNA base sequence .....

the missing anticodon .....

(2)

The table below shows the base triplets that code for two amino acids.

Amino acid	Encoding base triplet
Aspartic acid	GAC, GAU
Proline	CCA, CCG, CCC, CCU

(d) Aspartic acid and proline are both amino acids. Describe how two amino acids differ from one another. You may use a diagram to help your description.

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(e) Deletion of the sixth base (G) in the sequence shown in the diagram above would change the nature of the protein produced but substitution of the same base would not. Use the information in the table and your own knowledge to explain why.

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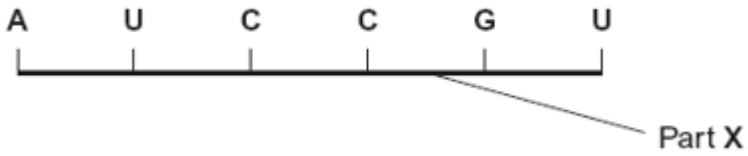
(Total 8 marks)

Q3. 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.

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

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

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(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	

(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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(Total 7 marks)

Q4.(a) Messenger RNA (mRNA) is used during translation to form polypeptides. Describe how mRNA is produced in the nucleus of a cell.

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Q5 a) (i) Why is the genetic code described as being universal?

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(ii) The genetic code uses four different DNA bases. What is the maximum number of different DNA triplets that can be made using these four bases?

(1)

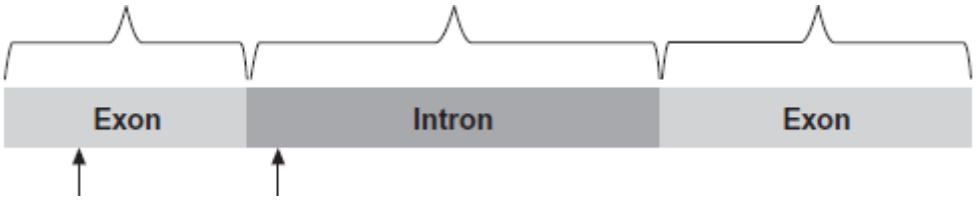
Transcription of a gene produces pre-mRNA.

(b) Name the process that removes base sequences from pre-mRNA to form mRNA.

.....**(1)**

(c) The figure below shows part of a pre-mRNA molecule. Geneticists identified two mutations that can affect this pre-mRNA, as shown in the figure.

Base sequence coding for amino acids	Base sequence removed from pre-mRNA	Base sequence coding for amino acids



Mutation 1, single base deletion

Mutation 2, single base substitution

(i) **Mutation 1** leads to the production of a non-functional protein.

Explain why.

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(ii) What effect might **mutation 2** have on the protein produced?

Explain your answer.

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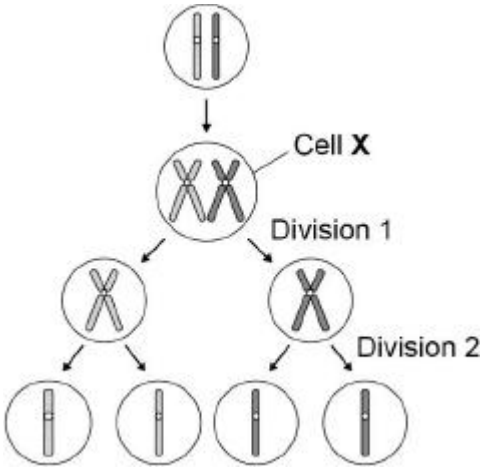
(Total 8 marks)

Q6. The figure below summarises the process of meiosis. The circles represent cells and the structures within each cell represent chromosomes.



(a) Describe and explain the appearance of **one** of the chromosomes in cell **X**.

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(b) Describe what has happened during division 1 in the figure above.

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.....**(2)**

(c) Identify **one** event that occurred during division 2 but **not** during division 1.

.....**(1)**

(d) Name **two** ways in which meiosis produces genetic variation.

1 .....

2 .....

(2)
(Total 8 marks)

Q7. The table shows some differences between three varieties of banana plant.

	Variety **A**	Variety **B**	Variety **C**
Number of chromosomes in a leaf cell	22	33	44
Growth rate of fruit / cm^3 $week^{-1}$	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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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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(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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(Total 7 marks)

Q8. Organisms can be classified using a hierarchy of phylogenetic groups.

(a) Explain what is meant by:

(i) a hierarchy

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(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
C	12
D	15
E	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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(iii) Cytochrome c is more useful than haemoglobin for studying how closely related different organisms are. Suggest **one** reason why.

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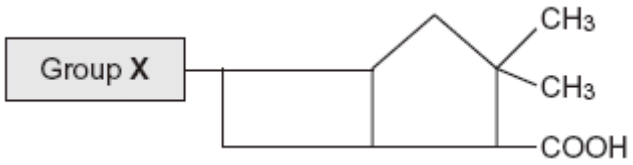
(Total 7 marks)

Q9. Penicillins are antibiotics. Some bacteria produce an enzyme that breaks down one sort of penicillin.

(a) There are different sorts of penicillin. All of these have the same basic chemical structure shown in the diagram but group **X** is different.



A bacterial infection that cannot be treated with one sort of penicillin can be treated with a different sort. Use your knowledge of enzyme action to explain why the different sort of penicillin is effective in treating the infection.

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(b) Farmers often keep large numbers of cattle together. Farmers used to give cattle food which had antibiotics added to it.

(i) Suggest how adding antibiotics to the food of the cattle increased profit for the farmers.

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.....**(2)**

(ii) Adding antibiotics to the food of cattle is now banned in many countries. Use your knowledge of selection to explain why adding antibiotics was banned.

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(Total 7 marks)

Q10.(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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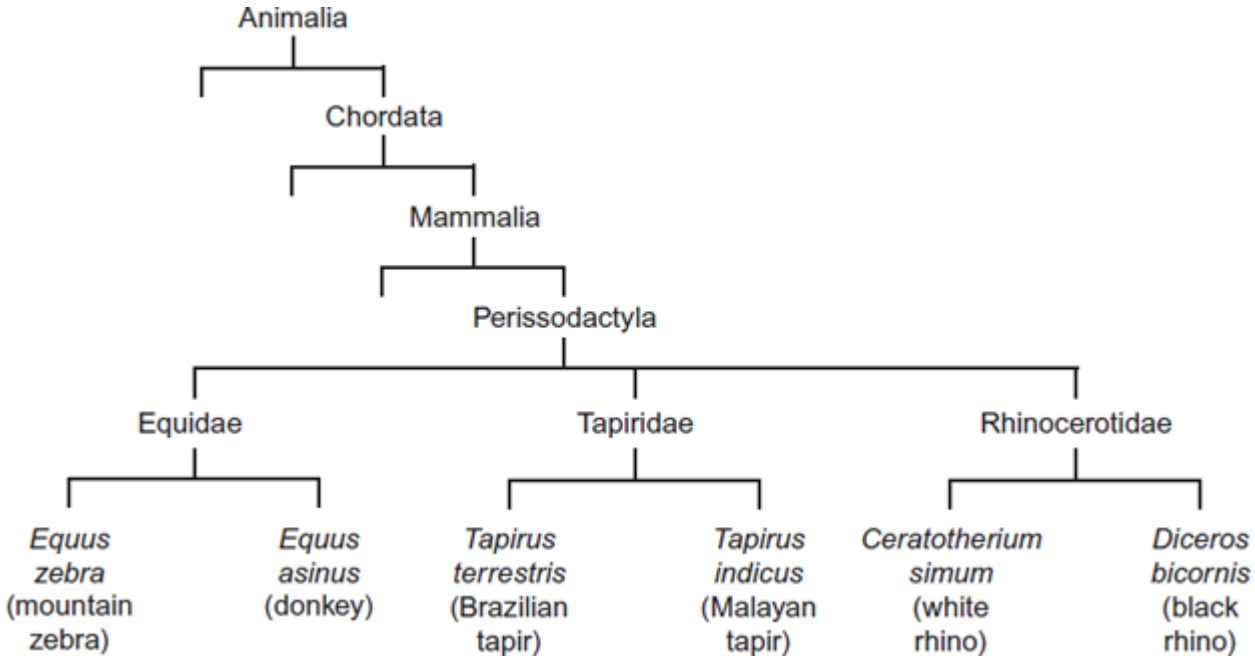
(Total 9 marks)

Q11. 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?

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(1)

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

.....**(1)**

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

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.....**(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.

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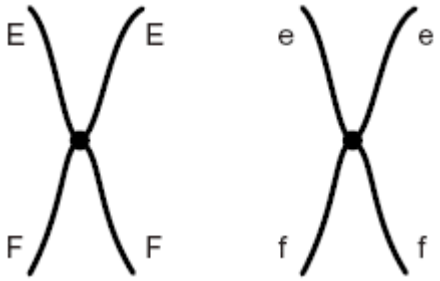
(Total 8 marks)

Q12.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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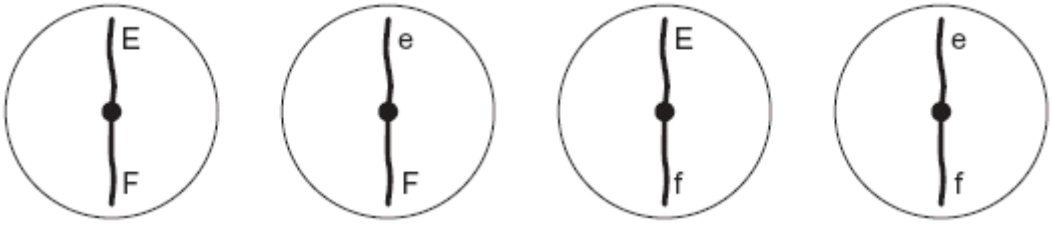
.....**(2)**

(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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(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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(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)

Q13. Malaria is a disease caused by a parasite. Scientists investigated the effect of malaria on competition between two species of *Anolis* lizard on a small Caribbean island. They sampled both populations by collecting lizards from a large number of sites on the island.

(a) (i) Explain the importance of collecting lizards from a large number of sites.

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.....**(1)**

(ii) Describe **one** method the scientists could have used to ensure that the sites were chosen without bias.

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.....**(2)**

(iii) The population number of both species of lizard varied at different times of the year. Suggest **two** reasons why.

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2.....

.....**(2)**

The scientists investigated the percentage of lizards of both species that were infected with malaria at different sites on the island. They collected samples of both lizards at intervals of 3 months for 1 year. They also recorded the elevation (height above sea level) of each site. Some of their results are shown in the table.

Site	Elevation of collection site / metres	Total number of *A. gingivinus* collected in one year	Percentage of *A. gingivinus* infected with malaria	Total number of *A. wattsi* collected in one year	Percentage of *A. wattsi* infected with malaria
1	10	13	0	0	0
2	80	30	0	0	0
3	120	35	23	3	0
4	200	40	30	7	0
5	300	52	46	12	0
6	315	35	31	13	1
7	370	155	37	79	2
8	414	124	44	68	4

(b) When analysing their results, the scientists used the percentage of lizards infected at each site, rather than the number of lizards infected. Explain why.

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(c) A preliminary study suggested that malarial infections were more common at higher elevations. Use the information provided to evaluate this suggestion.

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(2)

(d) (i) As a result of this investigation, the scientists concluded that the presence of malaria provided a competitive advantage to *A. wattsi.* Use the information provided to explain how they reached this conclusion.

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(ii) The malarial parasite of *Anolis* lizards destroys both red and white blood cells.Suggest how an increase in the percentage of *A. gingivinus* infected with malaria could result in *A.wattsi* having a competitive advantage.

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(iii) The scientists carried out a statistical test to determine whether the correlation between the number of *A. wattsi* collected and the percentage of *A. gingivinus* infected was significant. They obtained a value for P of < 0.01.

Use the terms **probability** and **chance** to help explain what this means.

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(2)
(Total 15 marks)

Q14. Cytochrome c is a protein found in all eukaryotes. In humans it consists of 102 amino acids. Biologists have compared the amino acid sequence in some other species with that in humans. The table shows amino acids 9 to 13 in the amino acid sequences of cytochrome c from four species.

	Amino acid in this position in cytochrome c				
Species	9	10	11	12	13
Human	Ile	Phe	Ile	Met	Lys
Chicken	Ile	Phe	Val	Gln	Lys
Dogfish	Val	Phe	Val	Gln	Lys
Chimpanzee	Ile	Phe	Ile	Met	Lys

(a) What do the results suggest about the relationship between humans and the other three species?

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.....**(2)**

(b) Suggest **one** advantage of using cytochrome c to determine relationships between species.

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.....**(1)**

(c) Comparing the base sequence of a gene provides more information than comparing the amino acid sequence for which the gene codes. Explain why.

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(Total 5 marks)

Q15. (a) Explain what is meant by stabilising selection and describe the circumstances under which it takes place.

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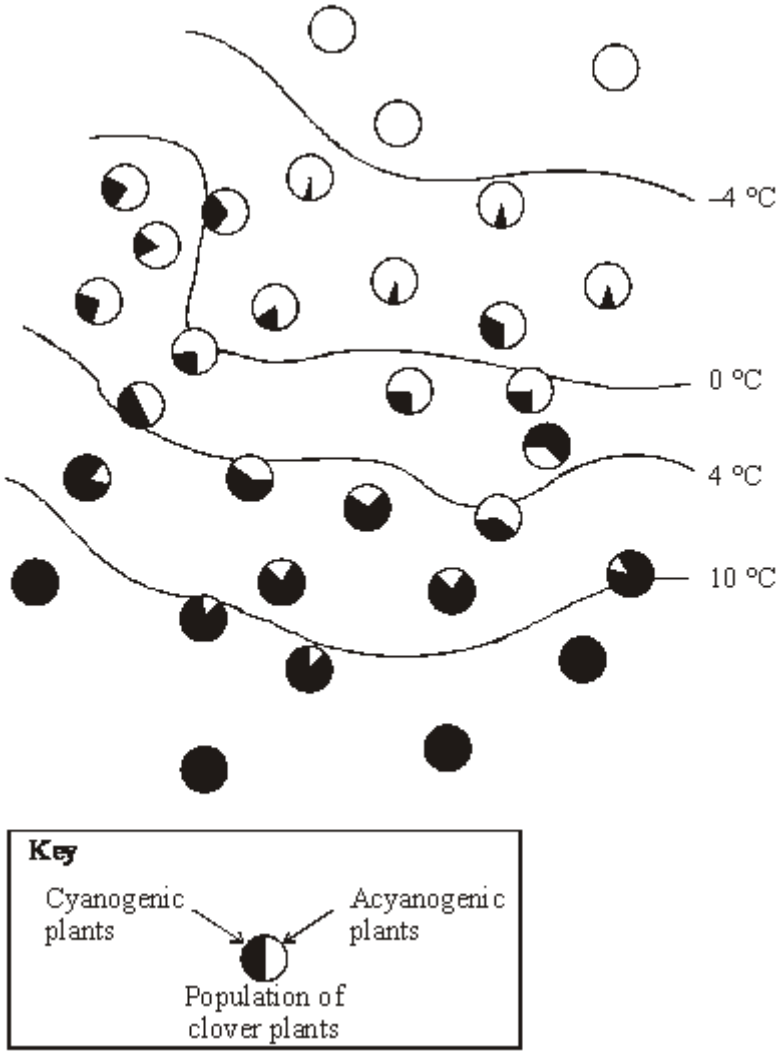
(b) Some European clover plants can produce cyanide. Those plants that can produce cyanide are called cyanogenic; those that cannot produce cyanide are called acyanogenic. Cyanide is toxic to the cells of animals and plants.

When the leaves of cyanogenic plants are damaged by slugs, or exposed to low temperatures, membranes within the cells are broken. This causes the release of the enzymes that control the reactions which produce cyanide.

The proportions of cyanogenic and acyanogenic plants in clover populations were determined in different parts of Europe. These are shown in the diagram below, together with the mean minimum winter temperatures. Slugs are not usually active at temperatures below 0 °C.



Explain the proportions of cyanogenic and acyanogenic plants in clover populations growing in the area where the mean minimum winter temperature is below –4°C and in the area where it is above 10 °C.

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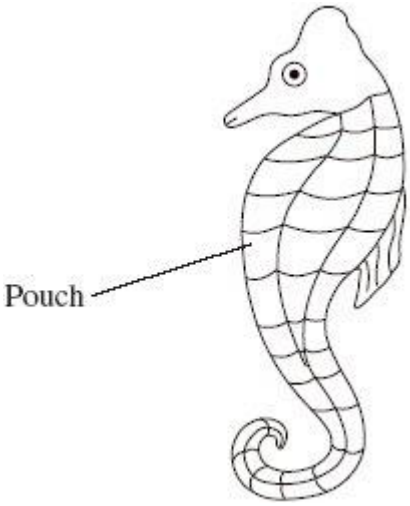
(Total 10 marks)

Q16. The diagram shows a seahorse. A seahorse is a fish. Mating in seahorses begins with courtship behaviour. After this, the female transfers her unfertilised eggs to the male's pouch. Most male fish fertilise eggs that have been released into the sea. However, a male seahorse fertilises the eggs while they are inside his pouch. The fertilised eggs stay in the pouch where they develop into young seahorses.



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

1 .....

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2 .....

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(2)

(b) Give **one** way in which reproduction in seahorses increases the probability of

(i) fertilisation

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.....**(1)**

(ii) survival of young seahorses.

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.....**(1)**

Scientists investigated the effect of total body length on the selection of a mate in one Australian species of seahorse. The scientists used head length as a measure of total body length.

(c) (i) Use the diagram to suggest why the scientists measured head length rather than total body length.

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.....**(1)**

(ii) Suggest why the scientists were able to use head length as a measure of total body length.

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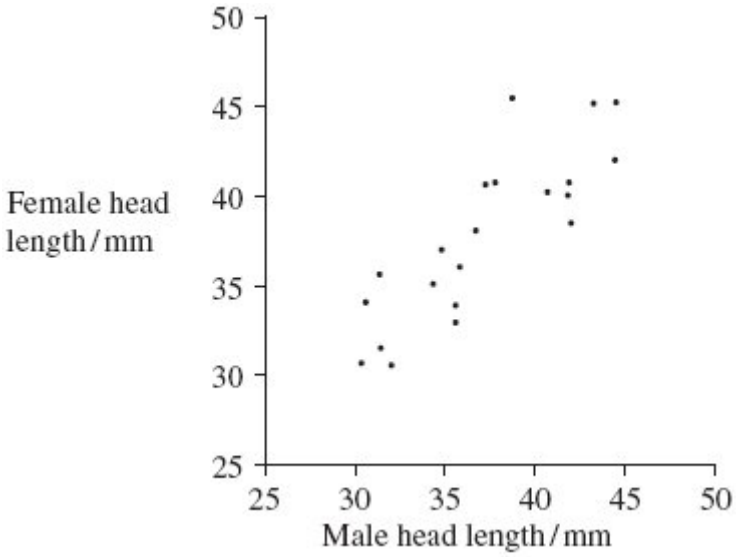
.....**(1)**

The scientists measured the head lengths of the female and male of a number of pairs.
The results are shown in the graph.



(d) The scientists concluded that total body length affects the selection of a mate.
Explain how the results support this conclusion.

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(e) A female with a head length of 50 mm selected a mate. Explain how you could use the graph to predict the total head length of the mate selected.

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(f) Scientists studied two species of North American seahorse. They thought that these two species are closely related. Describe how comparisons of biological molecules in these two species could be used to find out if they are closely related.

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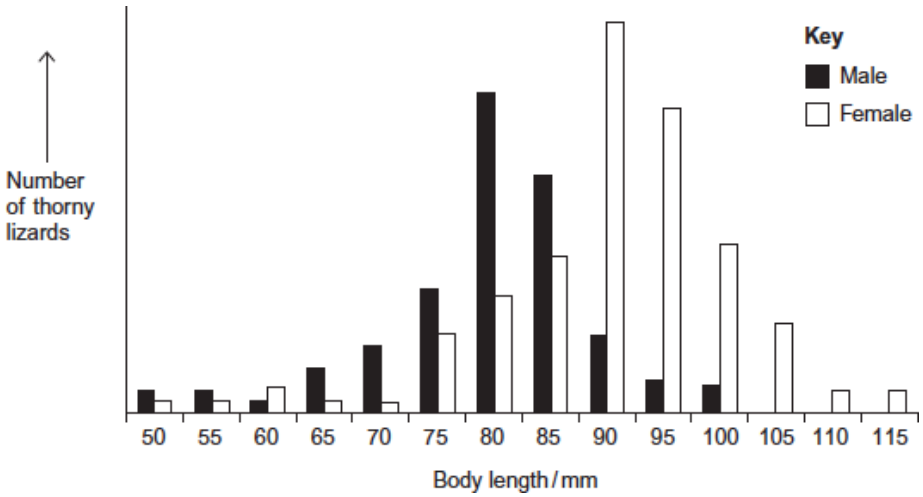
(Total 15 marks)

Q17.(a) Ecologists measured the body lengths of male and female thorny lizards living in the same habitat. The ecologists measured the body lengths to the nearest 5 mm.
The graph shows how they presented their results.



Give **two** differences in the variation in body length of male and female thorny lizards.

1 .....

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2 .....

.....**(2)**

(b) Another group of ecologists investigated biodiversity of lizards in a woodland area.

Their results are shown in the table.

Lizard species	**Number of individuals**
Dominican giant anole	5
Hispaniolan green anole	11
Hispaniolan stout anole	22
Bark anole	91
Hispaniolan grass anole	13
Cope's galliwasp	5
Cochran's least gecko	8
Peninsula least gecko	1

The index of diversity can be calculated using the formula

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

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 lizards in the woodland area.
Show your working.

Answer = ...

(2)

(ii) The ecologists also determined the index of diversity of lizards in an oil palm plantation next to the woodland area. They found fewer species of plant in the oil palm plantation. Lizards feed on plants and insects.

Explain why fewer species of plant would lead to fewer species of lizard in the oil palm plantation.

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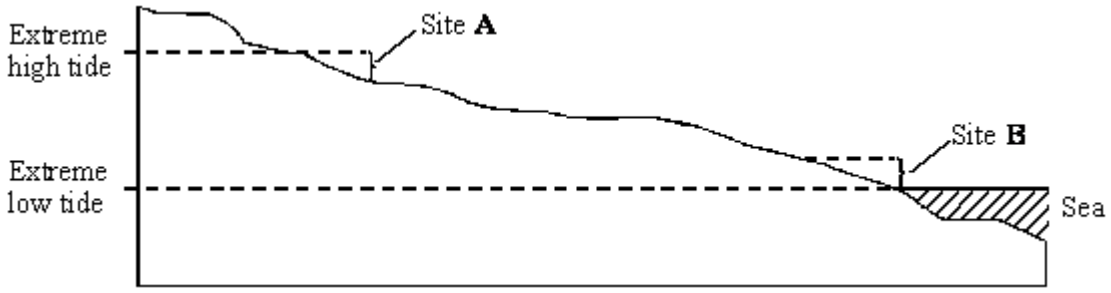
(Total 7 marks)

Q18. Parts of the sea shore form a very hostile environment for living organisms. Twice each day the incoming and outgoing tides alternately cover the organisms on the sea shore with water and then leave them exposed. The force of the waves could also dislodge any organisms that were not firmly attached.

The diagram shows a section through a rocky shore. Two sites were studied: site **A** was on the upper shore and site **B** on the lower shore.



The table shows the seaweeds that were found growing at sites **A** and **B**.

Site A: upper shore	Mean number per m^2	Site B: lower shore	Mean number per m^2
Ascophyllum nodosum	2	*Corallina officinalis*	31
Fucus spiralis	10	*Fucus serratus*	8
Fucus vesiculosus	4	*Laminaria digitata*	15
Pelvetia canaliculata	6	*Laminaria hyperborea*	3
		Laminaria saccharina	6
		Laurencia pinnatifida	18
		Palmaria palmata	6
Index of diversity		Index of diversity	4.77

(a) (i) Use the formula $d = \frac{N(N-1)}{\Sigma n(n-1)}$

where **d** = index of diversity
N = total number of organisms of all species
n = total number of organisms of a particular species

to calculate the index of diversity for the seaweeds growing at site **A**.
Show your working.

Index of diversity at site **A** = ...**(2)**

(ii) Give **one** advantage of calculating the index of diversity rather than just recording the number of species present.

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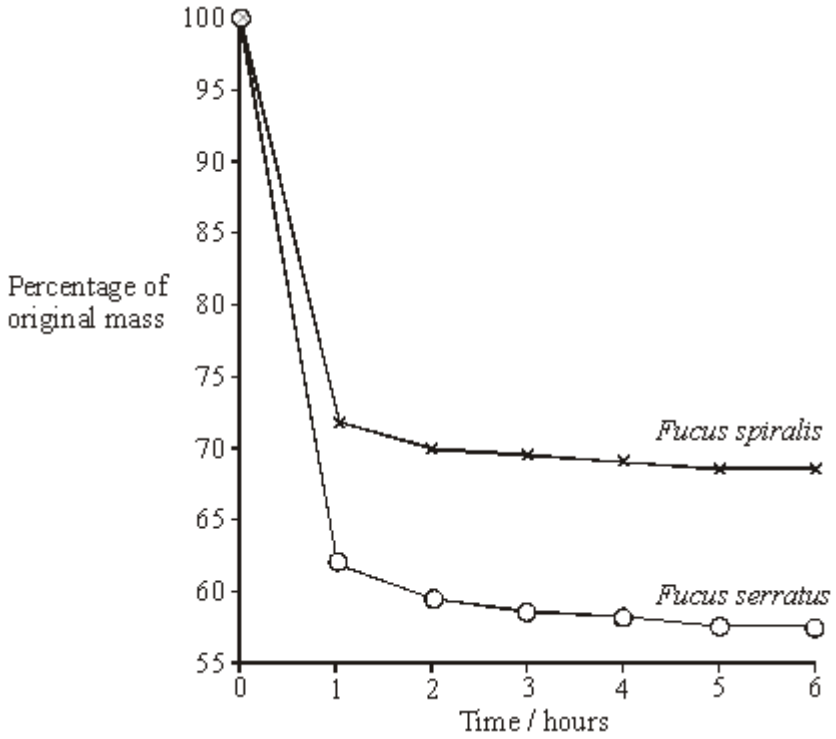
.....**(1)**

(b) Availability of water is one abiotic factor which determines the distribution of seaweeds. The graph shows loss in mass due to water evaporation for two of the seaweed species. The two seaweeds belong to the same genus but one was found only on the upper shore and the other only on the lower shore.



Explain how the results shown in the graph relate to the distribution of these two seaweeds on the sea shore.

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.....**(3)**

(Total 6 marks)

Q19. Species richness and an index of diversity can be used to measure biodiversity within a community.

(a) What is the difference between these two measures of biodiversity?

.....

.....**(1)**

Scientists investigated the biodiversity of butterflies in a rainforest. Their investigation lasted several months.

The scientists set one canopy trap and one understorey trap at five sites.

- The canopy traps were set among the leaves of the trees 16–27 m above ground level.
- The understorey traps were set under trees at 1.0–1.5 m above ground level.

The scientists recorded the number of each species of butterfly caught in the traps. The table below summarises their results.

Species of butterfly	**Mean number of butterflies**		**P value**
	In canopy	**In understorey**	
Prepona laertes	15	0	< 0.001
Archaeoprepona demophon	14	37	< 0.001
Zaretis itys	25	11	> 0.05
Memphis arachne	89	23	< 0.001
Memphis offa	21	3	< 0.001
Memphis xenocles	32	8	< 0.001

(b) The traps in the canopy were set at 16–27 m above ground level. Suggest why there was such great variation in the height of the traps.

.....

.....**(1)**

(c) By how many times is the species diversity in the canopy greater than in the understorey? Show your working.

Use the following formula to calculate species diversity.

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

where N is the total number of organisms of all species and n is the total number of organisms of each species.

Answer = ...**(3)**

(d) The scientists carried out a statistical test to see if the difference in the distribution of each species between the canopy and understorey was due to chance. The P values obtained are shown in the table.

Explain what the results of these statistical tests show.

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..... **(3)**

(Total 8 marks)

Q20. The table shows the taxons and the names of the taxons used to classify one species of otter. They are **not** in the correct order.

	Taxon	**Name of taxon**
J	Family	Mustelidae
K	Kingdom	Animalia
L	Genus	Lutra
M	Class	Mammalia
N	Order	Carnivora
O	Phylum	Chordata
P	Domain	Eukarya
Q	Species	lutra

(a) Put letters from the table above into the boxes in the correct order. Some boxes have been completed for you.

		O	**M**			**L**	**Q**

(1)

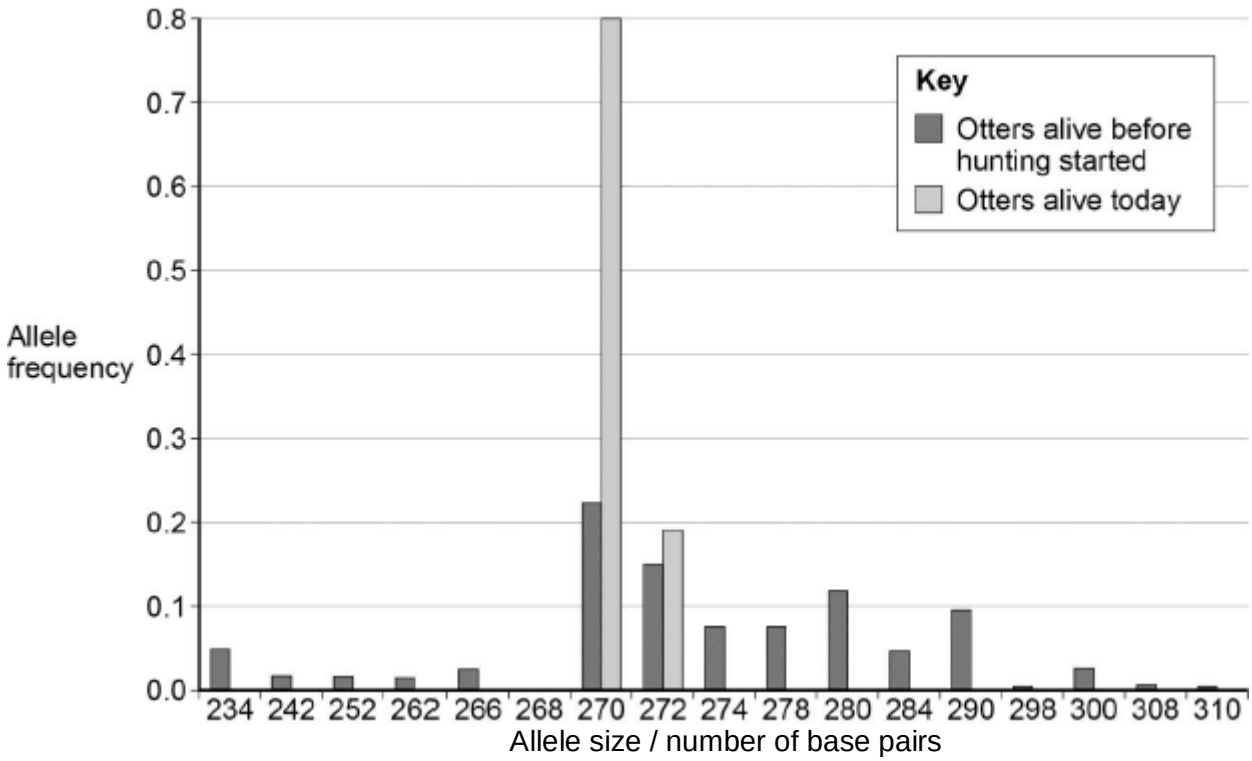
(b) Give the scientific name of this otter.

.....**(1)**

Scientists investigated the effect of hunting on the genetic diversity of otters. Otters are animals that were killed in very large numbers for their fur in the past. The scientists obtained DNA from otters alive today and otters that were alive before hunting started.

For each sample of DNA, they recorded the number of base pairs in alleles of the same gene. Mutations change the numbers of base pairs over time.

The figure below shows the scientists' results.



(c) The scientists obtained DNA from otters that were alive before hunting started.

Suggest **one** source of this DNA.

.....

.....**(1)**

(d) What can you conclude about the effect of hunting on genetic diversity in otters? Use data from the figure above to support your answer.

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.....**(2)**

(e) Some populations of animals that have never been hunted show very low levels of genetic diversity. Other than hunting, suggest **two** reasons why populations might show very low levels of genetic diversity.

1 .....

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2 .....

.....**(2)**

(Total 7 marks)