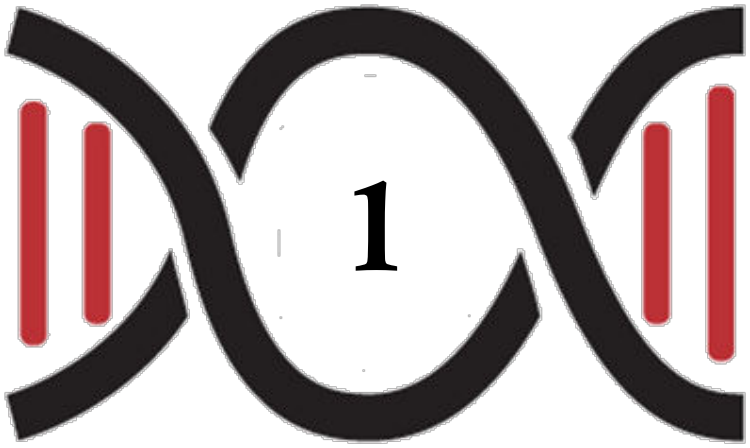
LONDON SCIENCE COLLEGE

AQA A2 BIOLOGY

TOPIC 7

GENETICS/POPULATION/EVOLUTION/ECOSYSTEMS



1 (a) What term is used to describe populations of different species living in the same habitat?

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(1)

(b) Different species occupy different ecological niches.

Explain the advantage of species occupying different niches.

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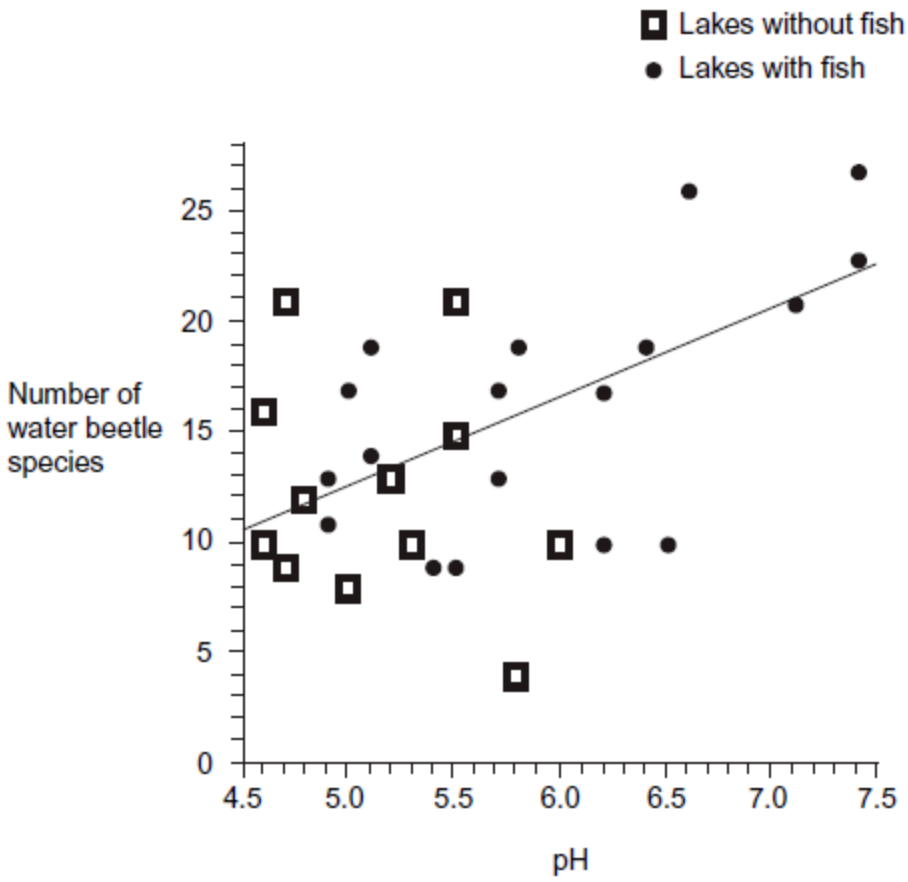
(1)

Scientists recorded the number of water beetle species in 30 lakes. In each lake, they measured the pH of the water and recorded whether there were any fish present.

The graph shows their results.



(c) A student concluded that a decrease in acidity caused an increase in the number of water beetle species.

Evaluate this conclusion.

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(3)

(d) Explain how the presence of fish in a lake could cause an increase in the number of water beetle species.

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(1)
(Total 6 marks)

2 (a) Explain what is meant by the term phenotype.

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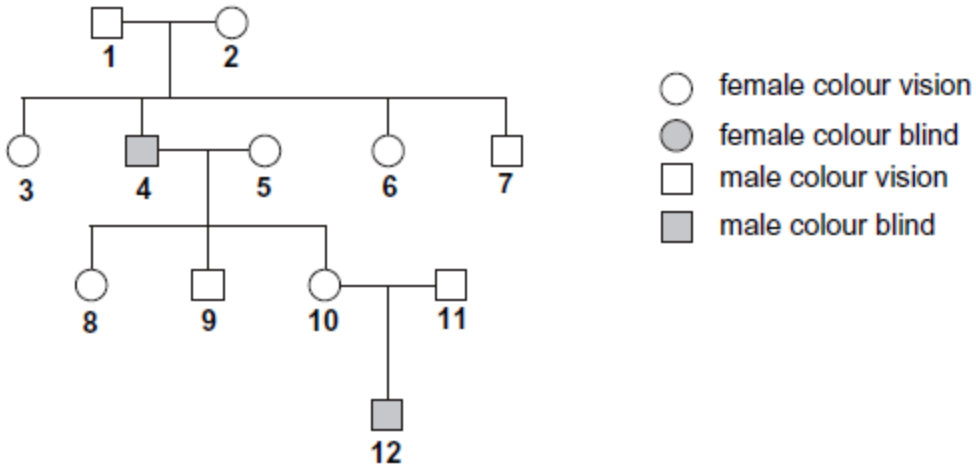
(2)

(b) One type of colour blindness is controlled by a gene carried on the X chromosome. The allele for this type of colour blindness, **b**, is recessive to the allele for colour vision, **B**.

The diagram shows the phenotypes in a family tree for this sex-linked condition.



(i) Explain **one** piece of evidence from the diagram which shows that colour blindness is recessive.

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(2)

(ii) Give the genotype of individual **8**.

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(1)

(c) (i) The allele for tongue-rolling, **T**, is dominant to the allele for non-tongue rolling, **t**.

The gene controlling tongue-rolling is **not** sex-linked. Individuals **10** and **11** are both heterozygous for tongue-rolling.

What is the probability that individuals **10** and **11** will produce a male child who is colour blind and a non-tongue roller?

Answer = ...

(2)

(ii) In a population, the frequency of the allele for tongue-rolling, **T**, is 0.4.

Use the Hardy-Weinberg equation to calculate the percentage of people in this population that are heterozygous for tongue-rolling.

Answer = ... %

(2)
(Total 9 marks)

3 There are nine subspecies of giraffe. These subspecies evolved when populations of giraffe were separated for long time periods. Each subspecies has distinct coloured skin markings. Some biologists have suggested that up to six of these subspecies should be classified as different species.

(a) Explain how different subspecies of giraffe may have evolved from a common ancestor. Use information from the passage in your answer.

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(5)

(b) Biologists compared the mitochondrial DNA of the different subspecies of giraffe. They used the results from comparing this DNA to conclude that six of the nine subspecies are separate species.

Suggest how they came to this conclusion.

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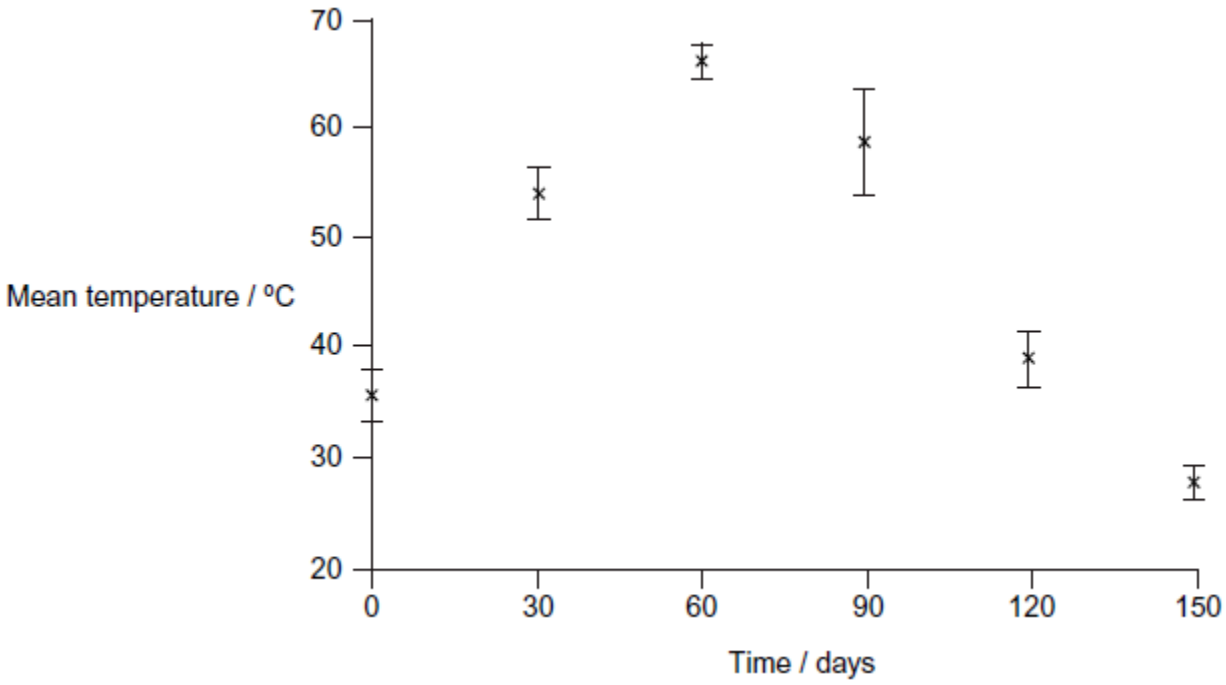
(2)
(Total 7 marks)

4 The organic material in household waste can be used to make compost for use as a fertiliser. Scientists investigated changes during one process used to make this compost. The method involved placing the waste in large containers for 150 days. At regular intervals the containers were rotated. The scientists measured the temperature of samples of waste during the investigation.

Figure 1 shows the results they obtained. The vertical bars show standard deviations.

Figure 1



(a) Explain how microorganisms contributed to the increase in temperature during processing of organic waste.

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(2)

(b) Explain the advantage of showing the data using standard deviations rather than ranges.

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(2)

(c) Suggest **two** advantages of rotating the containers during the process.

1 .....

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2 .....

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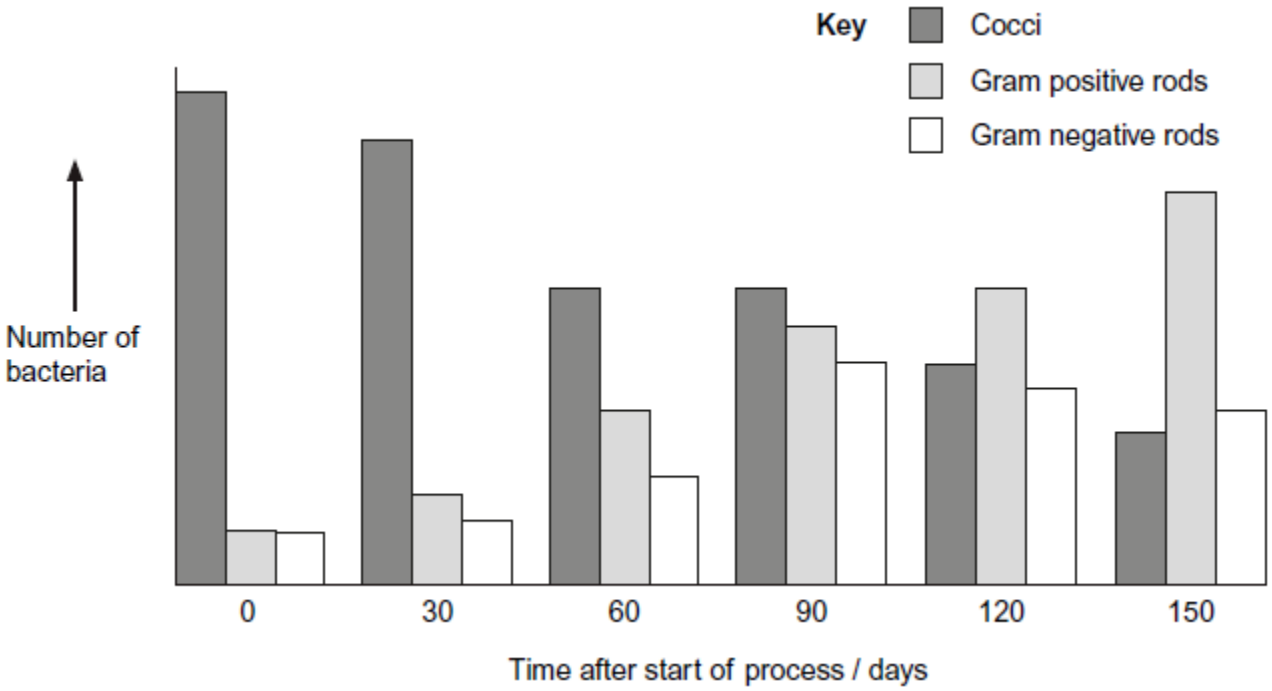
(2)

(d) The scientists took a sample of the waste at the start of the process. They then took samples every 30 days. In each sample, they determined the numbers of particular types of bacteria.
Figure 2 shows the changes in the number of three types of bacteria during the process.

Figure 2



The scientists concluded that the results in **Figure 1** and **Figure 2** are evidence for a form of succession during the process.

Use the information to suggest how they reached this conclusion.

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(3)
(Total 9 marks)

5 Algae are photosynthesising organisms. Some grow on rocky shores. Scientists investigated the abundance of different species of algae at two sites, **A** and **B**, on a rocky shore. Site **A** was on the upper shore and site **B** was on the lower shore. The diagram shows the location of sites **A** and **B** on the rocky shore.

Table 1 shows some of the results the scientists obtained.

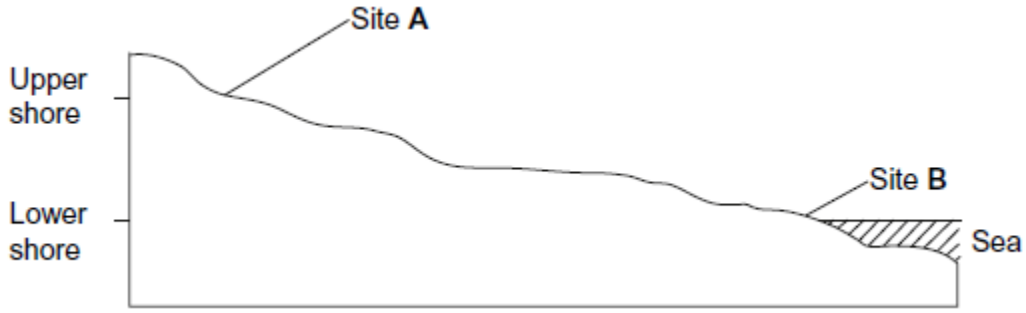

Table 1

	Site A **Upper shore**	**Site B** **Lower shore**
Species of algae with percentage cover more than 1%	*Gigartina leptorhynchos* *Gigartina canaliculata* *Gelidium coulteri* *Rhodoglossum affine*	*Gigartina spinosa* *Rhodoglossum affine* *Laurencia pacifica* *Gastroclonium coulteri* *Centroceros clavulatum* *Gigartina canaliculata* *Corallina vancouveriensis*

(a) The scientists recorded data from 40 large rocks at each site.

Describe **one** method that the scientists could have used to ensure that the large rocks were chosen without bias.

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(2)

(b) The scientists used percentage cover rather than frequency to record the abundance of algae present

Suggest why.

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(1)

(c) Apart from availability of water, describe and explain how **two** abiotic factors may have caused differences in the species of algae growing at sites **A** and **B**.

Factor 1 .....

Explanation .....

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Factor 2 .....

Explanation .....

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(2)

(d) Use the information provided in **Table 1** to explain why the diversity of consumers will be greater at site **B**.

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(2)

(e) The scientists also investigated the algae eaten by two consumers found on the rocky shore, the sea slug and the shore crab. The scientists carried out their investigation in a laboratory.

- They put each consumer into a separate tank through which aerated seawater flowed slowly.
- Each tank contained 5 grams of one species of alga.
- After 50 hours, they measured the mass of the alga remaining in each tank.
- They repeated this procedure several times using a different sea slug and a different shore crab each time.

The scientists then calculated the mean mass of each species of alga eaten by the consumers. They used a statistical test to determine the P value.

Table 2 shows some of the results they obtained.

Table 2

Species of alga	Mean mass eaten / g		P value
	Sea slug	Shore crab	
Laurencia pacifica	4.42	0.22	<0.01
Egregia leavigata	0.12	0.08	>0.05
Microcystis pyrifera	0.19	0.14	>0.05
Cystoseira osmondacea	0.17	0.04	<0.05

(i) The consumers were starved for 5 days before the investigation.

Explain why.

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(2)

(ii) The data in **Table 2** for the mean mass of alga eaten were adjusted for loss of mass by the alga due to respiration.

Suggest how the scientists were able to determine the loss of mass due to respiration of a sample of alga.

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(3)

(iii) Suggest what conclusions the scientists could have made from this investigation when using the probability values in **Table 2**.

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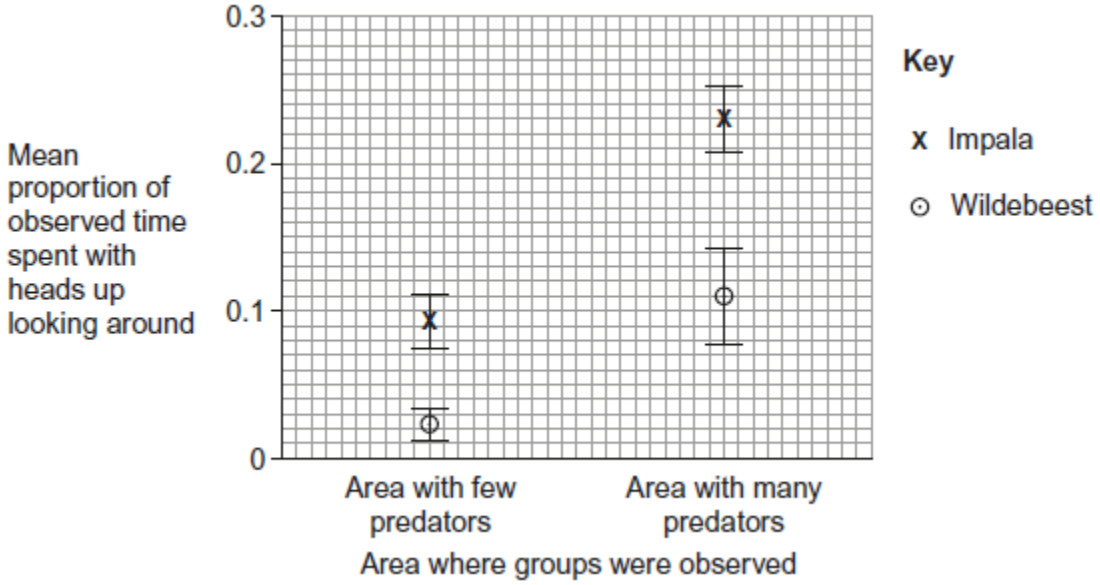
(3)
(Total 15 marks)

6 Impala and wildebeest are species of herbivore that live in large groups. They spend most of their time feeding with their heads near the ground.

Scientists investigated the relationship between the number of predators in an area and the mean proportion of time these herbivores spent with their heads up, looking around rather than feeding. They obtained data from groups of impala and wildebeest in two areas. In one area there were few predators and in the other area there were many predators.

The graph shows their results. The bars show standard deviations.



(a) The scientists observed both groups of animals for 75 hours.

Use data from the graph to calculate the difference in the mean number of hours spent by each species looking around in the area where there were **many** predators.

Show your working.

Difference ..... hours

(2)

(b) The scientists concluded that these herbivores spend more time looking for predators in areas where there are many predators.

Do these data support this conclusion? Give reasons for your answer.

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(4)

(c) The behaviour of the herbivores in having their heads up has a benefit but it also has costs. The benefit is being able to see, and escape from, predators.

Suggest and explain **one** cost to the herbivores of this behaviour.

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(2)
(Total 8 marks)

7 (a) What is the role of ATP in myofibril contraction?

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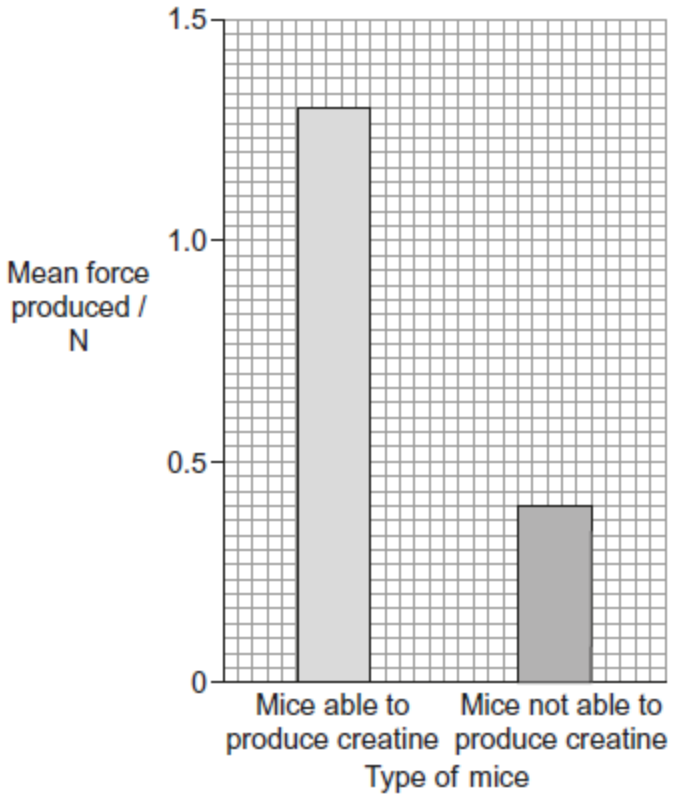
(2)

(b) Scientists investigated the effect of not being able to produce creatine on the force produced by muscle. They used mice with a mutation that made them not able to produce creatine.
The force produced when these mice gripped with their paws was compared with the force produced by normal mice that were able to produce creatine.

The graph shows the scientists' results.



(i) What was the percentage fall in the mean force produced by mice not able to produce creatine, compared with the normal mice? Show your working.

Answer ..... %

(2)

(ii) Suggest an explanation for these results.

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(2)

(c) The mice that were not able to produce creatine were homozygous for a recessive allele of a gene. Mice that are heterozygous for this allele are able to produce forces similar to those of normal mice that are homozygous for the dominant allele of the same gene.

Explain why the heterozygous mice can produce forces similar to those of normal mice.

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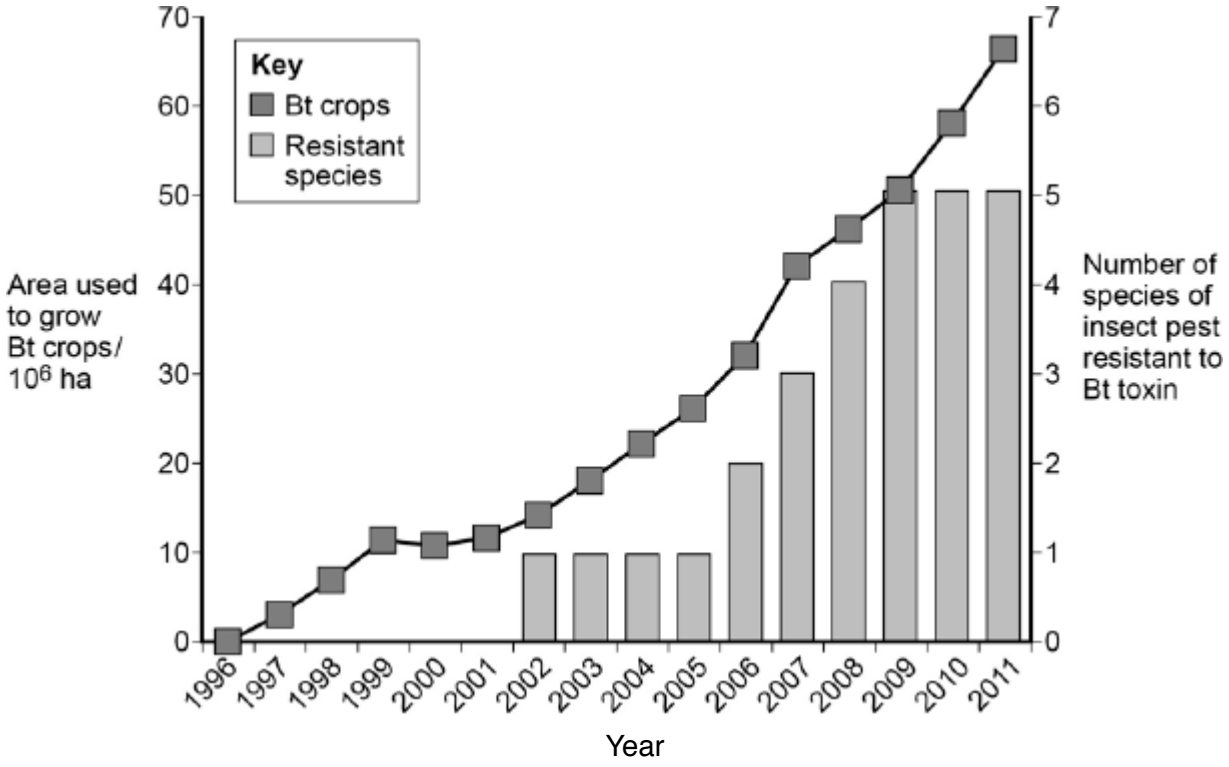
(2)
(Total 8 marks)

8 To reduce the damage caused by insect pests, some farmers spray their fields of crop plants with pesticide. Many of these pesticides have been shown to cause environmental damage.

Bt plants have been genetically modified to produce a toxin that kills insect pests. The use of Bt crop plants has led to a reduction in the use of pesticides.

Scientists have found that some species of insect pest have become resistant to the toxin produced by the Bt crop plants.

The figure below shows information about the use of Bt crops and the number of species of insect pest resistant to the Bt toxin in one country.



(a) Can you conclude that the insect pest resistant to Bt toxin found in the years 2002 to 2005 was the same insect species? Explain your answer.

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(1)

(b) One farmer stated that the increase in the use of Bt crop plants had caused a mutation in one of the insect species and that this mutation had spread to other species of insect. Was he correct? Explain your answer.

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(4)

(c) There was a time lag between the introduction of Bt crops and the appearance of the first insect species that was resistant to the Bt toxin.
Explain why there was a time lag.

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(3)
(Total 8 marks)

9 (a) In fruit flies, the genes for body colour and wing length are linked. Explain what this means.

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(1)

A scientist investigated linkage between the genes for body colour and wing length.
He carried out crosses between fruit flies with grey bodies and long wings and fruit flies with black bodies and short wings.

Figure 1 shows his crosses and the results.

- **G** represents the dominant allele for grey body and **g** represents the recessive allele for black body.
- **N** represents the dominant allele for long wings and **n** represents the recessive allele for short wings.

Figure 1

Phenotype of parents	grey body, long wings	×	black body, short wings
Genotype of parents	**GGNN**		**ggnn**
Genotype of offspring	**GgNn**		
Phenotype of offspring	all grey body, long wings		

These offspring were crossed with flies homozygous for black body and short wings.

The scientist's results are shown in **Figure 2**.

Figure 2

GgNn crossed with **ggnn**

	Grey body, long wings	**Black body, short wings**	**Grey body, short wings**	**Black body, long wings**
Number of offspring	975	963	186	194

(b) Use your knowledge of gene linkage to explain these results.

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(Extra space) .....

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(4)

(c) If these genes were **not** linked, what ratio of phenotypes would the scientist have expected to obtain in the offspring?

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(1)

(d) Which statistical test could the scientist use to determine whether his observed results were significantly different from the expected results?

Give the reason for your choice of statistical test.

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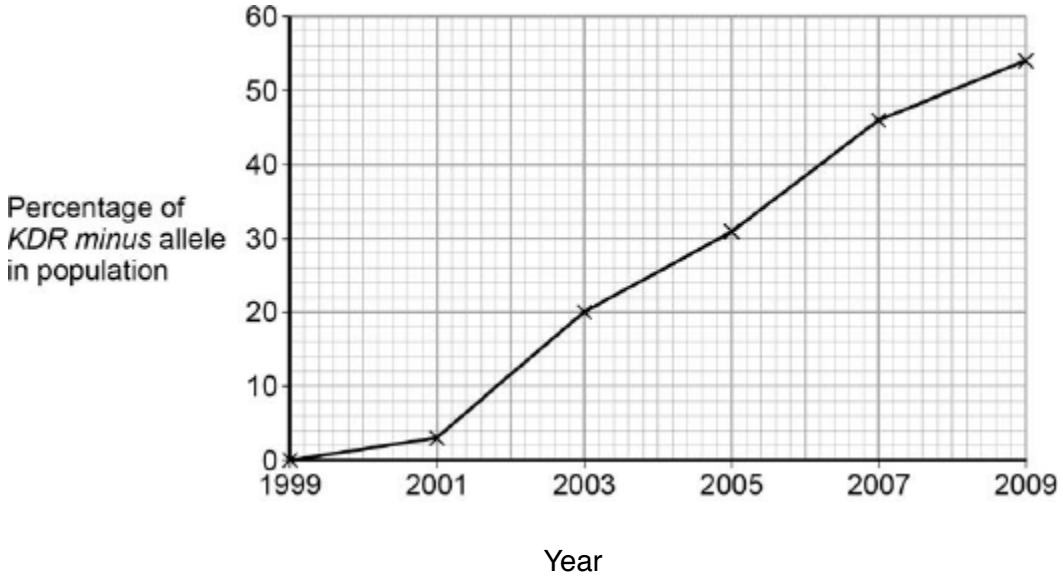
(2)
(Total 8 marks)

10 Malaria is a disease that is spread by insects called mosquitoes. In Africa, DDT is a pesticide used to kill mosquitoes, to try to control the spread of malaria.

Mosquitoes have a gene called *KDR*. Today, some mosquitoes have an allele of this gene, *KDR minus*, that gives them resistance to DDT. The other allele, *KDR plus*, does not give resistance.

Scientists investigated the frequency of the *KDR minus* allele in a population of mosquitoes in an African country over a period of 10 years.

The figure below shows the scientists' results.



(a) Use the Hardy–Weinberg equation to calculate the frequency of mosquitoes heterozygous for the *KDR* gene in this population in 2003.

Show your working.

Frequency of heterozygotes in population in 2003 .....

(2)

(b) Suggest an explanation for the results in the figure above.

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(Extra space) .....

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(4)

The *KDR plus* allele codes for the sodium ion channels found in neurones.

(c) When DDT binds to a sodium ion channel, the channel remains open all the time. Use this information to suggest how DDT kills insects.

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(2)

(d) Suggest how the *KDR minus* allele gives resistance to DDT.

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(2)
(Total 10 marks)

11 Read the following passage carefully.

A large and growing number of disorders are now known to be due to types of mitochondrial disease (MD). MD often affects skeletal muscles, causing muscle weakness.

We get our mitochondria from our mothers, via the fertilised egg cell. Fathers do not pass on mitochondria via their sperm. Some mitochondrial diseases are caused by mutations of mitochondrial genes inside the mitochondria. Most mitochondrial diseases are caused by mutations of genes in the cell nucleus that are involved in the functioning of mitochondria. These mutations of nuclear DNA produce recessive alleles.

One form of mitochondrial disease is caused by a mutation of a mitochondrial gene that codes for a tRNA. The mutation involves substitution of guanine for adenine in the DNA base sequence. This changes the anticodon on the tRNA. This results in the formation of a non-functional protein in the mitochondrion.

There are a number of ways to try to diagnose whether someone has a mitochondrial disease. One test involves measuring the concentration of lactate in a person's blood after exercise. In someone with MD, the concentration is usually much higher than normal. If the lactate test suggests MD, a small amount of DNA can be extracted from mitochondria and DNA sequencing used to try to find a mutation.

Use information in the passage and your own knowledge to answer the following questions.

(a) Mitochondrial disease (MD) often causes muscle weakness (lines 1–3). Use your knowledge of respiration and muscle contraction to suggest explanations for this effect of MD.

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(Extra space) .....

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(3)

Two couples, couple **A** and couple **B**, had one or more children affected by a mitochondrial disease. The type of mitochondrial disease was different for each couple.

None of the parents showed signs or symptoms of MD.

- Couple **A** had four children who were all affected by an MD.
- Couple **B** had four children and only one was affected by an MD.

(b) Use the information in lines 5–9 and your knowledge of inheritance to suggest why:

- all of couple **A**'s children had an MD
- only one of couple **B**'s children had an MD.

Couple **A** .....

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Couple **B** .....

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(Extra space) .....

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(4)

(c) Suggest how the change in the anticodon of a tRNA leads to MD (lines 10–13).

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(Extra space) .....

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(3)

(d) If someone has MD, the concentration of lactate in their blood after exercise is usually much higher than normal (lines 15–17). Suggest why.

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(Extra space) .....

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(3)

(e) A small amount of DNA can be extracted from mitochondria and DNA sequencing used to try to find a mutation (lines 18–19).

From this sample:

- how would enough DNA be obtained for sequencing?
- how would sequencing allow the identification of a mutation?

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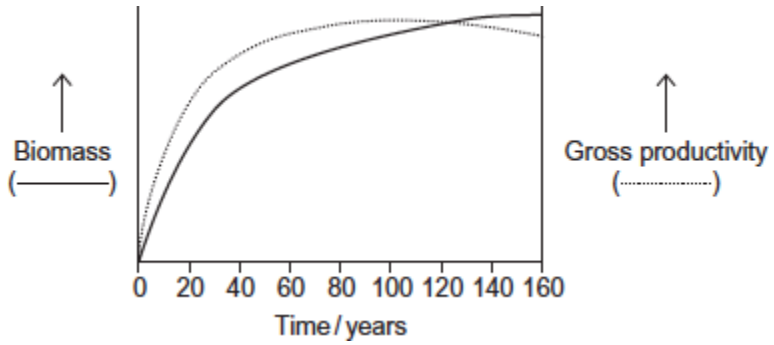
(2)
(Total 15 marks)

12 The graph shows how gross productivity and biomass in an area changed with time in the succession from bare soil to mature woodland.



(a) (i) Suggest appropriate units for gross productivity.

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(1)

(ii) Explain the decrease in gross productivity as the woodland matures.

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(2)

(b) Use your knowledge of succession to explain the increase in biomass during the first 20 years.

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[Extra space] .....

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(3)

(c) Use the information in the graph and your knowledge of net productivity to explain why biomass shows little increase after 100 years.

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(2)

(d) Suggest **one** reason for conserving woodlands.

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(1)
(Total 9 marks)

13 In cats, males are XY and females are XX. A gene on the X chromosome controls fur colour in cats. The allele **G** codes for ginger fur and the allele **B** codes for black fur. These alleles are codominant. Heterozygous females have ginger and black patches of fur and their phenotype is described as tortoiseshell.

(a) Explain what is meant by **codominant** alleles.

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(1)

(b) Male cats with a tortoiseshell phenotype do **not** usually occur. Explain why.

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(1)

(c) A tortoiseshell female was crossed with a black male. Use a genetic diagram to show all the possible genotypes and the ratio of phenotypes expected in the offspring of this cross.

Use $\mathbf{X^G}$ to indicate the allele **G** on an X chromosome.
Use $\mathbf{X^B}$ to indicate the allele **B** on an X chromosome.

Genotypes of offspring .....

Phenotypes of offspring .....

Ratio of phenotypes .....

(3)

(d) Polydactyly in cats is an inherited condition in which cats have extra toes. The allele for polydactyly is dominant.

(i) In a population, 19% of cats had extra toes. Use the Hardy-Weinberg equation to calculate the frequency of the recessive allele for this gene in this population. Show your working.

Answer = ...

(2)

(ii) Some cat breeders select for polydactyly. Describe how this would affect the frequencies of the homozygous genotypes for this gene in their breeding populations over time.

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(1)

(Total 8 marks)