EXAM PAPERS PRACTICE

Species and Taxonomy

These practice questions can be used by students and teachers and is

Suitable for AQA A Level 7402 Biology Topic Question

Level: AQA A LEVEL 7402

Subject: Biology

Exam Board: AQA A Level 7402

Topic: Species and Taxonomy

1 (a) There are many different species of field mouse in Europe. Using a phylogeneticclassification, all of these species have names that start with *Apodemus*.

What information does this give about field mice?

_____

_____

_____

_____

(2)

The long-tailed field mouse, *Apodemus sylvaticus*, is a small mammal common in mainland Britain.

(b) Complete **Table 1** to show the classification of the long-tailed field mouse.

Table 1

Taxon	Name of Taxon
	Eukarya
Kingdom	Animalia
	Chordata
	Mammalia
Order	Rodentia
Family	Muridae

(2)

The St. Kilda field mouse lives only on one island off the coast of Scotland. It is very similar in appearance to the long-tailed field mouse but is larger and has lighter coloured fur.

Biologists wanted to find out if the St. Kilda field mouse and the long-tailed field mouse populations belonged to different species. They measured the length of the same features of a large number of individuals from the two populations.

The results are shown in **Table 2**.

Table 2

Population	**Mean length (±SD) / mm**	
	Head and body	Tail
St. Kilda field mouse	112.3 (±9.3)	105.5 (±8.4)
Long-tailed field mouse	95.2 (±8.2)	90.2 (±7.3)

(c) Do the data in **Table 2** provide evidence that the two populations belong to different species? Use calculations of ratios to support your answer.

(3)

(d) Describe how breeding experiments could determine whether the two populations are from the same species.

(2)

(Total 9 marks)

2 **Table 1** shows how a bird called the bluethroat (*Luscinia svecica*) is classified by biologists.

Table 1

Taxon	Name of taxon
Domain	Eukaryota
	Animalia
	Chordata
	Aves
	Passeriformes
	Muscicapidae
Genus	
Species	

(a) Complete **Table 1** by filling the seven blank spaces with the correct terms.

(2)

A group of scientists investigated genetic diversity in different species of bird. For each species, the scientists:

- collected feathers from a large number of birds
- extracted DNA from cells attached to each feather
- analysed the samples of DNA to find genetic diversity.

Table 2 summarises their results.

Table 2

Species of bird	Number of genes examined	Number of genes examined that showed genetic diversity
Willow flycatcher	708	197
House finch	269	80
Bluethroat	232	81

(b) In this investigation, what is meant by **genetic diversity?**

_____

_____

(1)

(c) The scientists concluded that the bluethroat showed greater genetic diversity than the willow flycatcher. Explain why they reached this conclusion. Use calculations to supportyour answer.

_____

_____

_____

_____

(2)

(Total 5 marks)

3 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.

_____

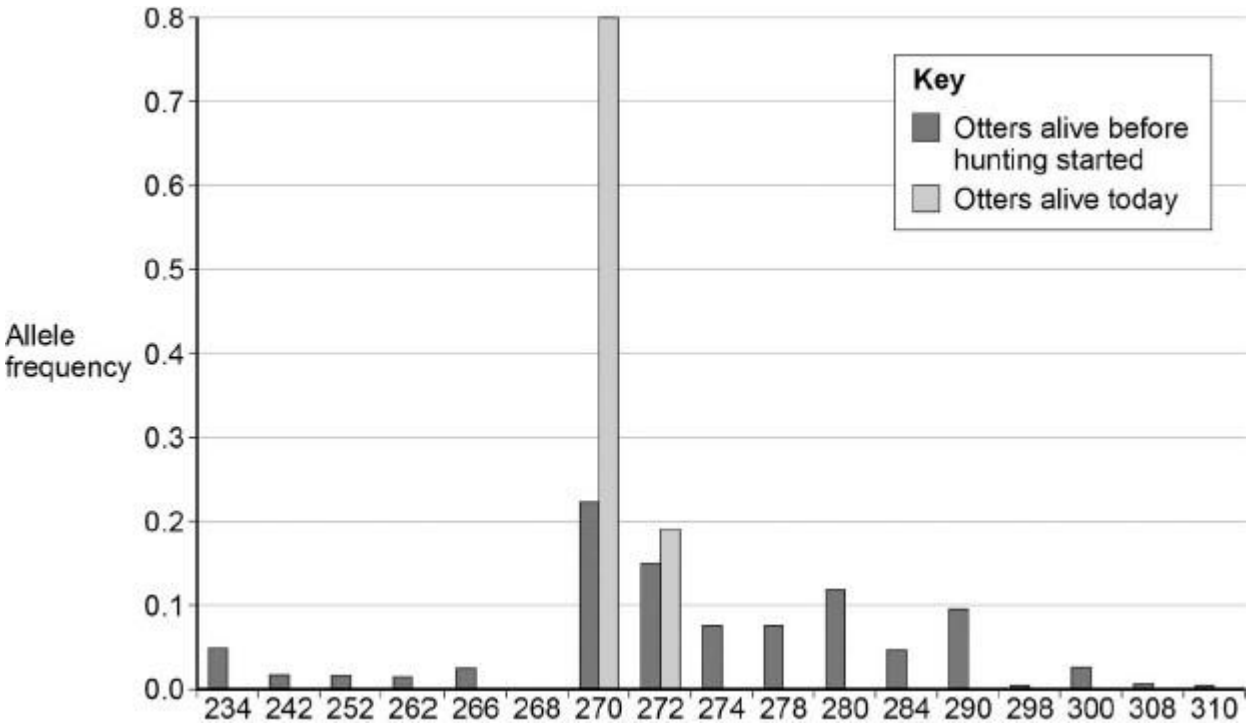
(1)

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.

_____

_____

_____

(2)

(e) Some populations of animals that have never been hunted show very low levels of geneticdiversity.

Other than hunting, suggest **two** reasons why populations might show very low levels of genetic diversity.

1. _____

_____

2. _____

_____

(2)

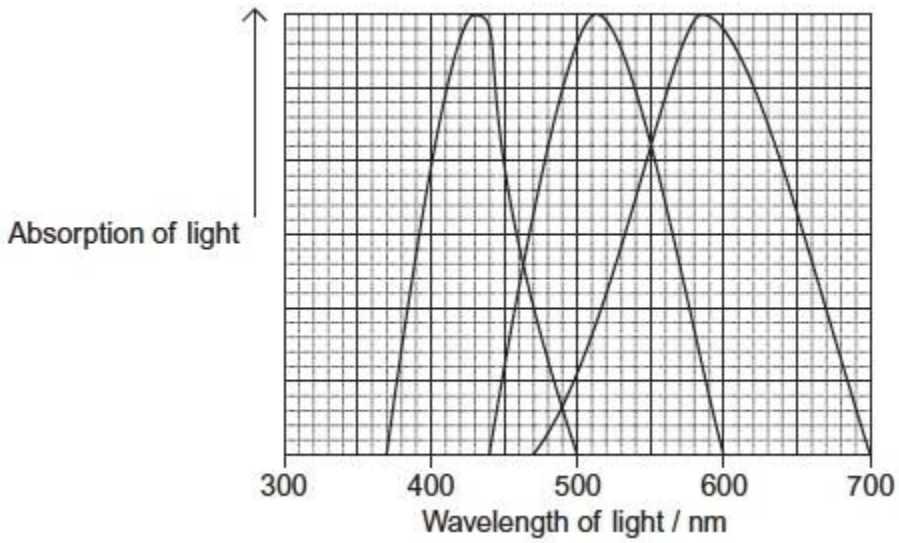
(Total 7 marks)

4 The retinas in the eyes of humans and birds have cone cells that absorb light of differentwavelengths.

Resource A

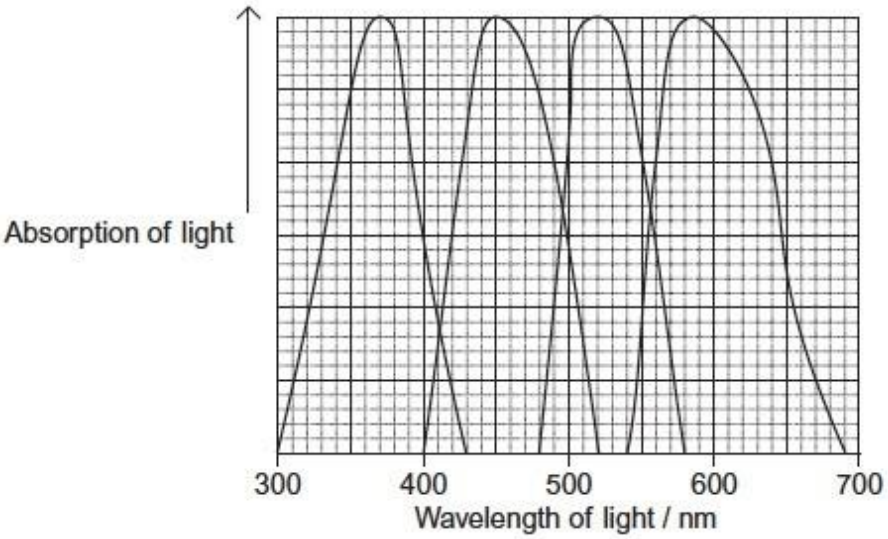
A scientist recorded the absorption of light of different wavelengths by different types of human cone cells. Her results are shown in **Figure 1**. Each curve shows the absorption of light by one type of cone cell.

Figure 1



She also recorded the absorption of light of different wavelengths by different types of bird cone cells. These results are shown in **Figure 2**. Each curve shows the absorption of light by one type of cone cell.

Figure 2



Resource B

Bluethroats are a species of small brightly coloured bird. The feathers on the throats of male birds reflect UV light (370 nm). Scientists investigated the response of female bluethroats to this reflected UV light.

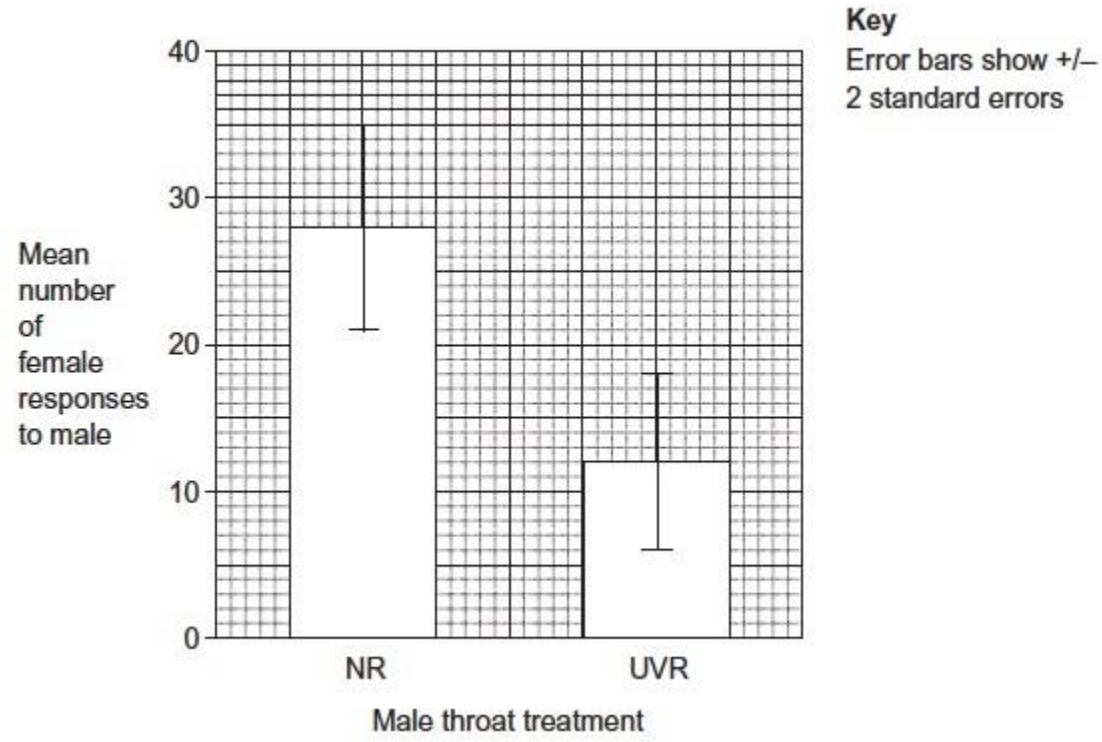
The scientists used 40 male birds selected because they were very similar to each other. The scientists treated the throat feathers of male birds as follows:

- they put a clear oil on the throat feathers of 20 males. They described these males as no UV reduction (NR).
- they put the same oil on the throat feathers of another 20 males but the oil contained a substance that absorbs UV light. They described these males as UV reduced (UVR).

In each experiment, the scientists placed two males where a female could see them. One male was NR and the other was UVR. During the next 5 minutes, they recorded how many times the female responded by moving towards each male.

Their results are shown in **Figure 3**.

Figure 3



Use **Resource B** to answer Questions (a) to (d).

(a) The male birds were selected because they were very similar to each other.
Suggest **two** reasons why it was important that they were of similar age.

1 _____

_____

_____

2 _____

_____

_____

(2)

(b) Of the 40 male birds the scientists selected 20 to receive the NR treatment. They selected these birds at random.
Suggest how.

_____

_____

_____

(1)

(c) The scientists recorded how many times each female moved towards a male.

In designing the experiment, suggest **two** assumptions the scientists made when they decided to record this movement.

1 _____

_____

2 _____

_____

(2)

(d) The pigment in the throat feathers of the male birds that reflects UV light is a protein. This protein arose by a gene mutation.
Explain how a gene mutation could result in a new protein.

(3)

Use **Resources A and B** to answer Question (e).

(e) A student who read both resources concluded that female bluethroats are attracted to the blue throat feathers of males when selecting a mate.
Do these data support this conclusion? Give reasons for your answer.

(4)

(Total 12 marks)

5 (a) Give **three** ways in which courtship behaviour increases the probability of successfulmating.

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 thenatural song in stimulating courtship behaviour.

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

(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.

[Extra space]

(4)

(Total 9 marks)

6 (a) Explain what is meant by a

(i) phylogenetic group

_____

_____

(1)

(ii) species.

_____

_____

_____

_____

(2)

The classification of tigers and clouded leopards is shown in **Table 1**.

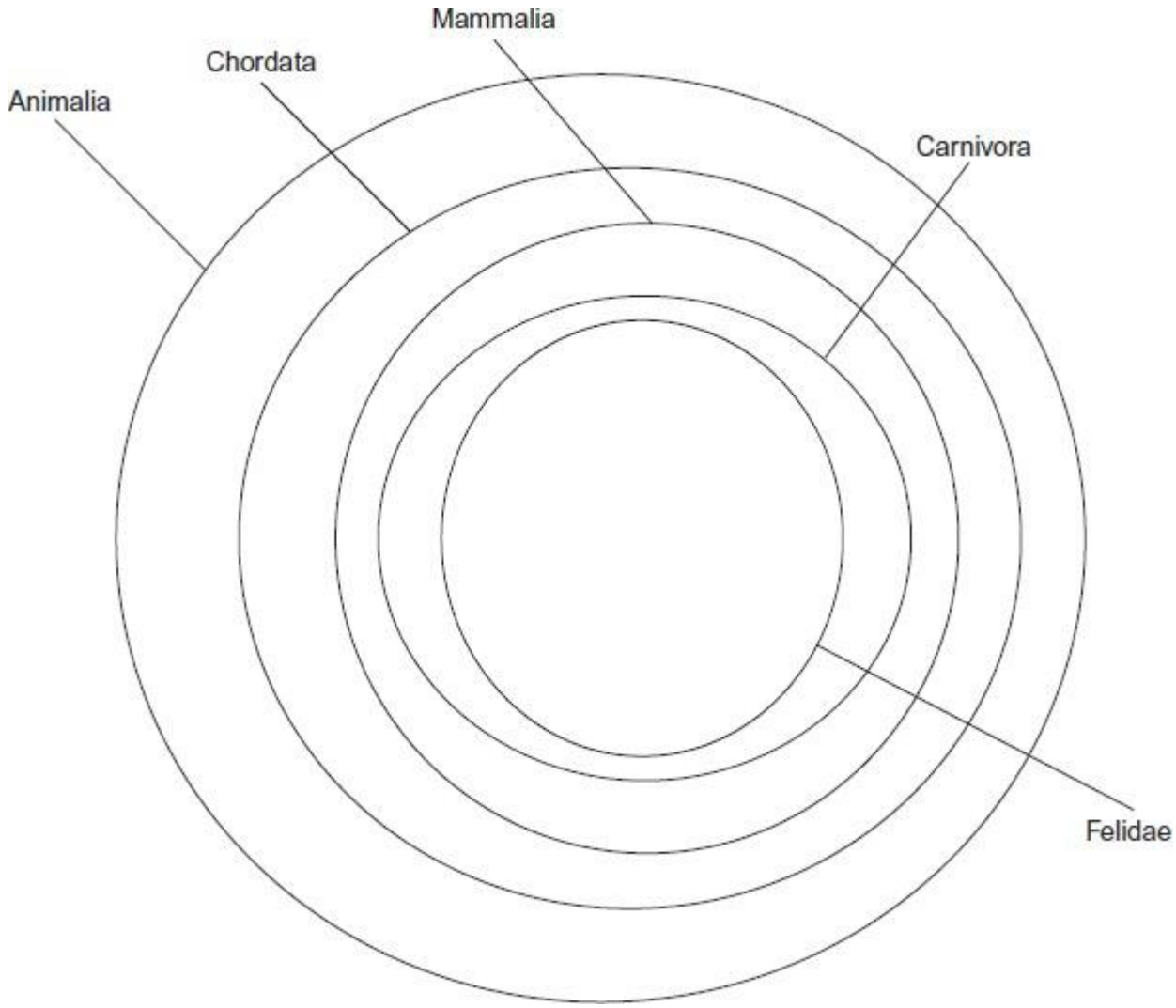
Table 1

Taxonomic group	Tiger	Clouded Leopard
Kingdom	Animalia	Animalia
	Chordata	Chordata
	Mammalia	Mammalia
Order	Carnivora	Carnivora
	Felidae	Felidae
	Panthera	Neofelis
Species	Tigris	Nebulosa

(b) Complete **Table 1** by adding the **four** other taxonomic groups to which the tiger and clouded leopard belong.

(1)

The circles in the diagram represent the hierarchy of taxonomic groups for the classificationshown in **Table 1**.



(c) Draw additional circles on the diagram and label them to include all the information about the tiger and clouded leopard shown in **Table 1**.

(2)

Table 2 shows part of the nucleotide sequence in a gene in populations of tigers living indifferent parts of the world.

Table 2

Siberian tiger	G C A C C G T
South China tiger	A C G C C G C
Sumatran tiger	A C G C C G C

(d) Explain what the information in **Table 2** suggests about the phylogenetic relationships between these tigers.

_____

_____

_____

_____

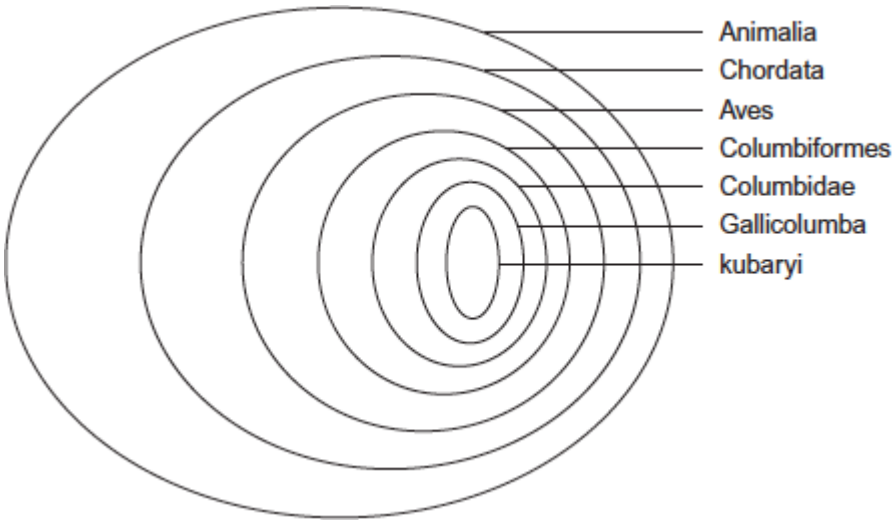
_____

(2)

(Total 8 marks)

7 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?

_____

(1)

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

_____

(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.

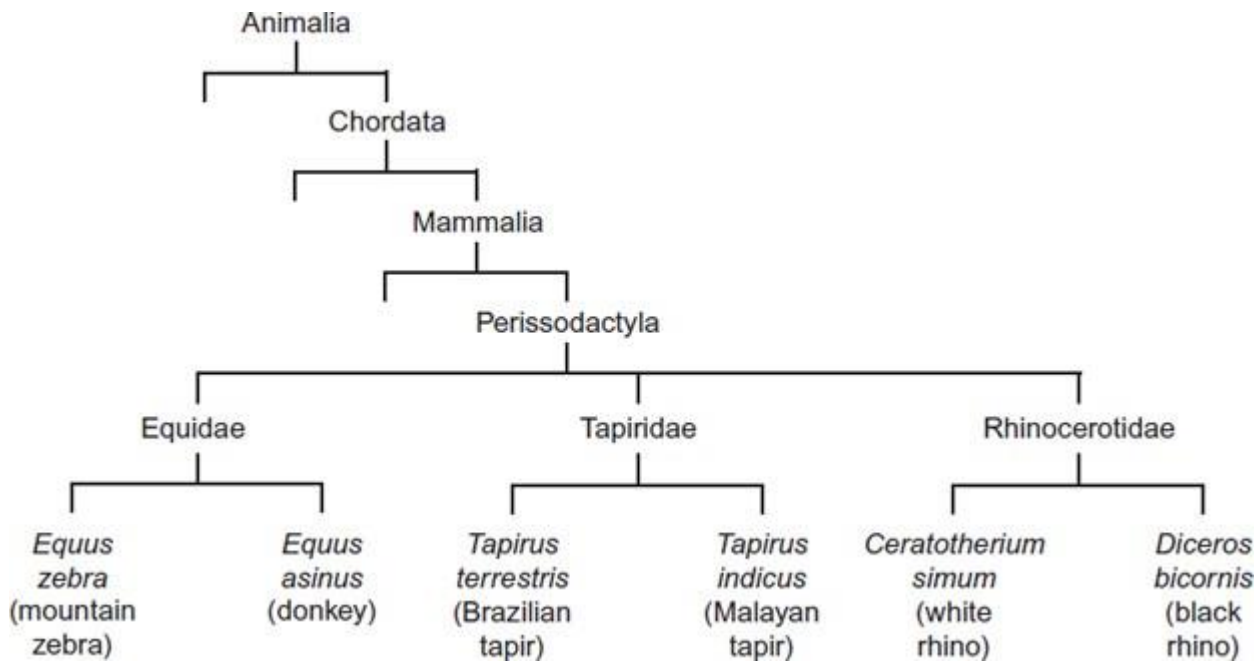
_____

_____

(1)

(Total 3 marks)

8 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**?

_____

_____

_____

_____

(Extra space) _____

_____

(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)

9 *(a)* What is a *species?*

_____

_____

_____

(2)

(b) Scientists investigated the diversity of plants in a small area within a forest. The tableshows 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.

(Extra space)

(3)

(Total 7 marks)

10 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.

(Extra space)

(5)

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

(1)

(Total 6 marks)

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

(a) Explain what is meant by:

(i) a hierarchy

_____

_____

_____

_____

_____

(2)

(ii) a phylogenetic group.

_____

_____

_____

(1)

(b) Cytochrome c is a protein involved in respiration. Scientists determined the amino acidsequence 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.

_____

_____

_____

_____

_____

(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.

_____

_____

_____

(1)

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

_____

_____

_____

(1)

(Total 7 marks)

12 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 (± standard deviation)	13.6 (±1.9)	10.8 (±1.3)	14.2 (±1.6)	11.6 (±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.

_____

_____

_____

_____

_____

(2)

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

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

_____

_____

_____

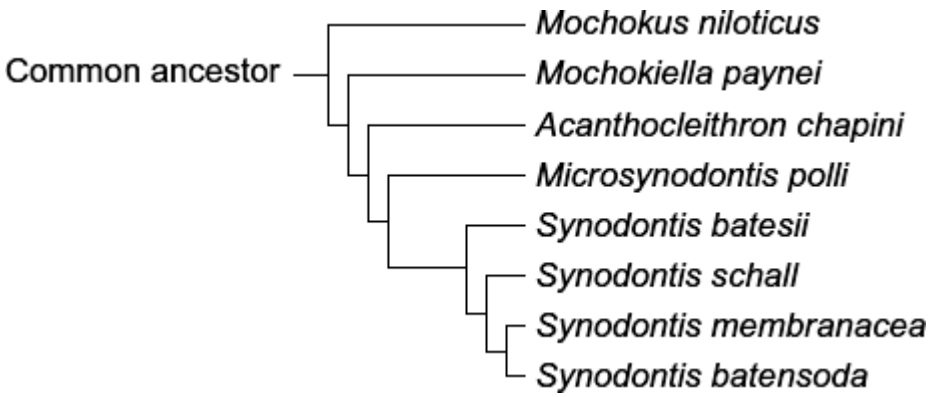
_____

_____

(2)

(Total 6 marks)

13 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.

_____

_____

_____

(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)

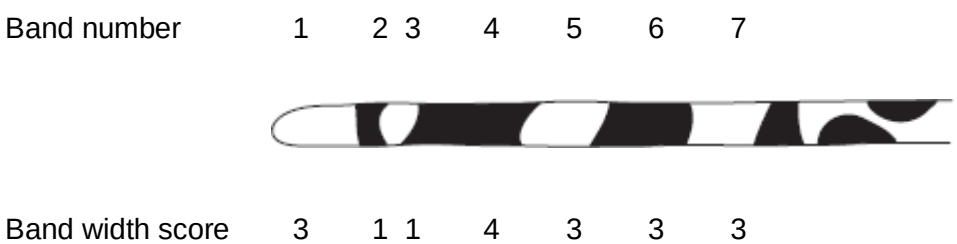
14 The body markings of cheetahs vary, in particular the pattern of bands on their tails. Cheetahs are solitary animals but the young stay with their mother until they are between 14 and 18 months old.

Scientists investigated the banding pattern on the tails of cheetahs living in the wild.

- They drove a car alongside a walking cheetah and used binoculars to study the tail pattern.
- They gave each cheetah a banding pattern score based on the width of the dark and light bands on the end of the tail.
- They scored the width of the bands on the right and left side of the tail using a 5 point scale of width.

A typical pattern on the right side of one cheetah's tail is shown in **Figure 1**.

Figure 1



The scientists collected data from each cheetah on four separate occasions. **Figure 2** shows thedata for one of the cheetahs.

Figure 2

Side of tail	Mean band width score (± standard deviation)						
	Band 1	**Band 2**	**Band 3**	**Band 4**	**Band 5**	**Band 6**	**Band 7**
Right	3.00 (± 0.82)	1.00 (± 0.00)	1.00 (± 0.00)	3.75 (± 0.50)	2.75 (± 0.50)	3.00 (± 0.00)	3.00 (± 0.00)
Left	3.75 (± 0.50)	3.25 (± 0.50)	2.00 (± 0.50)	3.00 (± 0.00)	2.00 (± 0.00)	2.50 (± 0.50)	3.00 (± 0.50)

(a) The scientists only used data from cheetahs which were fully grown. Suggest why.

_____

_____

(1)

(b) The scientists estimated the width of the bands on the same cheetah on four separate occasions. They did not always get the same score.

(i) Give **two** pieces of evidence from **Figure 2** which show that the scientists sometimes obtained different scores for the same band.

1. _____

_____

2. _____

_____

(2)

(ii) The method the scientists used resulted in them getting different scores for the same band. Suggest why.

_____

_____

(1)

(c) What is the evidence from **Figure 2** that the dark and light bands do **not** form rings of equal width around the tail?

_____

_____

(1)

(d) The scientists found the difference in banding pattern between

- offspring in the same family
- cheetahs chosen randomly.

Explain how scientists could use this information to show that some variation in tail banding was genetic.

(Extra space)

(3)

(Total 8 marks)

15 In 2002, biologists identified a new group of insects. They called these insects gladiators.

(a) (i) *Mantophasma zephyra* is one species of gladiator. Complete the table to show how this species is classified.

Kingdom	Animalia
	Arthropoda
	Insecta
	Notoptera
Family	Mantophasmatodae
Species	

(2)

(ii) This system of classification consists of a hierarchy. Explain what is meant by ahierarchy.

_____

_____

_____

_____

(2)

(b) In 2002, very few gladiators were available for identification. Scientists around the world used photographs to establish the relationship of gladiators to other insects.

Explain how.

_____

_____

(1)

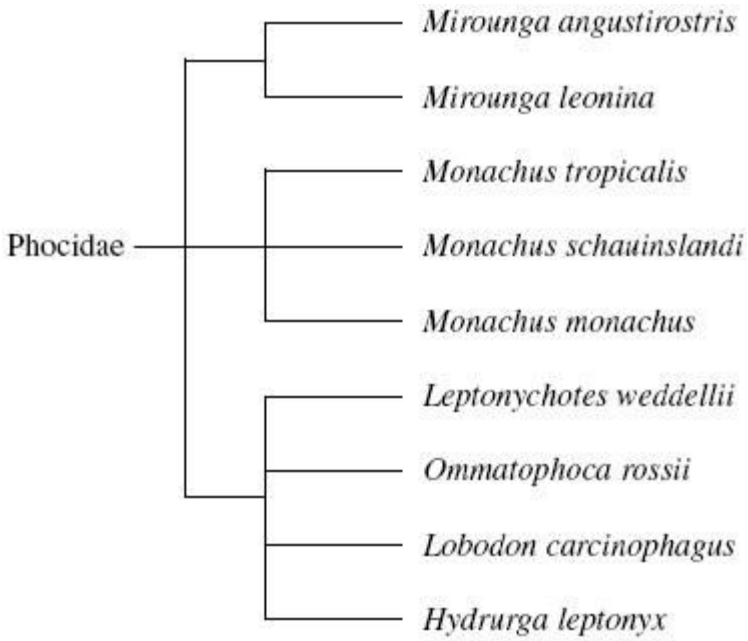
(Total 5 marks)

16 (a) An order is a taxonomic group. All seals belong to the same order. Name **one** other taxonomic group to which all seals belong.

_____

(1)

(b) The diagram shows how some species of seal are classified.



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

(1)

(ii) All the seals shown in the diagram are members of the Phocidae. Phocidae is an example of a taxonomic group. Of which taxonomic group is it an example?

_____

(1)

(iii) The diagram is based on the evolutionary history of the seals. What does the information in the diagram suggest about the common ancestors of *Mirounga angustirostris*, *Mirounga leonina* and *Monachus tropicalis*?

_____

_____

_____

(1)

(c) A species of seal shows genetic diversity. Explain what is meant by genetic diversity.

_____

_____

(1)

(Total 5 marks)

17 (a) The guinea pig, *Cavia porcellus*, is a small mammal.
Complete the table to show theclassification of the guinea pig.

Kingdom	
	Chordata
	Mammalia
	Rodentia
Family	Caviidae
Genus	
Species	

(2)

(b) In South America, there are several species of guinea pig. They are thought to have arisen by sympatric speciation.
Explain how sympatric speciation may have occurred.

_____

_____

_____

_____

_____

_____

(3)

(c) In guinea pigs, hair length and hair colour are controlled by two genes on different chromosomes. The hair may be either long or short and its colour either black or brown.

A male guinea pig and a female guinea pig both had short, black hair. The male was homozygous for hair length, and the female was homozygous for hair colour. Repeated crossings of these two guinea pigs resulted in offspring of four different genotypes, all of which had short, black hair.

Complete the genetic diagram to explain these results. Write in the box the symbols you will use to represent the alleles.

Allele for short hair = _____	Allele for long hair = _____
Allele for black hair = _____	Allele for brown hair = _____

	Male	Female
Parental phenotypes	Short, black hair	Short, black hair
Parental genotypes	_____	_____
Gamete genotypes	_____	_____

Offspring genotypes _____

Offspring phenotypes: Short, black hair

(4)

(d) In another investigation, the same female guinea pig was twice mated with another male which had long, brown hair. Of the 14 offspring, 10 had short, black hair and 4 had long, black hair. The investigators expected equal numbers of offspring with these two phenotypes. They used a χ^2 test to determine whether the observed results fitted the expected 1:1 ratio.

Give a suitable null hypothesis for the investigation.

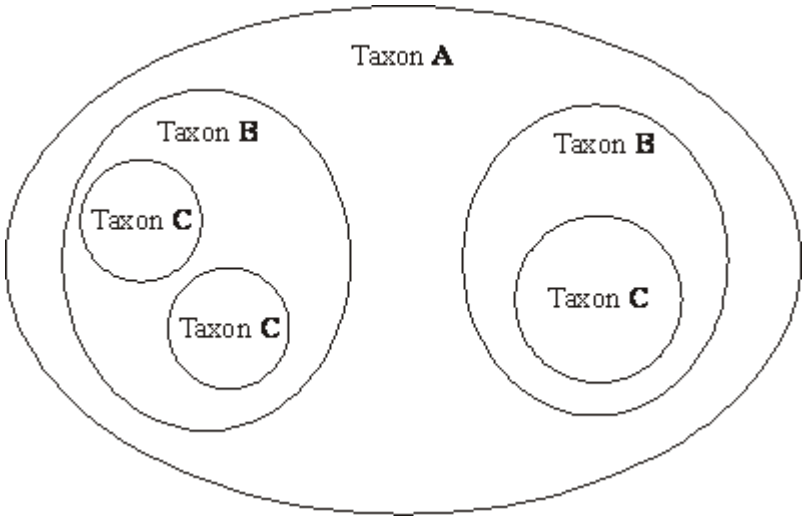
_____

_____

(1)

(Total 10 marks)

18 In taxonomy, each of the levels of classification (class, family, genus, kingdom, order, phylum and species) is called a taxon. The diagram represents just three of these levels of classification.



Explain which of these levels of classification could **not** be

(i) a genus;_____

_____

(ii) a phylum _____

_____

(Total 2 marks)

19 Finches are small birds. Fourteen species of finch are found on the Galapagos Islands.

(a) What is a species?

_____

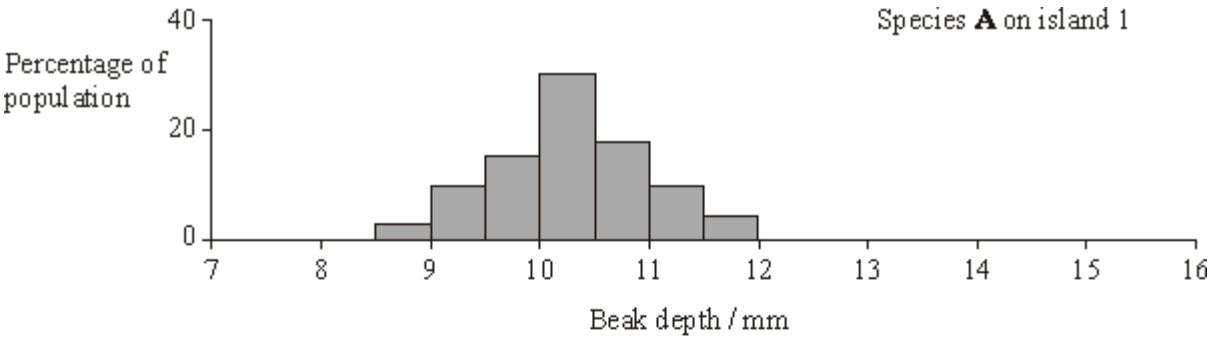
_____

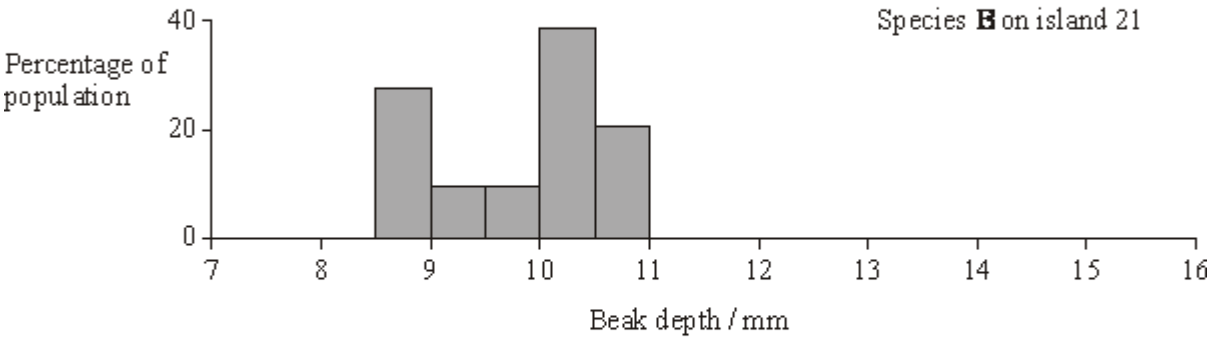
_____

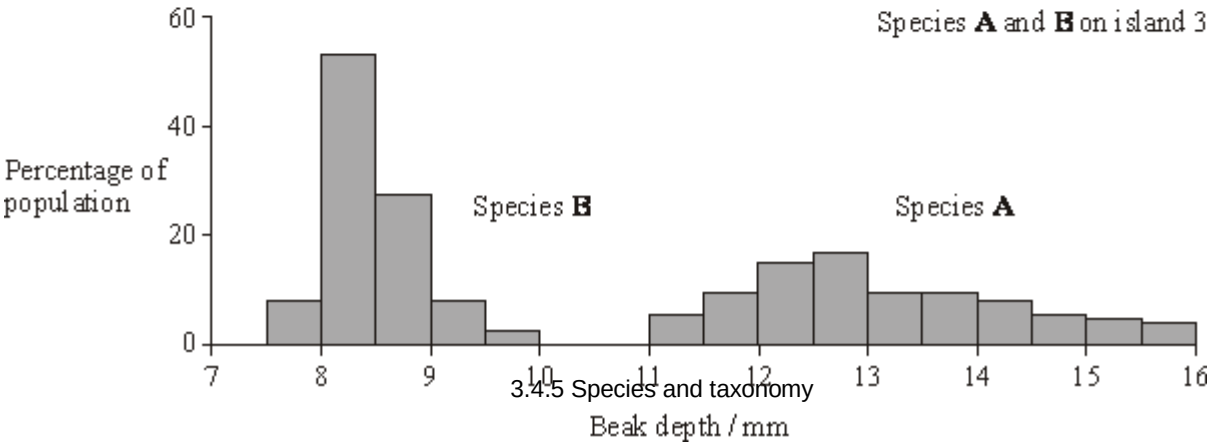
_____

(2)

(b) Measurements were made of the beak depth of two species of finch (species **A** and species **B**) on different islands. Species **A** is found on island 1, species **B** is found on island 2. Both species are found on island 3. They are thought to have colonised island 3 from islands 1 and 2 respectively. The graphs show the ranges of beak depths of the two species on the different islands.







What type of natural selection took place in the populations of both species after they hadcolonised island 3? Explain your answer.

_____

_____

_____

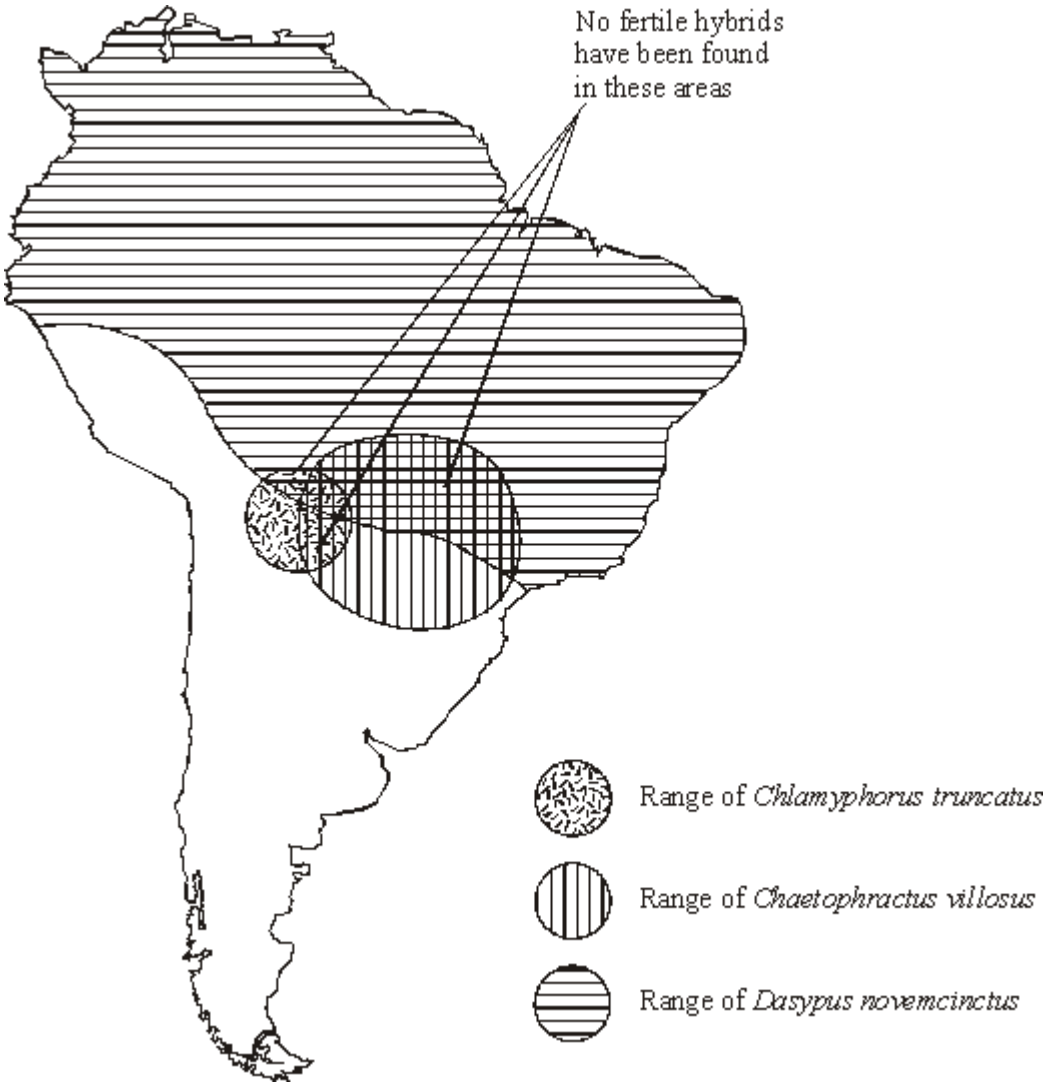
_____

_____

(3)

(Total 5 marks)

20 Armadillos are mammals. The map shows the ranges of three species of armadillo in South America.



(a) (i) What evidence in their ranges suggests that the three armadillos belong to differentspecies?

_____

_____

(1)

(ii) What further evidence would confirm that the three armadillos belong to different species?

_____

_____

(1)

(b) (i) Complete the table to show the classification of *Dasypus novemcinctus*.

Kingdom	
Phylum	Chordata
	Mammalia
	Xenarthra
	Dasypodidae
Genus	
Species	

(2)

(ii) What is the lowest taxonomic grouping that the three species of armadillos can share? Explain your answer.

_____

_____

_____

_____

(1)

(Total 5 marks)

21 (a) The cheetah, *Acinonyx jubatus*, and other cat species belong to the family Felidae. Complete the table to show the classification of the cheetah.

Kingdom	Animalia
	Chordata
	Mammalia
	Carnivora
Family	Felidae
Genus	

(2)

(b) This system of classification is described as hierarchical. Explain what is meant by a hierarchical classification.

_____

_____

(1)

(c) Despite differences in form, leopards, tigers and lions are classified as different species of the same genus. Cheetahs, although similar in form to leopards, are classified in a different genus.

(i) Describe **one** way by which different species may be distinguished.

_____

_____

(1)

(ii) Suggest **two** other sources of evidence which scientists may have used to classify cheetahs and leopards in different genera.

1. _____

_____

2. _____

_____

(2)

(Total 6 marks)

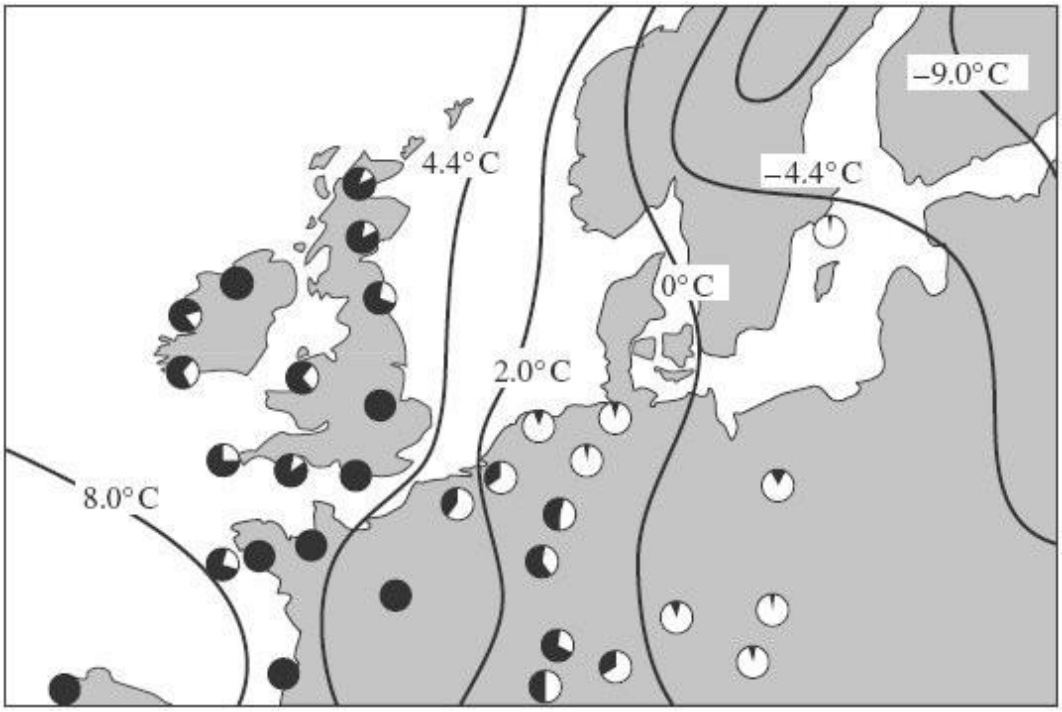
22 **S** Clover plants have leaves all through the year. Some clover plants have leaves that produce poisonous hydrogen cyanide gas when damaged. These cyanogenic plants are less likely to be eaten by snails. However, the leaves of these plants can be damaged by frost, resulting in the production of enough hydrogen cyanide to kill the plants. Acyanogenic plants do not produce hydrogen cyanide. This characteristic is genetically controlled.

The map shows the proportions of the two types of plant in populations of clover from different areas in Europe. It also shows isotherms, lines joining places with the same mean January temperature.

Key

Black area represents proportion of plants able to produce cyanide (cyanogenic)

White area represents proportion of plants not able to produce cyanide (acyanogenic)



(a) Explain how different proportions of cyanogenic plants may have evolved in populations indifferent parts of Europe.

(4)

(b) Differences in cyanide production may affect the total number of clover plants growing in different areas. Describe how you would use quadrats in an investigation to determine whether or not there is a difference in the number of clover plants in two large areas of equal size.

(4)

(Total 8 marks)

23 Lake Malawi in East Africa contains around 400 different species of cichlids which are small,brightly coloured fish. All these species have evolved from a common ancestor.

(a) Describe **one** way in which scientists could find out whether cichlids from two different populations belong to the same species.

(2)

(b) During the last 700 000 years there have been long periods when the water level was much lower and Lake Malawi split up into many smaller lakes. Explain how speciation of the cichlids may have occurred following the formation of separate, smaller lakes.

(4)

(c) Many species of cichlids are similar in size and, apart from their colour, in appearance. Suggest how the variety of colour patterns displayed by these cichlids may help to maintain the fish as separate species.

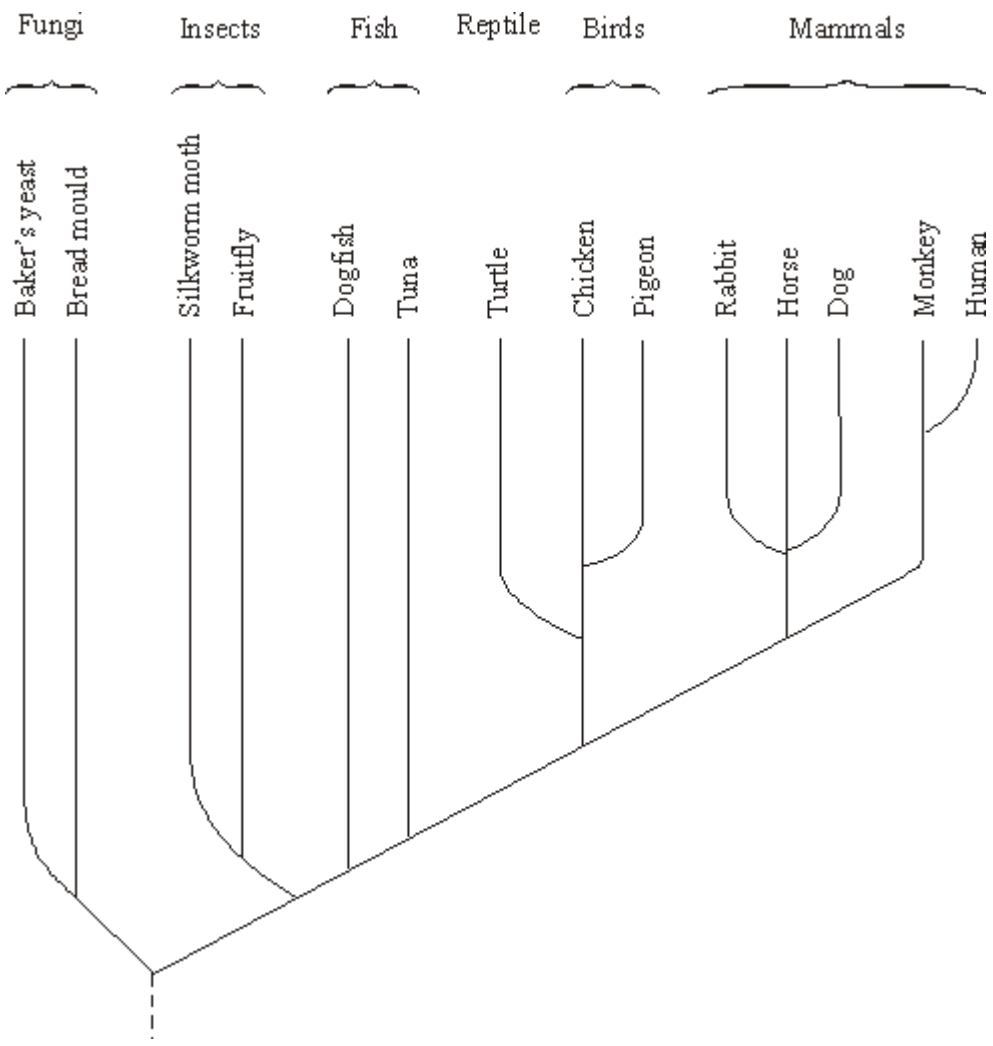
(2)

(Total 8 marks)

24 (a) Explain the principles which biologists use to classify organisms into groups.

(3)

Cytochrome c is a protein with about 100 amino acids and is present in all eukaryotic organisms. It has the same three-dimensional shape in all species, but only 30 of the amino acids are the same in all species. The amino acid sequence of cytochrome c has been used to construct the phylogenetic tree shown below.



(b) Name the kingdoms represented in this phylogenetic tree.

(1)

(c) What does the phylogenetic tree show about the evolutionary relationship between fungiand insects?

_____

_____

_____

_____

(2)

(d) Suggest how information on amino acid sequences is used to construct a phylogenetic tree.

_____

_____

_____

_____

(2)

(e) Suggest **one** advantage and **one** disadvantage of using cytochrome c to construct a phylogenetic tree.

Advantage

_____

_____

Disadvantage

_____

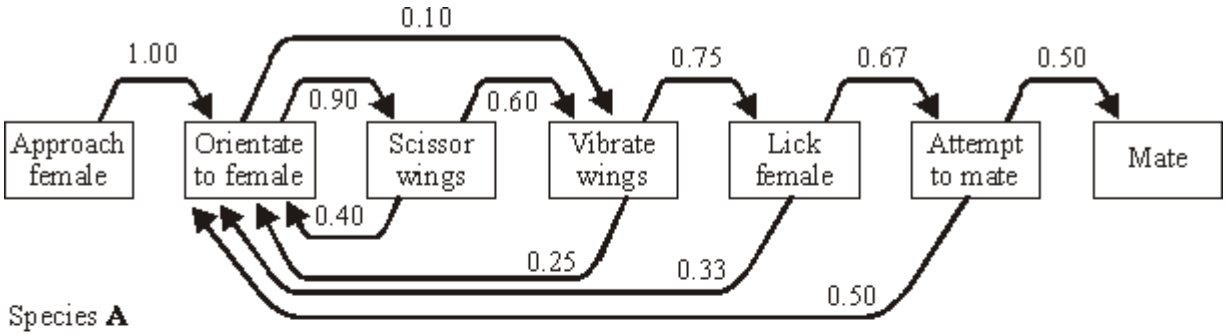
_____

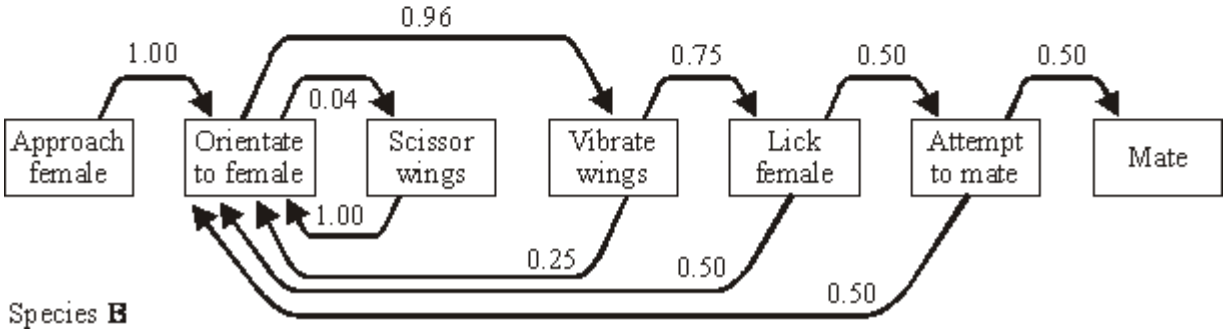
(2)

(Total 10 marks)

25 Courtship and mating in fruitflies can occur equally well in the light or dark.

The diagrams show the courtship sequence of males from two closely related species of fruitfly (species **A** and species **B**). The numbers show the probability of one courtship element following from another.





(a) Once a male of species **A** has orientated to the female, what is the probability that he will perform each courtship element once only and then attempt to mate?
Show your working.

Probability _____

(2)

(b) Suggest how the courtship sequences provide evidence to support the claim that the two species are

(i) closely related;

_____

_____

(1)

(ii) separate species.

_____

_____

(1)

(c) During courtship, vibration of the wings creates a sound. The sound is different in the two species of fruitfly. Explain how this prevents mating between members of different species.

_____

_____

_____

_____

(2)

(Total 6 marks)

26 (a) The mammals form a class called the Mammalia within the animal kingdom. The grey wolf is a species of mammal. **Figure 1** shows the groups within the Mammalia to which the wolf (labelled **W**) belongs.

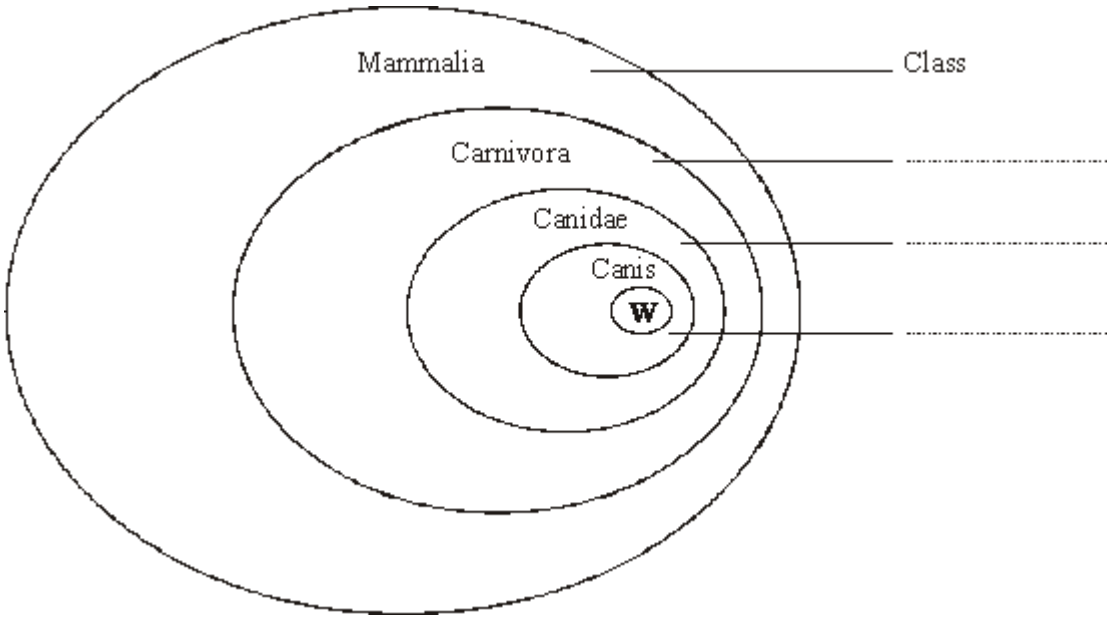


Figure 1

(i) Label **Figure 1** to show the names of the groups.

(2)

(ii) The lion, *Panthera leo*, belongs to another group in the Carnivora, called the Felidae. Add this information to **Figure 1**, using the letter L to represent the lion species.

(1)

(b) The diagrams show two systems of classification of mammals. **Figure 2** shows a simplehierarchy. **Figure 3** shows a phylogenetic system.

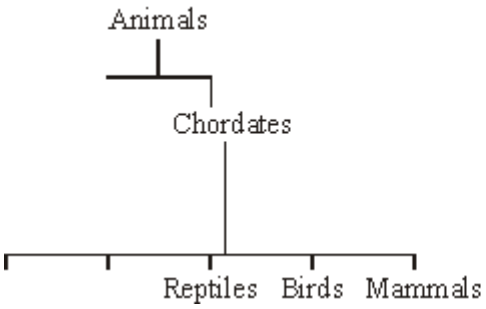


Figure 2

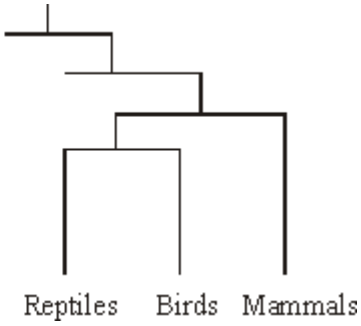


Figure 3

(i) What is meant by a hierarchy?

_____

_____

(1)

(ii) By reference to **Figures 2** and **3**, explain how a phylogenetic system differs from a simple hierarchy.

_____

_____

_____

_____

_____

_____

(3)

(Total 7 marks)

27 This question should be written in continuous prose, where appropriate.

Quality of Written Communication will be assessed in these answers.

(a) Use your knowledge of classification to arrange *class*, *phylum*, *genus* and *family* in order of decreasing number of species.

largest number of species | | | smallest number of species

_____ _____ _____ _____

(1)

(b) Cytochrome c is a protein involved in one of the reactions of aerobic respiration in a mitochondrion. The molecular structure of cytochrome c from different species has beenanalysed. More similarities are present in the structure of cytochrome c in closely relatedspecies than in distantly related species.

(i) Explain what is meant when two species are described as being *closely related*.

_____

_____

(1)

(ii) A difference in the molecular structure of cytochrome c may arise in a small population that becomes geographically isolated. Explain how the difference may arise and how it may spread in the population.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(Total 6 marks)

Mark schemes

1

(a) 1. Same genus;

2. Same evolutionary origin / common ancestor.

2

(b)

Taxon	Name of Taxon
Domain	Eukarya
Kingdom	Animalia
Phylum	Chordata
Class	Mammalia
Order	Rodentia
Family	Muridae

3 correct = 2 marks
2 correct = 1 mark
1 or 0 correct = 0 marks

2

(c) 1. (No) SDs of means of body sizes / sizes of parts of bodies overlap;

2. Calculation of correct head and body: tail ratios;

3. Almost identical, so same body shape / proportions;

3

(d) 1. Breed the two mice together;

2. (Same species) produce fertile offspring.

2

[9]

2

(a) 1. Kingdom, Phylum, Class, Order, Family;
2. *Luscinia svecica.*

1 mark for each correct column

Allow Genus and Species if both placed in box for species but not if both placed in genus box

2

(b) Number of different alleles of each gene.

Accept number of different base sequences (found) in each gene

1

(c) 1. Has greater proportion of genes / percentage of genes showing diversity;
2. Percentage is 35% compared with 28% / proportion is 0.35 compared with 0.28.

Allow correct figures that are not rounded up, i.e., 34.9% / 0.349 and 27.8% / 0.278

2

[5]

3

(a) PKNJ.

1

(b) Lutra lutra.

1

(c) Bone / skin / preserved remains / museums.

1

(d) 1. (Hunting) reduced population size(s), so (much) only few alleles left;

Accept bottleneck

2. Otters today from one / few surviving population(s);

Accept founder effect

3. Inbreeding.

*Allow any **two***

2 max

(e) 1. Population might have been very small / genetic bottleneck;
2. Population might have started with small number of individuals / by one pregnant female / founder effect;
3. Inbreeding.

*Allow any **two***

2 max

[7]

4

(a) 1. (So) age not a factor in female choice;

2. (So) will attract a mate;

3. (So similar) sexual maturity;

4. (So) have the correct feathers;

4. Accept 'have blue feathers'

2 max

(b) Number the birds, then numbers out of hat / random number generator;

Both aspects needed for mark

1

(c) 1. That movement was not related to some other factor (than the male);

2. That movement (towards the male) indicated mating behaviour;

3. (Females) only respond to throat feathers (of the male) / do not respond to other visual display / sounds / calls (by the male);

2 max

(d) 1. Change in sequence of bases / nucleotides;

2. (As a result of a) deletion / substitution;

3. Change in amino acid sequence / primary structure;

4. Change in tertiary structure of protein;

1. Do not accept 'change in the DNA sequence'

2. Accept e.g. addition / inversion / duplication / translocation

3

(e) Yes

1. (From resource A) birds can detect UV light;

2. (From resource B) difference between UVR and NR significant / not due to chance;

3. As error bars do not overlap;

*3 max if only **No** marks awarded*

2. Reject idea that 'results' in resource B are significant / not due to chance, must include idea of 'difference'

3. Reject 'as standard deviations do not overlap'

No

4. UV light may not be involved in mating / other factors may be involved in mating;

5. Some birds in UVR group were attractive to females;

6. (Experiment in resource B) carried out in artificial conditions / only 40 birds used / small sample size;

6. Neutral: idea that this is only one study / that there are no repeats

4 max

[12]

5 (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 whenno 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]

6 (a) (i) (Grouped according to) evolutionary links/history/relationships / common ancestry;

Ignore: closely related, factors, characteristics

Ignore: genetically similar

1

(ii) 1. Able to reproduce;

Accept: smallest taxonomic group/groups of organisms with same genes/ chromosomes/same number of chromosomes

Accept: breed for 'reproduce'

Ignore: mate

Reject: genetically identical

Ignore: similar genes/chromosomes

2. To produce fertile offspring;

Ignore: that are 'viable'

2

(b) Phylum
Class
Family
Genus;

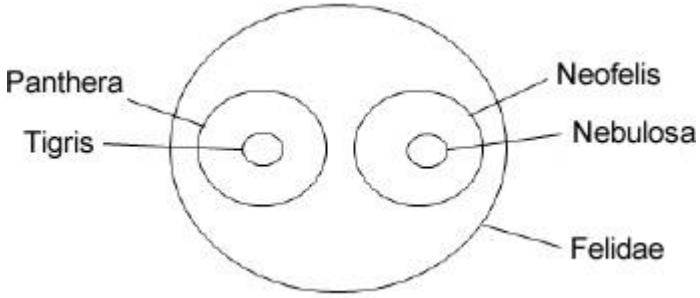
Accept: pleural answers phyla / genera / families

Accept phonetic answers phyllem/phylem/fylum/fyla/phylae/phyli /jenus/ jenera/familys

All 4 in correct order for 1 mark

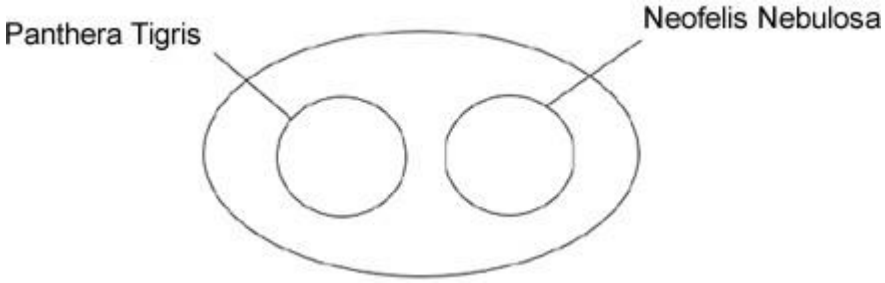
1

(c) 1. Two circles/with two inner circles with no overlap;



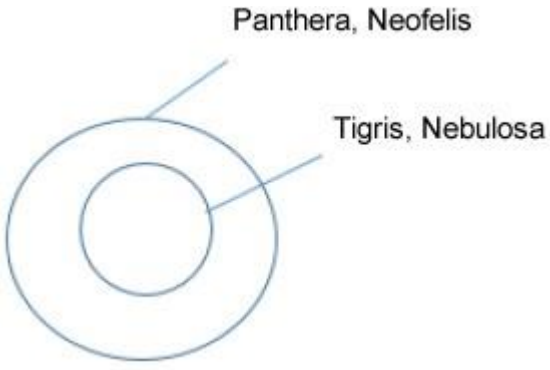
= 2 marks

OR



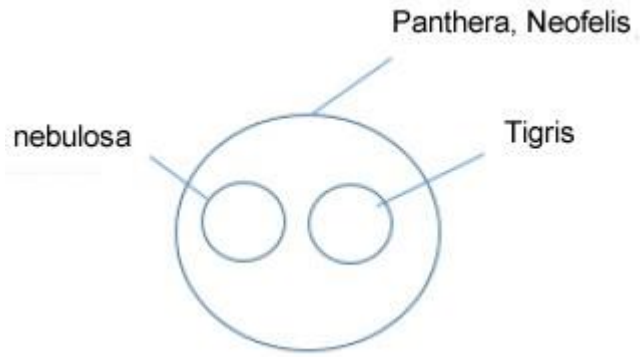
= 2 marks

OR



= 1 mark

OR



= 1 mark

2. Labels correct;

Ignore underlining / capitals

Accept: P tigris/ N nebulosa

Accept phonetic spelling

2

(d) 1. South China and Sumatran tigers share a more recent common ancestor;

Accept: more closely related (statement must be comparative)

Accept: a labelled hierarchy

2. (because) identical/same/matching (nucleotide) sequences;

Accept: converse for Siberian tiger eg Siberian is less closely related to South China AND Sumatran tigers

2

[8]

1

7 (a) Aves;

(b) Gallicolumba kubaryi;

Must have <u>both</u> words and in <u>this</u> order

Must be capital G

If starts with k, award mark as impossible to recognise difference

1

Ignore: underlining

Accept: phonetic spelling

Accept: G kubaryi (must be a capital / upper case G)

(c) No overlap.

1

[3]

8

(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]

9

(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]

10 (a) 1. No interbreeding / gene pools are separate / <u>geographic(al)</u> 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 <u>named</u> 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]

11 (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 / commonancestry;

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]

12 (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]

13

(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]

14

(a) Banding pattern changes as cheetah gets older / difficult to judge as tail is short / fluffy;

1

(b) (i) Mean not (always) a whole number;
Standard deviation not (always) zero;

2

(ii) Movement of tail / angle of sight / confused it with another band / subjective estimation;

*Accept reference to **Figure 1***

E.g. Bands 2 and 3 have same thickness but look different

1

(c) Band width not the same on both sides of tail;

1

(d) Offspring of the same family will be more similar genetically;As have same mother (and father) / parent;
Expect to see more differences in randomly chosen cheetahs; **3**

[8]

15

(a) (i) Phylum, Class, Order, Genus;

Mantophasma (M) / (Mantophasma) zephyra; **2**

(ii) Groups within (larger) groups;

No overlap; **2**

(b) Comparison of / look for similar features / structures / appearance; **1**

[5]

16

(a) Kingdom / phylum / class; **1**

(b) (i) 6; **1**

(ii) Family; **1**

(iii) The two species of *Mirounga* shared a common ancestor more recently than they did with *Monarchus tropicalis*; **1**

(c) Difference in DNA / base sequence / alleles / genes; **1**

[5]

17

(a) Table completed as below:

Kingdom	Animalia / Animals
Phylum	Chordata
Class	Mammalia
Order	Rodentia
Family	Caviidae
Genus	*Cavia*
Species	*porcellus*

Column 1 correct;
Column 2 correct; **2**

(b) Mutation occurs;

Correct e.g. of isolating mechanism
e.g.
temporal − different breeding seasons / feeding times /
ecological / behavioural − different courtship displays / different niches / habitats / feeding areas /
mechanical − mismatch of reproductive parts /
gamete incompatibility − sperm killed in female's reproductive tract /
hybrid inviability / hybrid infertility;
Ignore references to "genetic isolation" or "reproductive isolation"

Different selection pressures operate / changes in allele frequency / divergence of gene pools;

3

(c) Using candidate's symbols for alleles −
e.g. B = black, b = brown, S = short, s = long:

Parental genotypes <u>correct</u>: Male **A** SSBb Female **B** SsBB;

Gametes correctly <u>derived</u> from candidate's parental genotypes: SB Sb SB sB;

offspring genotypes correctly <u>derived</u> from candidate's suggested gametes − accept Punnett square or line diagram;

offspring genotypes <u>correct</u>: SSBB SsBB SSBb SsBb;

If monohybrid:cross ⇨ 0 marks

4

(d) There is no (significant) difference between observed and expected results / any difference is due to chance;

1

[10]

18 (i) Taxon **A** - there is more than one level / taxon below it / genus only has species / only has one level / taxon above it;

(ii) Taxon **C** - there is more than one level / taxon above it / phylum only has kingdom / only has one level taxon above it;

[2]

19 (a) group of organisms with
similar features; can (interbreed to)
produce fertile offspring; **2**

(b) directional selection;
any TWO from
selection against one extreme / for one extreme;
against broadest beaks in B and narrowest beaks
in **A** / for narrowest in **B** and broadest in **A**;
whole distribution / range / mean / mode / median is
shifted towards favoured extreme; **3 max**

[5]

20 (a) (i) there are no fertile hybrids found in the overlapping regions; **1**

(ii) even if mating took place, there would be no fertile hybrids /
different chromosome number / gene pool / evolutionary history / many morphological / biochemical / serological differences;

1

(b) (i)

Kingdom	**Animalia / Animals**
Phylum	Chordata
Class	Mammalia
Order	Xenarthra
Family	Dasypodidae
Genus	***Dasypus***
Species	***(D.) novemcinctus***
1 mark per correct column	

2

(ii) Family, as all three belong to different genera;

1

[5]

21 *(a)* phylum, class, order;
species, *Acinonyx jubatus;*

2

(b) larger groups containing smaller groups;

1

(c) (i) do not interbreed to produce fertile offspring / different DNA /different niches;

1

(ii) fossil record;
evolutionary history / phylogeny;
biochemical differences e.g. DNA / proteins / cytochromes;
homologous features / named feature;
karyotype / number and form of chromosomes;
(discount any example credited in (i))

2

[6]

22 (a) colder / below 0°C (January) areas, cyanogenic plants die in this cold / acyanogenic survive;
non-cyanogenic allele / gene passed on more often / its frequency increases;
warmer (January) areas cyanogenic plants at advantage,
because of less herbivore selection pressure / feeding;
so cyanogenic survive more often to pass on cyanogenic allele / gene.

4 max

(b) large (and equal) number of quadrats in each area;
(reject several)
random sampling method, described;
(accept described 'systematic' method)
percentage cover / point hits per quadrat / count plants;
mean / average value for each area;
statistics test to see if differences significant.

4 max

[8]

23 (a) breed together;
if fertile offspring, then same species;

2

(b) <u>isolation</u> of two populations;
variation already present due to mutations;

different environmental conditions / selection pressures leading to selection of different features and hence different alleles;
different frequency of alleles;
separate gene pools / no interbreeding;

4

(c) selection of mate dependent on colour pattern;
prevents interbreeding / keeps gene pools separate;

2

[8]

24

(a) large groups are divided
into smaller groups;(*not just 'hierarchical'*)
members of a group have features in common based on anatomy / fossils / embryology / DNA / specific aspect of cell biology / homologous structures;

reflects evolutionary history;

3

(b) fungi and animals;

1

(c) (insects and fungi) have common ancestor;
they diverged a long time ago / before others referred to in phylogenetic tree;

2

(d) those with similar sequences put in same groups / are more closely related;
the greater difference in amino acid sequence the longer ago the groups diverged;

2

(e) A - present in all (eukaryotic) species or organisms / quantifiable;
D - extinct species not considered / no timing of events available / only limited number of amino acid sequences / can't include prokaryotic species

2

[10]

25

(a) principle of sequential multiplication (0.9×0.6×0.75×0.67);
0.27;
(correct answer 2 marks)

2

(b) (i) similar sequence / actions / sign stimuli;

1

(ii) additional action in sequence(species A) / scissor wings blocks sequence in B;

1

(c) (acts as) sign stimulus;
responds only to species-specific sound;

2

[6]

26

(a) (i) Order, Family, Genus.
(all correct = 2 marks; 2 correct = 1 mark)

2

(ii) 3 concentric circles in Carnivora, labelled Felidae, Panthera and L;

1

(b) (i) large groups split into smaller groups (which do not overlap); **1**

(ii) (phylogenetic) based on evolutionary history;
shows ancestry of groups / points of divergence / example, e.g. reptiles and birds separated after mammals / reptiles and birds more closely related than mammals;
(hierarchical) based on shared characteristics (seen today); **3**

[7]

27 (a) phylum, class, family, genus; **1**

(b) (i) more recent common ancestor / DNA in common; **1**

(ii) mutation causes variation;
genes (coding) for protein / cytochrome c with different structures;
EITHER
individuals with a modified cytochrome c have a selective advantage / are selected for / these individuals are more likely to survive to have offspring / have more offspring;
(must link a comparison of survival to reproduction)

gene / allele frequency changes over generations / time;
OR
changed structure does not affect protein function;
these structural differences accumulate over time; **4**

[6]