A-level
BIOLOGY
(7402/2)
Paper 2

Specimen 2014 Session Time allowed: 2 hours

Materials
For this paper you must have:
- a ruler with millimetre measurements
- a calculator.

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the bottom of this page.
- Answer **all** questions.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 91.

Please write clearly, in block capitals, to allow character computer recognition.

Centre number ☐☐☐☐☐ Candidate number ☐☐☐☐

Surname ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

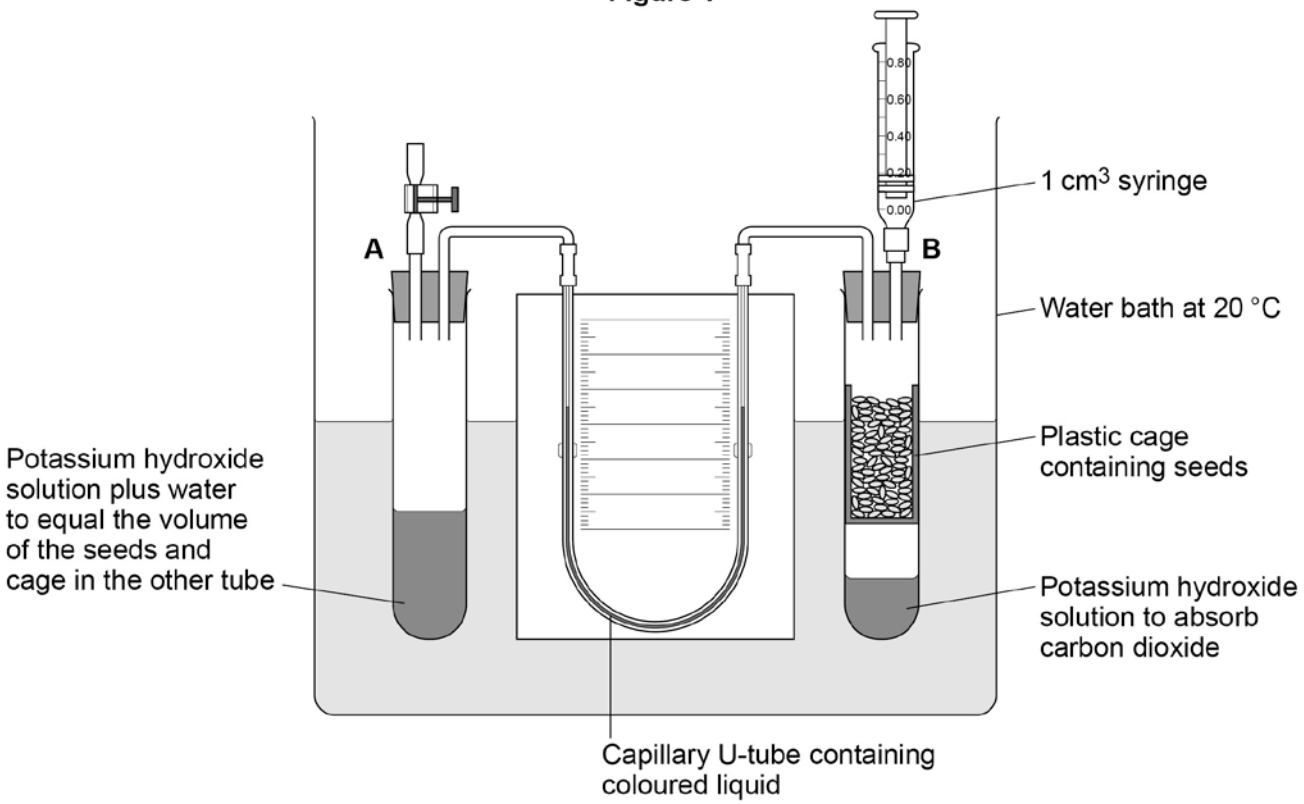
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Answer **all** questions in the spaces provided.

1 **Figure 1** shows the apparatus used for measuring the rate of oxygen consumption in aerobic respiration by seeds.

Figure 1



0 1 . 1 For the first 10 minutes, the tap attached to tube **A** was left open and the syringe from tube **B** was removed.

Suggest **three** reasons why the apparatus was left for 10 minutes.

[3 marks]

1 _____

_____

2 _____

_____

3 _____

_____

0 1 . 2 Suggest and explain why the chosen temperature was 20 °C for this experiment.

[2 marks]

Question 1 continues on the next page

After 10 minutes, the tap attached to tube **A** was closed and the syringe was attached to tube **B**. Every minute, the syringe plunger was moved until the levels in the U-tube were the same. The reading on the syringe volume scale was then recorded.

The results are shown in **Table 1**.

Table 1

Time / minutes	Reading on syringe volume scale / cm^3
0	0.84
1	0.81
2	0.79
3	0.76
4	0.73
5	0.70
6	0.68
7	0.66
8	0.63
9	0.62
10	0.58

0 1 . 3 During the experiment, the coloured liquid in the tubing moved towards tube **B**. Explain what caused this.

[3 marks]

[Extra space]

0 1 . 4 The mass of the seeds was 1.6 g. Use the information in **Table 1** to calculate the rate of oxygen consumption in $cm^3\,g^{-1}\,hour^{-1}$ by the seeds.

Show your working.

[2 marks]

Rate = _____ $cm^3\,g^{-1}\,hour^{-1}$

Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

0 2 . 1 Describe the roles of calcium ions and ATP in the contraction of a myofibril.

[5 marks]

[Extra space]

0 2 . 2 ATP is an energy source used in many cell processes. Give **two** ways in which ATP is a suitable energy source for cells to use.

[2 marks]

1

2

0 3 . 1 In fruit flies, the genes for body colour and wing length are linked. Explain what this means.

[1 mark]

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 2 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 2

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 3**.

Figure 3

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

0 3 . 2 Use your knowledge of gene linkage to explain these results.

[4 marks]

[Extra space]

0 3 . 3 If these genes were **not** linked, what ratio of phenotypes would the scientist have expected to obtain in the offspring?

[1 mark]

0 3 . 4 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.

[2 marks]

4 A biologist investigated the stimulation of a Pacinian corpuscle in the skin of a fingertip.
She used microelectrodes to measure the maximum membrane potential of a Pacinian corpuscle and its sensory neurone when different pressures were applied to the fingertip.

Figure 4 shows the Pacinian corpuscle, its sensory neurone and the position of the microelectrodes.

Figure 4

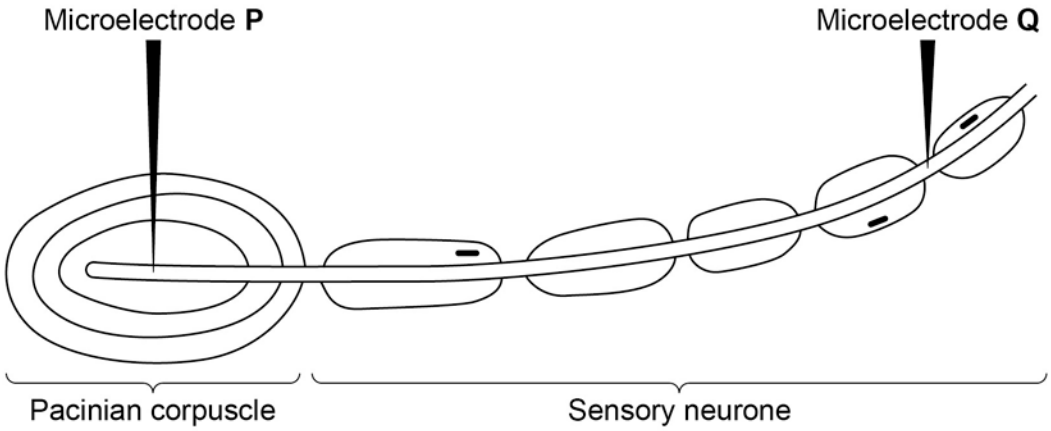


Table 2 shows some of the biologist's results.

Table 2

Pressure applied to the fingertip	Membrane potential at P / millivolts	Membrane potential at Q / millivolts
None	–70	–70
Light	–50	–70
Medium	+30	+40
Heavy	+40	+40

0 4 . 1 Explain how the resting potential of –70 mV is maintained in the sensory neurone when no pressure is applied.

[2 marks]

0 4 . 2 Explain how applying pressure to the Pacinian corpuscle produces the changes in membrane potential recorded by microelectrode **P**.

[3 marks]

[Extra space]

0 4 . 3 The membrane potential at **Q** was the same whether medium or heavy pressure was applied to the finger tip. Explain why.

[2 marks]

0 4 . 4 Multiple sclerosis is a disease in which parts of the myelin sheaths surrounding neurones are destroyed. Explain how this results in slower responses to stimuli.

[2 marks]

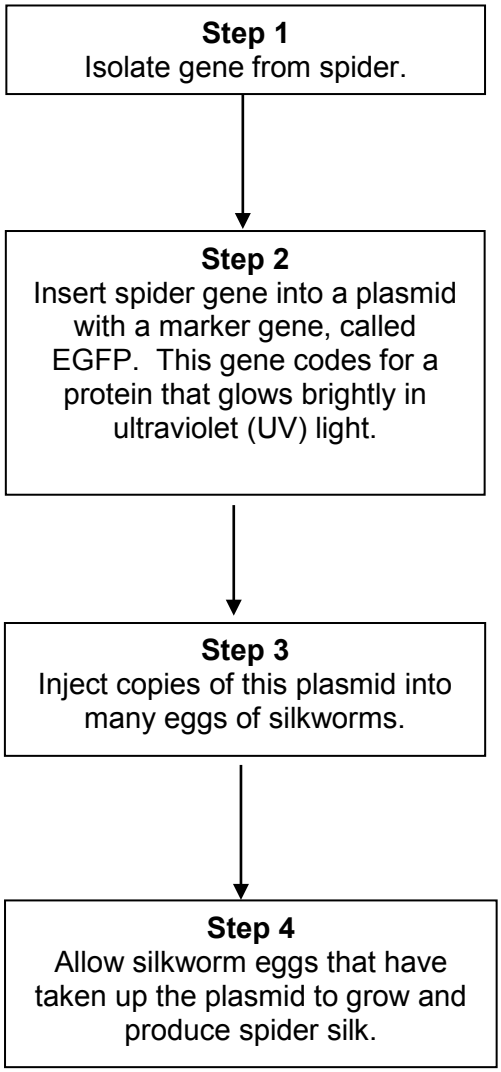
5 Silkworms secrete silk fibres, which are harvested and used to manufacture silk fabric.

Scientists have produced genetically modified (GM) silkworms that contain a gene from a spider.

The GM silkworms secrete fibres made of spider web protein (spider silk), which is stronger than normal silk fibre protein.

The method the scientists used is shown in **Figure 5**.

Figure 5



0 5 . 1 Suggest why the plasmids were injected into the eggs of silkworms, rather than into the silkworms**.**

[2 marks]

0 5 . 2 Suggest why the scientists used a marker gene and why they used the EGFP gene.

[2 marks]

The scientists ensured the spider gene was expressed only in cells within the silk glands.

0 5 . 3 What would the scientists have inserted into the plasmid along with the spider gene to ensure that the spider gene was only expressed in the silk glands of the silkworms?

[1 mark]

0 5 . 4 Suggest **two** reasons why it was important that the spider gene was expressed only in the silk glands of the silkworms.

[2 marks]

1

2

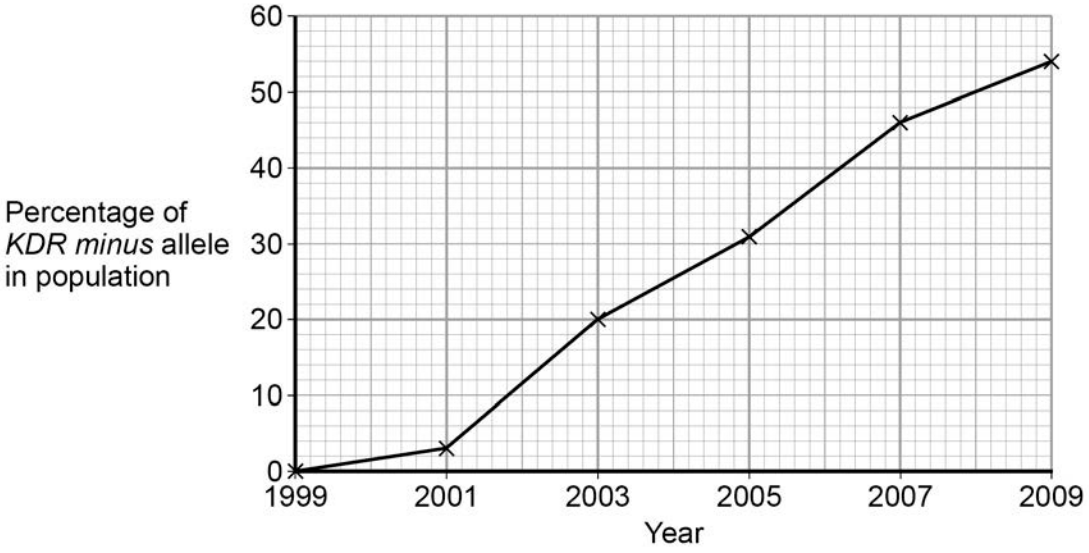
6 Malaria is a disease that is spread by insects called mosquitoes. In Africa, DDT is a pesticide used to kill mosquitoes, to try to control the spread of malaria.

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.

Figure 6 shows the scientists' results.

Figure 6



0 6 . 1 Use the Hardy–Weinberg equation to calculate the frequency of mosquitoes heterozygous for the *KDR* gene in this population in 2003.

Show your working.

[2 marks]

Frequency of heterozygotes in population in 2003 _____

0 6 . 2 Suggest an explanation for the results in **Figure 6.**

[4 marks]

[Extra space]

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

0 6 . 3 When DDT binds to a sodium ion channel, the channel remains open all the time. Use this information to suggest how DDT kills insects.

[2 marks]

0 6 . 4 Suggest how the *KDR minus* allele gives resistance to DDT.

[2 marks]

7 Osmoreceptors are specialised cells that respond to changes in the water potential of the blood.

0 7 . 1 Give the location of osmoreceptors in the body of a mammal.

[1 mark]

0 7 . 2 When a person is dehydrated, the cell volume of an osmoreceptor decreases. Explain why.

[2 marks]

0 7 . 3 Stimulation of osmoreceptors can lead to secretion of the hormone ADH. Describe and explain how the secretion of ADH affects urine produced by the kidneys.

[4 marks]

[Extra space]

The efficiency with which the kidneys filter the blood can be measured by the rate at which they remove a substance called creatinine from the blood. The rate at which they filter the blood is called the glomerular filtration rate (GFR).

In 24 hours, a person excreted 1660 mg of creatinine in his urine. The concentration of creatinine in the blood entering his kidneys was constant at 0.01 mg cm^{-3}.

0 7 . 4 Calculate the GFR in cm^3 $minute^{-1}$.

[1 mark]

Answer = _____

0 7 . 5 Creatinine is a breakdown product of creatine found in muscle tissues. Apart from age and gender, give **two** factors that could affect the concentration of creatinine in the blood.

[1 mark]

1 _____

2 _____

Turn over for the next question

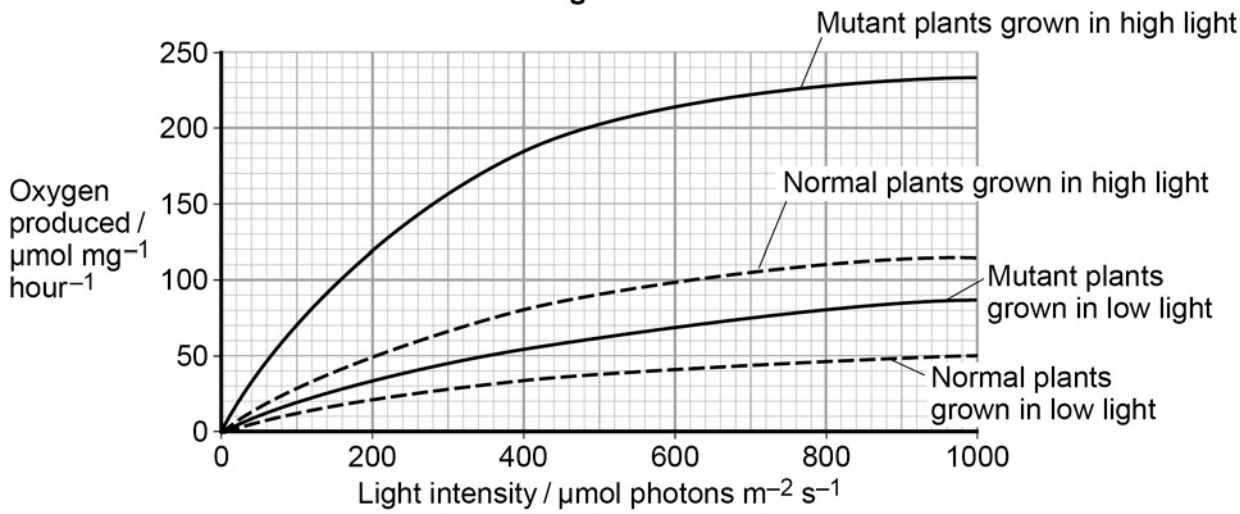
8 Chloroplasts contain chlorophyll a and chlorophyll b. Scientists found tobacco plants with a mutation that caused them to make more chlorophyll b than normal tobacco plants. They investigated the effect of this mutation on the rate of photosynthesis.

The scientists carried out the following investigation.

- They grew normal and mutant tobacco plants. They grew some of each in low light intensity and grew others in high light intensity.
- They isolated samples of chloroplasts from mature plants of both types.
- Finally, they measured oxygen production by the chloroplasts they had isolated from the plants.

Figure 7 shows the scientists' results.

Figure 7



0 8 . 1 Explain why the scientists measured the rate of production of oxygen in this investigation.

[2 marks]

In each trial, the scientists collected oxygen for 15 minutes.

0 8 . 2 Calculate the difference in the oxygen produced by the chloroplasts from mutant plants grown in low and high light intensities at a light intensity of 500 µmol photons m^{-2} s^{-1} during these trials.

Show your working.

[2 marks]

Difference _____ µmol O_2 mg^{-1}

0 8 . 3 The scientists suggested that mutant plants producing more chlorophyll b would grow faster than normal plants in all light intensities.

Explain how these data support this suggestion.

[4 marks]

[Extra space] _____

0 9 . 1 Explain how the methylation of tumour suppressor genes can lead to cancer.

[3 marks]

[Extra space]

Scientists investigated a possible relationship between the percentage of fat in the diet and the death rate from breast cancer in women from 10 countries.

Their data is shown in **Table 3**.

Table 3

Percentage of fat in diet of population	Death rate of women from breast cancer per 100 000 women
9.5	1.5
15.0	7.0
20.0	12.0
25.0	9.0
32.0	15.0
35.0	8.0
35.0	20.0
40.5	18.0
43.0	24.0
45.0	26.0

0 9 . 2 Describe how you would plot a suitable graph of these data. Explain your choice of type of graph.

[3 marks]

[Extra space]

0 9 . 3 What can you conclude from these data?

[2 marks]

Turn over for the next question

1 0 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.

1 0 . 1 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.

[3 marks]

[Extra space]

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.

1 0 . 2 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.

[4 marks]

Couple **A** _____

_____

_____

_____

Couple **B** _____

_____

_____

_____

[Extra space] _____

_____

_____

_____

Question 10 continues on the next page

1 0 . 3 Suggest how the change in the anticodon of a tRNA leads to MD (lines 10–13).

[3 marks]

[Extra space]

1 0 . 4 If someone has MD, the concentration of lactate in their blood after exercise is usually much higher than normal (lines 15–17). Suggest why.

[3 marks]

[Extra space]

1 0 . 5 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?

[2 marks]

END OF QUESTIONS

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