Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____

A-level
BIOLOGY

Paper 2

Monday 11 June 2018 Afternoon Time allowed: 2 hours

Materials

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

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the space provided. Do not write outside the box around each page or on blank pages.
- Show all your working.
- Do all rough work in this book. Cross through any work you do not want to be marked.

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

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
TOTAL	

Do not write outside the box

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

0 1 Heat stress is a condition that often occurs in plants exposed to high temperatures for a prolonged period of time. Heat stress is a major factor in limiting the rate of photosynthesis.

0 1 . 1 Heat stress decreases the light-dependent reaction of photosynthesis.

Explain why this leads to a decrease in the **light-independent reaction**.

[2 marks]

0 1 . 2 Another effect of heat stress is a decrease in the activity of the enzyme rubisco. A decrease in the activity of an enzyme means that the rate of the reaction it catalyses becomes slower.

A decrease in the activity of the enzyme rubisco would limit the rate of photosynthesis.

Explain why.

[2 marks]

0 1 . 3 Where precisely is rubisco found in a cell?

[1 mark]

Do not write outside the box

Scientists investigated the effect of temperature on the activity of two enzymes isolated from the leaf cells of cotton plants.

- Rubisco
- Rubisco activase – an enzyme that activates rubisco

Figure 1 and **Figure 2** show their results.

Figure 1

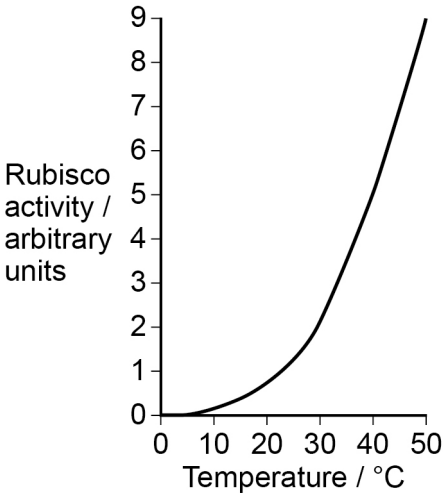
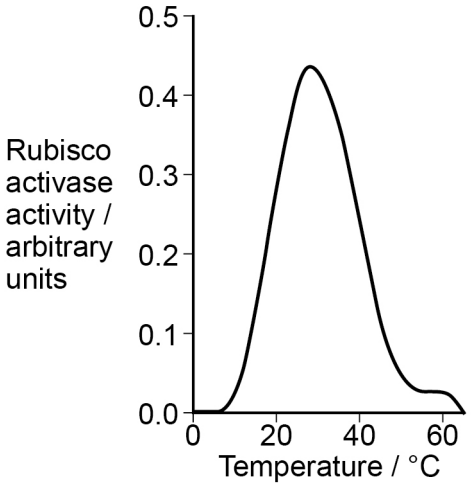


Figure 2



0 1 . 4 The scientists concluded that heat stress reduces the activity of rubisco in plant leaves by affecting rubisco activase.

Use all the information to evaluate their conclusion.

[4 marks]

9

Turn over ►

Do not write outside the box

0 2 . 1 There are different types of gene mutation.

Put a tick (✓) in the box next to the statement which describes **incorrectly** the effect of the mutation in an exon of a gene.

[1 mark]

A substitution may not result in a change to the encoded amino acid. ☐

An inversion will result in a change in the number of DNA bases. ☐

A deletion will result in a frame shift. ☐

An addition will result in a frame shift. ☐

0 2 . 2 Describe how alterations to tumour suppressor genes can lead to the development of tumours.

[3 marks]

Do not write outside the box

0 2 . 3 A type of malignant tumour cell divides every 8 hours.

Starting with one of these cells, how many tumour cells will be present after 4 weeks?
Assume none of these cells will die.

Give your answer in standard form.

[2 marks]

Answer = _____

6

Turn over for the next question

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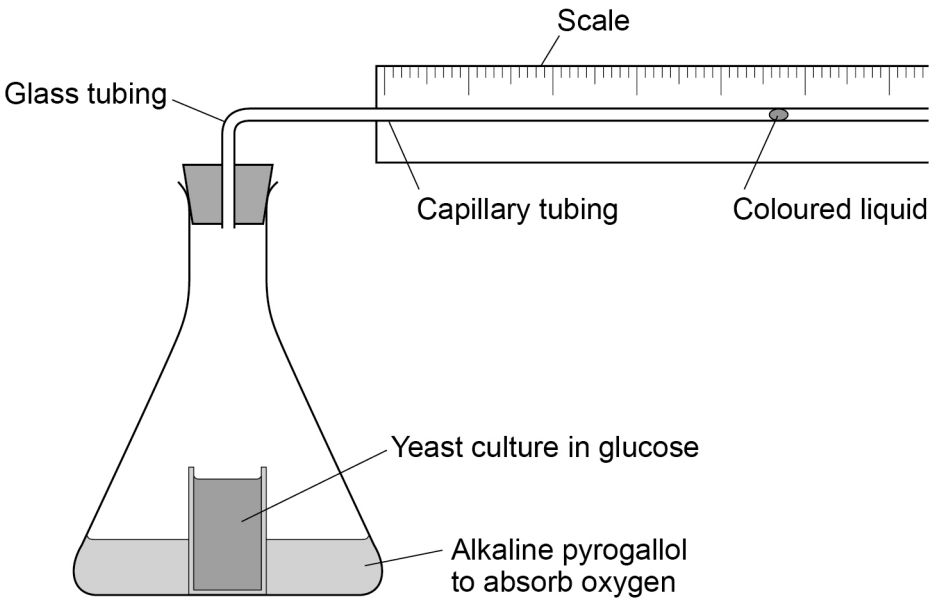
0 3 Yeast cells can respire aerobically or anaerobically. A student used the apparatus shown in **Figure 3** to measure the rate of respiration in yeast.

She:

- positioned the flask in a water bath so that the yeast culture reached a constant temperature
- then left the apparatus for one hour before starting her investigation.

Figure 3



0 3 . 1 Suggest **one** reason why it was important that the student left the apparatus for one hour after the yeast culture reached a constant temperature.

[1 mark]

_____

_____

Do not write outside the box

0 3 . 2 During her investigation, the coloured liquid moved to the right.

Explain why it moved to the right.

[2 marks]

0 3 . 3 The student found that the coloured liquid moved 1.5 cm in 24 hours. The diameter of the lumen (hole) of the capillary tubing was 1 mm.

The volume of a capillary tubing is given by $\pi r^2 l$, where π is 3.14 and l = length.

Calculate the volume of gas produced in cm^3 $hour^{-1}$.
Show your working.

[2 marks]

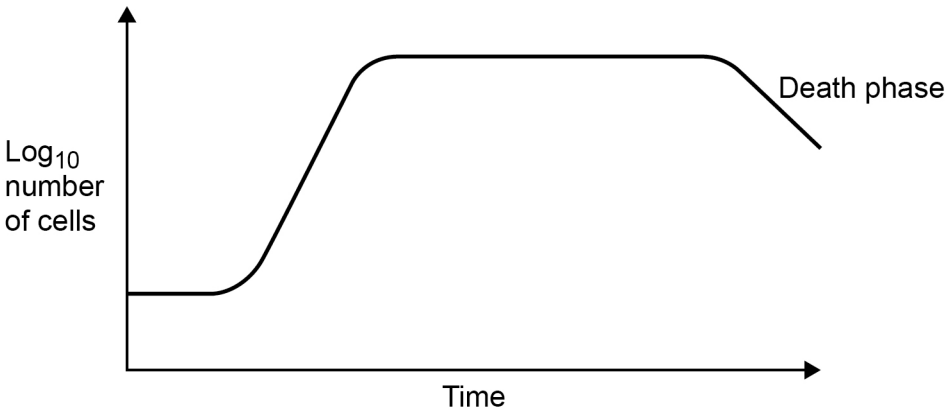
Answer = _____ cm^3 $hour^{-1}$

Turn over ►

Do not write outside the box

Figure 4 shows a typical population growth curve for yeast under laboratory conditions.

Figure 4



0 3 . 4 Explain why a log scale is used to record the number of cells.

[1 mark]

0 3 . 5 Many yeast cells die during the death phase.

Suggest **one** reason why.

[1 mark]

Do not write outside the box

0 3 . 6 The following equation can be used to make predictions of the growth in the population of yeast cells under ideal laboratory conditions.

$$\mathbf{X_t = X_0\, e^{rt}}$$

X_t = the population after a certain time
X_0 = the population at the start
e = 2.72 (base of natural logarithm)
r = growth rate
t = time period in hours over which r applies

A population of 2000 yeast cells was left for 10 hours.
The value for the growth rate was 0.5

Assuming no yeast cells died, calculate the predicted size of the population after 10 hours. Show your working.

[2 marks]

Answer = _____

9

Turn over for the next question

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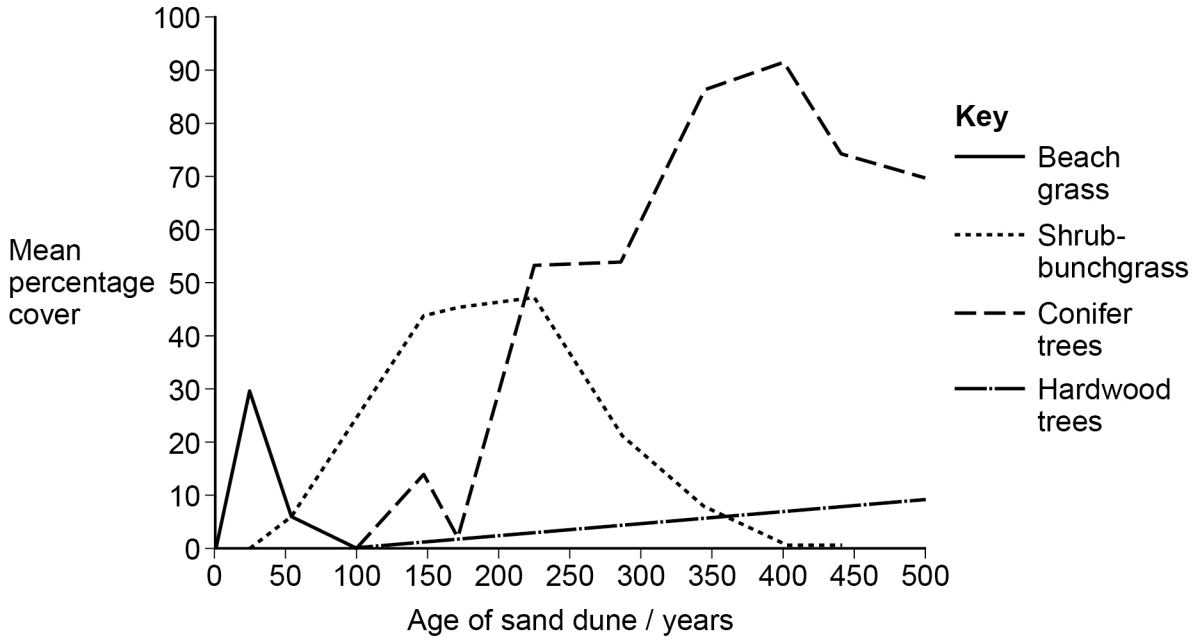
0 4 Scientists investigated the process of succession on sand dunes. They measured the percentage cover of different species of plants on sand dunes of different ages. Some of the results the scientists obtained are shown in **Figure 5**.

Figure 5



0 4 . 1 Describe how you would determine the mean percentage cover for beach grass on a sand dune.

[3 marks]

Do not write outside the box

0 4 . 2 The scientists concluded that the results shown in **Figure 5** were due to succession taking place.

Use **Figure 5** to explain why the scientists reached this conclusion.

[4 marks]

Question 4 continues on the next page

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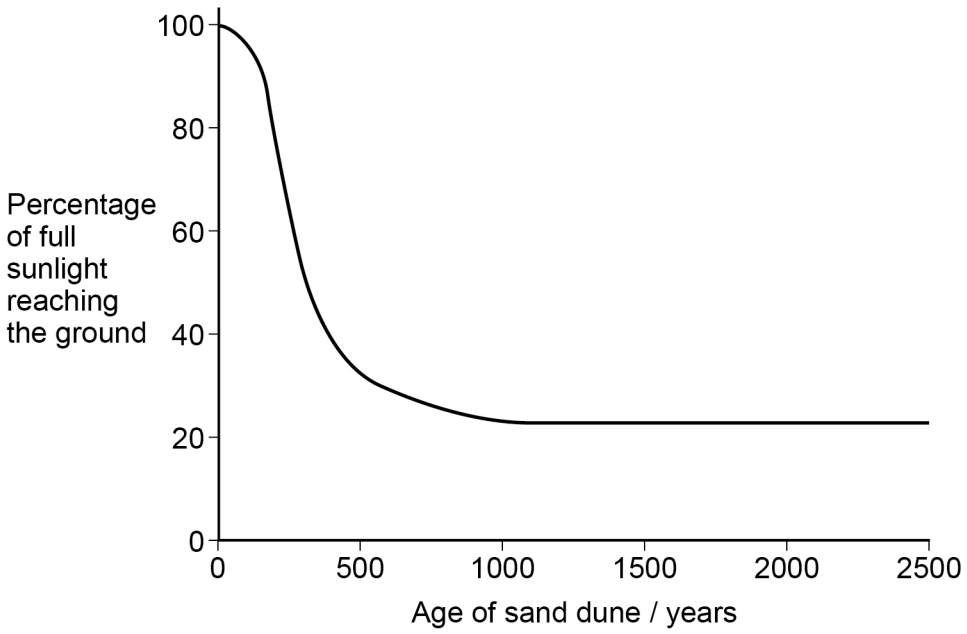
The scientists also investigated how the proportion of sunlight reaching the ground changed during succession. Some of the results the scientists obtained are shown in **Figure 6**.

Figure 6



0 4 . 3 Use **Figure 5** to explain the results in **Figure 6**.

[1 mark]

0 4 . 4 Using evidence from **Figure 6**, what can you conclude about the net primary productivity (NPP) in the sand dunes that are older than 1000 years?

Explain your answer.

[2 marks]

10

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0 5 Furosemide and CVT are drugs used to remove excess fluid from the body. Scientists investigated the effect of these drugs on the volume of urine produced by human volunteers. The scientists used the following method.

- They divided volunteers into three groups, **A**, **B** and **C** at random.
- They gave all the volunteers the same food for 3 days.
- After 3 days, they gave the volunteers in group **A** a tablet containing furosemide, the volunteers in group **B** a tablet containing CVT and the volunteers in group **C** a placebo (a tablet that did **not** contain either drug).
- They then found the mean volume of urine produced by each group in the 4 hours after taking the tablets.

Some of the results the scientists obtained are shown in **Table 1**.
A value of ± 2 standard deviations from the mean includes over 95% of the data.

Table 1

Group	**Mean volume of urine produced in 4 hours / cm^3 (± 2 standard deviations)**
A (furosemide)	1980 (± 152)
B (CVT)	1201 (± 119)
C (placebo)	312 (± 57)

0 5 . 1 All the volunteers were given the same food for 3 days.

Suggest and explain **one** reason why they were given the same food.

[2 marks]

Do not write outside the box

0 5 . 2 Using **Table 1**, what can you conclude about the effectiveness of furosemide and CVT in the removal of excess fluid from the body?

[2 marks]

0 5 . 3 Furosemide is sometimes used to treat high blood pressure.

Suggest how furosemide would cause a decrease in blood pressure.

[1 mark]

0 5 . 4 Furosemide inhibits the absorption of sodium and chloride ions from the filtrate produced in the nephrons.

Explain how furosemide causes an increase in the volume of urine produced.

[3 marks]

Do not write outside the box

The scientists also measured the mean rate of flow of blood plasma into the kidneys.

The results the scientists obtained are shown in **Table 2**.

Table 2

Group	**Mean rate of flow of blood plasma into the kidneys / cm^3 min^{-1}**
A (furosemide)	380
B (CVT)	342
C (placebo)	295

0 5 . 5 The mean rate of flow of blood plasma is 60% of the mean rate of blood flow into the kidneys.

How much greater is the flow of blood into the kidneys with furosemide than with group **C** (placebo) over the 4 hours of the investigation? Give your answer in cm^3.

[1 mark]

Answer = _____ cm^3

9

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0 6 . 1 In genetic crosses, the observed phenotypic ratios obtained in the offspring are often **not** the same as the expected ratios.

Suggest **two** reasons why.

[2 marks]

1 _____

_____

2 _____

_____

In tomato plants, the genes for height and for the type of leaf are on the same homologous pair of chromosomes. The allele **T**, for a tall plant, is dominant to the allele **t**, for a dwarf plant. The allele **M**, for normal leaves, is dominant to the allele **m**, for mottled leaves.

A biologist carried out crosses between parent plants heterozygous for both genes and examined the offspring produced. The position of the two alleles for both genes was the same in each parent plant as shown in **Figure 7**. The phenotypes and number of offspring produced are shown in **Table 3**.

Figure 7

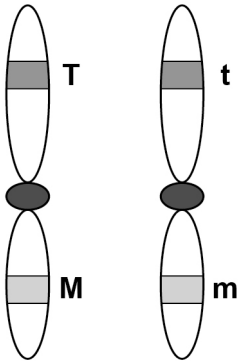

Table 3

Phenotype of offspring	Number of offspring
Tall plants and normal leaves	1860
Tall plants and mottled leaves	68
Dwarf plants and normal leaves	57
Dwarf plants and mottled leaves	580

0 6 . 2 What would be the genotype of the offspring with dwarf plants and mottled leaves?

[1 mark]

_____

Do not write outside the box

0 6 . 3 Use the information provided to explain the results in **Table 3**.

[3 marks]

0 6 . 4 Complete **Table 4** to show the expected ratio of phenotypes if the same cross had been carried out but the genes for height of plant and for the type of leaf were on different homologous pairs of chromosomes.

[2 marks]

Table 4

Phenotype of offspring	Ratio of offspring

8

Turn over ►

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0 7 . 1 Dopamine is a neurotransmitter released in some synapses in the brain. The transmission of dopamine is similar to that of acetylcholine.

Dopamine stimulates the production of nerve impulses in postsynaptic neurones.

Describe how.

Do **not** include in your answer the events leading to the release of dopamine and the events following production of nerve impulses at postsynaptic neurones.

[3 marks]

0 7 . 2 Dopamine has a role in numerous processes in the brain including pain relief. The release of dopamine can be stimulated by chemicals called endorphins produced in the brain. Endorphins attach to opioid receptors on presynaptic neurones that release dopamine.

Morphine is a drug that has a similar structure to endorphins and can provide pain relief.

Explain how.

[2 marks]

Do not write outside the box

0 7 . 3 GABA is a neurotransmitter released in some inhibitory synapses in the brain. GABA causes negatively charged chloride ions to enter postsynaptic neurones.

Explain how this inhibits postsynaptic neurones.

[3 marks]

8

Turn over for the next question

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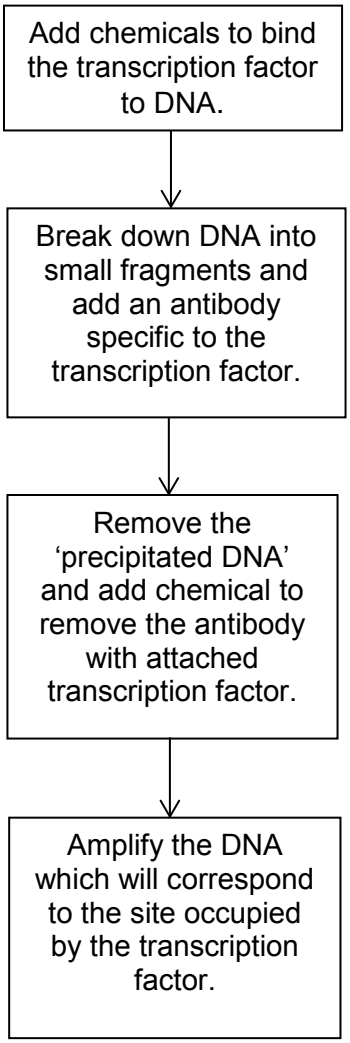
0 8 . 1 What is meant by a genome?

[1 mark]

Chromatin immunoprecipitation is one method to determine where a transcription factor binds to DNA. The principle behind this procedure is shown in **Figure 8**.

Figure 8



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0 8 . 2 Explain why the antibody binds to the transcription factor.

[2 marks]

0 8 . 3 Use **Figure 8** to explain what 'precipitated DNA' consists of.

[1 mark]

Soybeans are used in a number of processed foods. However, soybeans contain a protein known as P34 that causes an allergic response in some people. Scientists have created transgenic soybeans that produce single-stranded cDNA, which prevents transcription of the *P34* gene. They used recombinant plasmids as vectors to transform soybean cells. After they had screened these cells for production of the P34 protein, they cultured the transformed cells to form soybean plants.

0 8 . 4 Suggest how single-stranded cDNA could prevent transcription of the *P34* gene.

[1 mark]

Question 8 continues on the next page

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0 8 . 5 Describe the roles of **two** named types of enzymes used to insert DNA fragments into plasmids.

[2 marks]

Type of enzyme _____

Role _____

_____

_____

_____

Type of enzyme _____

Role _____

_____

_____

_____

0 8 . 6 The soybean cells were screened for the presence of the P34 protein. This process involved the use of gel electrophoresis to separate proteins extracted from soybean cells.

Suggest **two** features of the structure of different proteins that enable them to be separated by gel electrophoresis.

[2 marks]

1 _____

_____

_____

2 _____

_____

_____

9

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0 9 Lactose is the main sugar in milk and is hydrolysed by the enzyme lactase. Lactase is essential to newborn mammals as milk is their only source of food. Most mammals stop producing lactase when they start feeding on other food sources. Humans are an exception to this because some continue to produce lactase as adults. The ability to continue producing lactase is known as lactase persistence (LP) and is controlled by a dominant allele. A number of hypotheses based on different selection pressures have been put forward to explain LP in humans.

0 9 . 1 One hypothesis for LP in humans suggests that the selective pressure was related to some human populations farming cattle as a source of milk.

Describe how farming cattle as a source of milk could have led to an increase in LP.

[4 marks]

0 9 . 2 Use the information provided to explain why the number of people showing LP would **rapidly** increase once selection for this condition had been established.

[2 marks]

Do not write outside the box

0 9 . 3 Lactase persistence is caused by a mutation in DNA. This mutation does **not** occur in the gene coding for lactase.

Suggest and explain how this mutation causes LP.

[2 marks]

_____

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_____

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_____

8

Turn over for the next question

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1 0 Read the following passage.

Complete achromatopsia is a form of complete colour blindness. It is caused by having only rods and no functional cone cells. People with complete achromatopsia have difficulty in seeing detail. Complete achromatopsia is caused by an autosomal recessive allele and is usually very rare in populations with only one in 40 000 being affected. However on the Pacific island of Pingelap ten percent of the population are affected.

One form of red-green colour blindness is caused by a sex-linked recessive allele which affects more men than women. People with this red-green colour blindness are unable to distinguish between red and green, and also between other colours. They have green-sensitive cones but the photoreceptive pigment they contain does not function.

Scientists investigated the use of gene therapy to correct red-green colour blindness in monkeys. They injected viruses containing the gene for the green-sensitive pigment directly into the eyes of the monkeys. Although the monkeys maintained two years of colour vision, there is debate on whether this form of gene therapy is worthwhile. No clinical trials of this procedure have been carried out on humans. Current research into the treatment of red-green colour blindness involves the use of induced pluripotent stem cells (iPS cells). The use of iPS cells could have advantages over the use of gene therapy.

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

1 0 . 1 People with complete achromatopsia have difficulty in seeing detail (lines 2–3).

Explain why.

[3 marks]

Do not write outside the box

1 0 . 2 Ten percent of the population on the Pacific island of Pingelap are affected by complete achromatopsia (lines 3–6).

Use the Hardy-Weinberg equation to calculate the percentage of this population who are heterozygous for this disorder.
Show your working.

[2 marks]

Answer = _____ %

1 0 . 3 Red-green colour blindness affects more men than women (lines 7–8).

Explain why.

[2 marks]

_____

_____

_____

_____

_____

Question 10 continues on the next page

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1 0 . 4 People with red-green colour blindness are unable to distinguish between red and green, and also between other colours (lines 8–10).

Explain why.

[3 marks]

1 0 . 5 Current research into the treatment of red-green colour blindness involves the use of induced pluripotent stem cells (iPS cells) (lines 17–19).

Suggest how iPS cells could correct red-green colour blindness.

[2 marks]

Do not write outside the box

1 0 . 6 The use of iPS cells could have advantages over the use of gene therapy to correct red-green colour blindness (lines 19–20).

Using the information from the passage, suggest and explain reasons why.

[3 marks]

15

END OF QUESTIONS

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