

Surname _____

Other Names _____

Centre Number _____

Candidate Number _____

Candidate Signature _____

A-level

BIOLOGY

Paper 2

7402/2

Monday 11 June 2018

Afternoon

Time allowed: 2 hours

At the top of the page, write your surname and other names, your centre number, your candidate number and add your signature.

[Turn over]

For this paper you must have:

- **a ruler with millimetre measurements**
- **a scientific calculator.**

INSTRUCTIONS

- **Use black ink or black ball-point pen.**
- **Answer ALL questions.**
- **You must answer the questions in the space provided. Do not write 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.**

**DO NOT TURN OVER UNTIL TOLD TO
DO SO**



Answer ALL questions in the spaces provided.

0	1
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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]**

[Turn over]

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]

[Turn over]



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

Rubisco activity /
arbitrary units

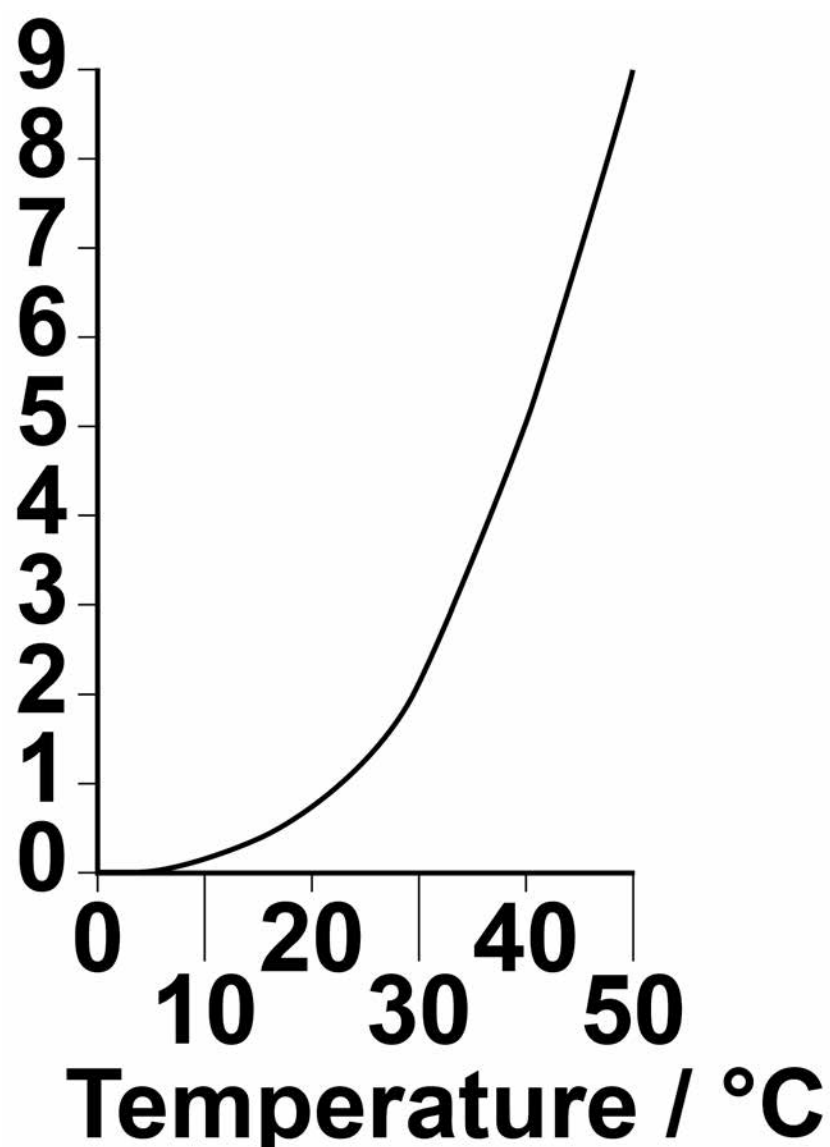
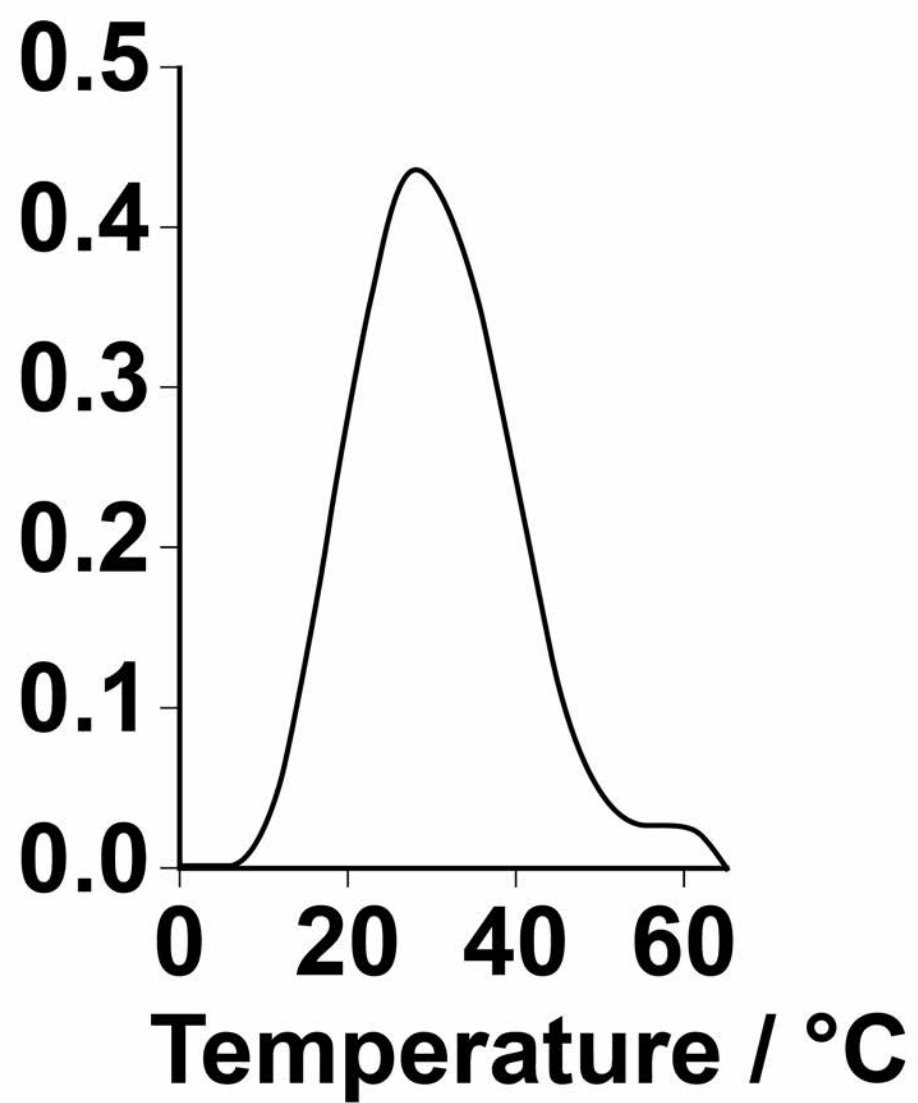


FIGURE 2

**Rubisco activase
activity / arbitrary
units**



[Turn over]

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]**

[Turn over]

9



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.



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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 = _____

[Turn over]

6



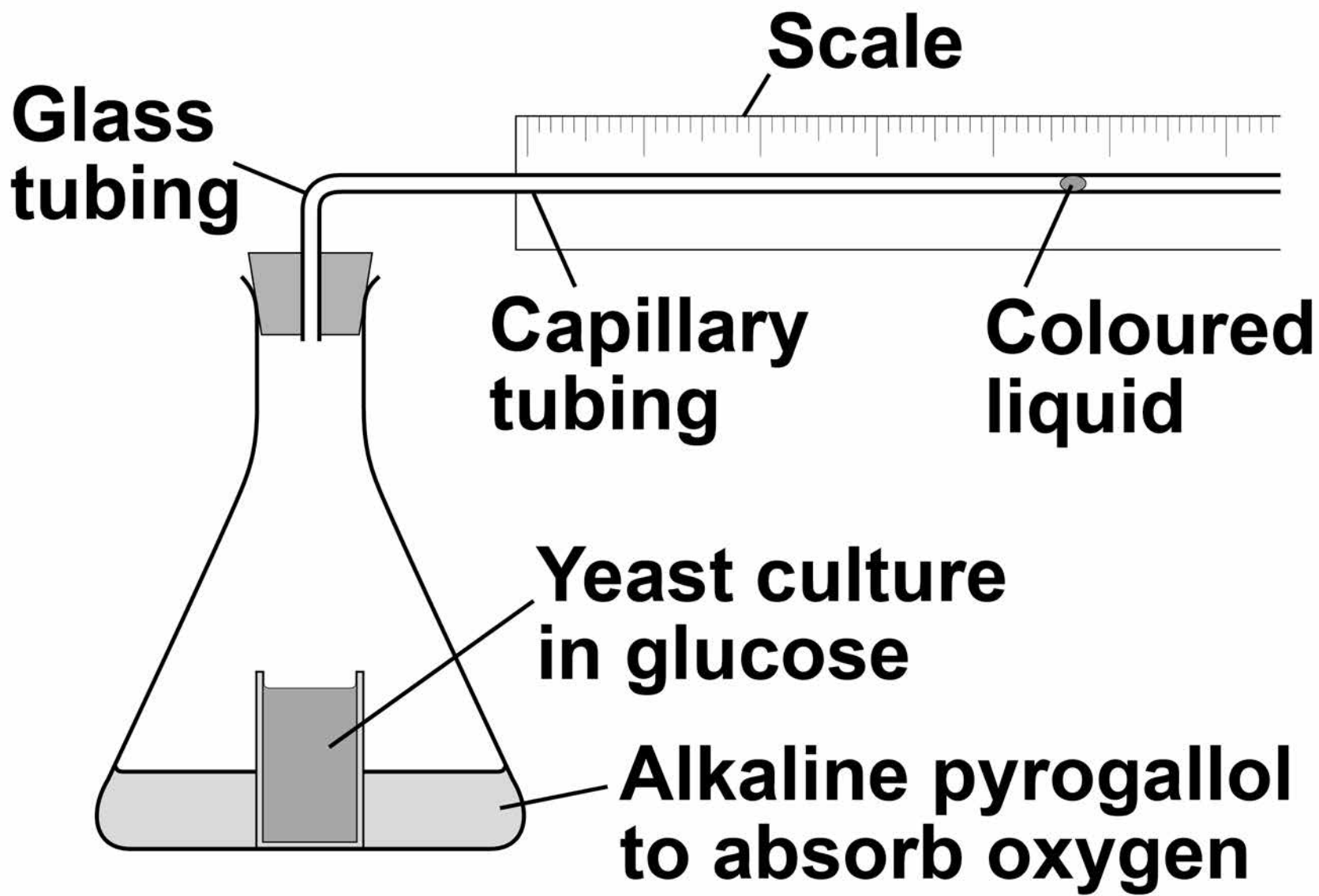
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Yeast cells can respire aerobically or anaerobically. A student used the apparatus shown in FIGURE 3, on page 17, to measure the rate of respiration in yeast.

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]

[Turn over]



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03.2

During her investigation, the coloured liquid moved to the right.

Explain why it moved to the right. [2 marks]

[Turn over]



03.3 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 $\text{cm}^3 \text{ hour}^{-1}$.
Show your working. [2 marks]

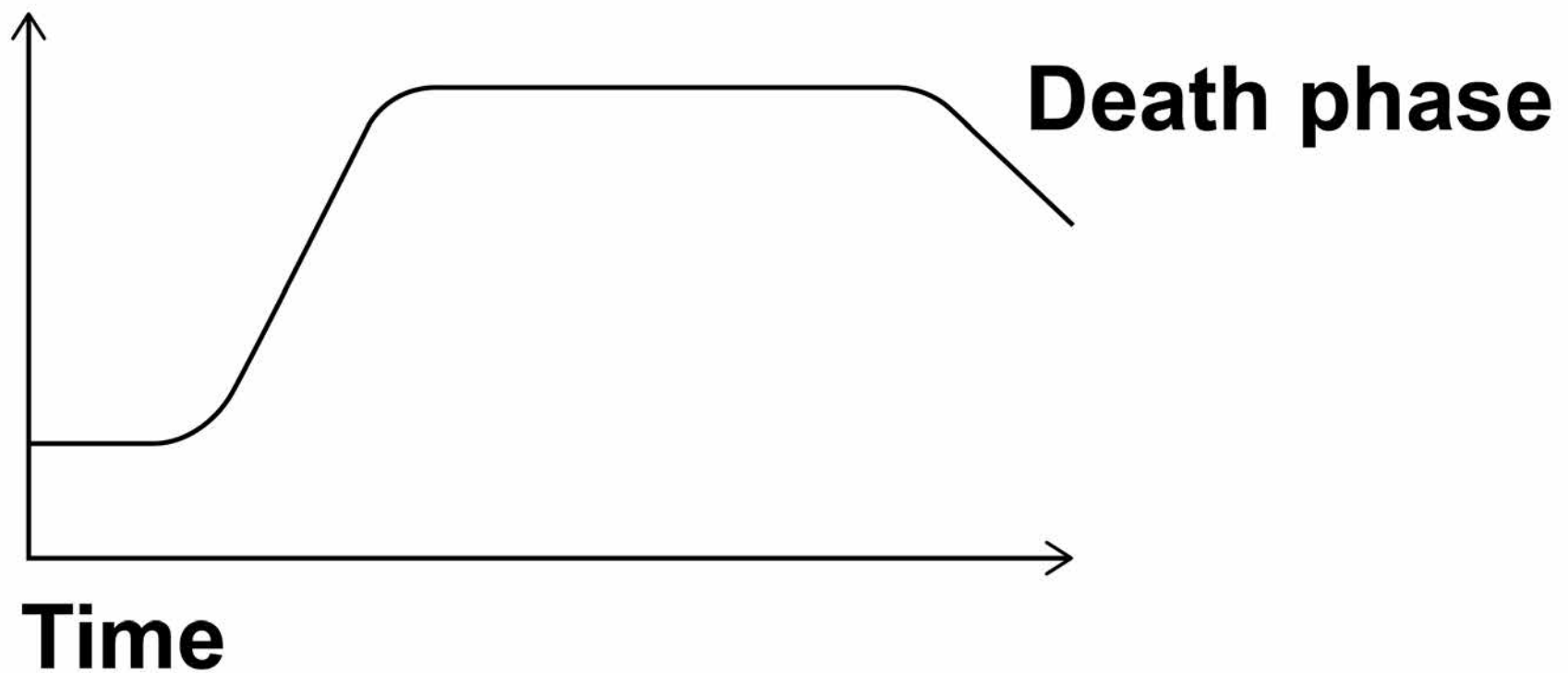
Answer = _____ $\text{cm}^3 \text{ hour}^{-1}$



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

FIGURE 4

**Log₁₀
number
of cells**



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

[Turn over]



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

**Suggest ONE reason why.
[1 mark]**

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[Turn over]



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

$$X_t = X_0 e^{rt}$$

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



25

Assuming no yeast cells died, calculate the predicted size of the population after 10 hours. Show your working. [2 marks]

Answer = _____

[Turn over]

9



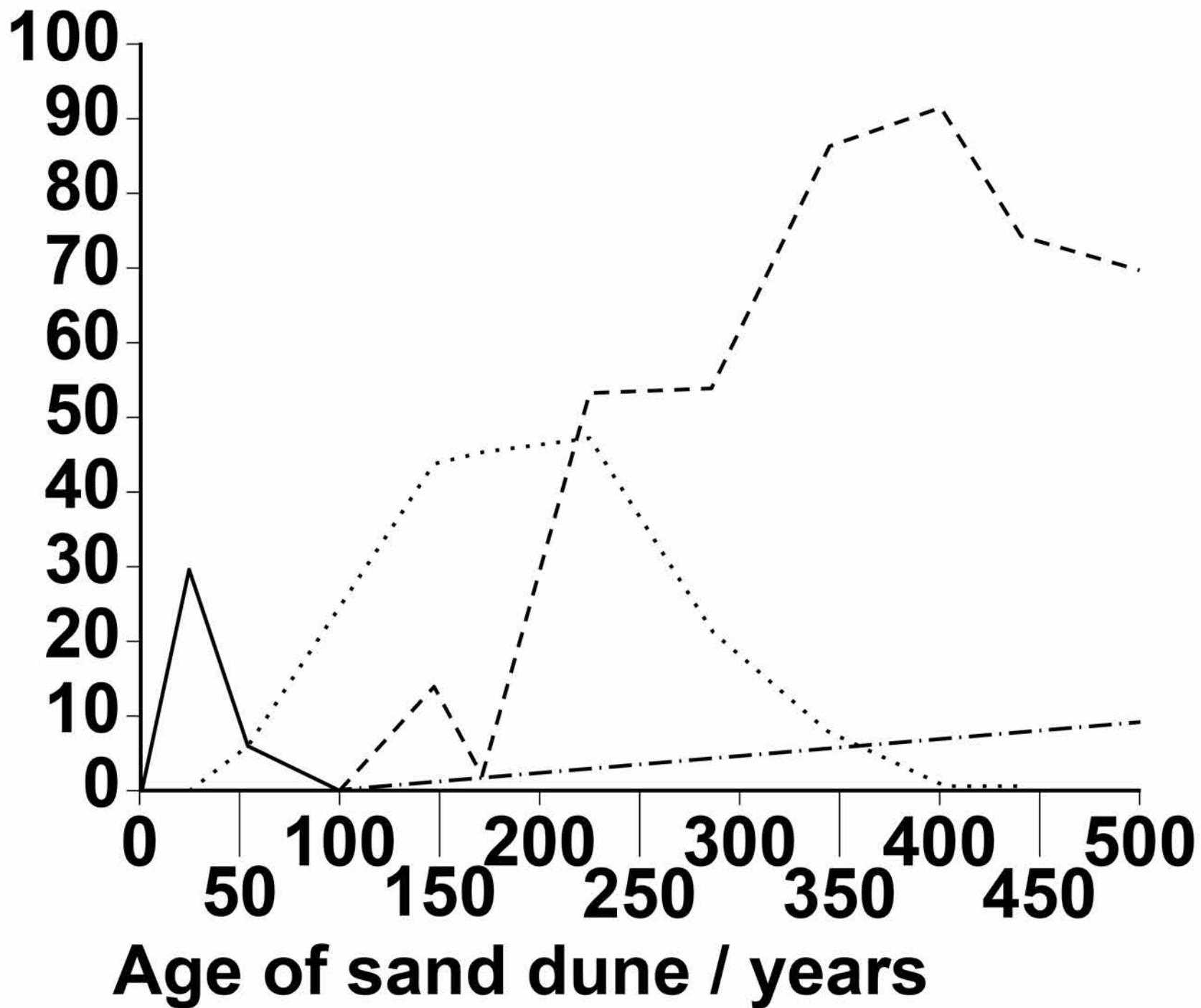
0	4
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Scientists investigated the process of succession on sand dunes. They measured the percentage cover of different species of plants on sand dunes of different ages. Some of the results the scientists obtained are shown in FIGURE 5, on page 27.



FIGURE 5

Mean
percentage
cover



KEY

- Beach grass
- Conifer trees
- Shrub-bunchgrass
- - - Hardwood trees

[Turn over]



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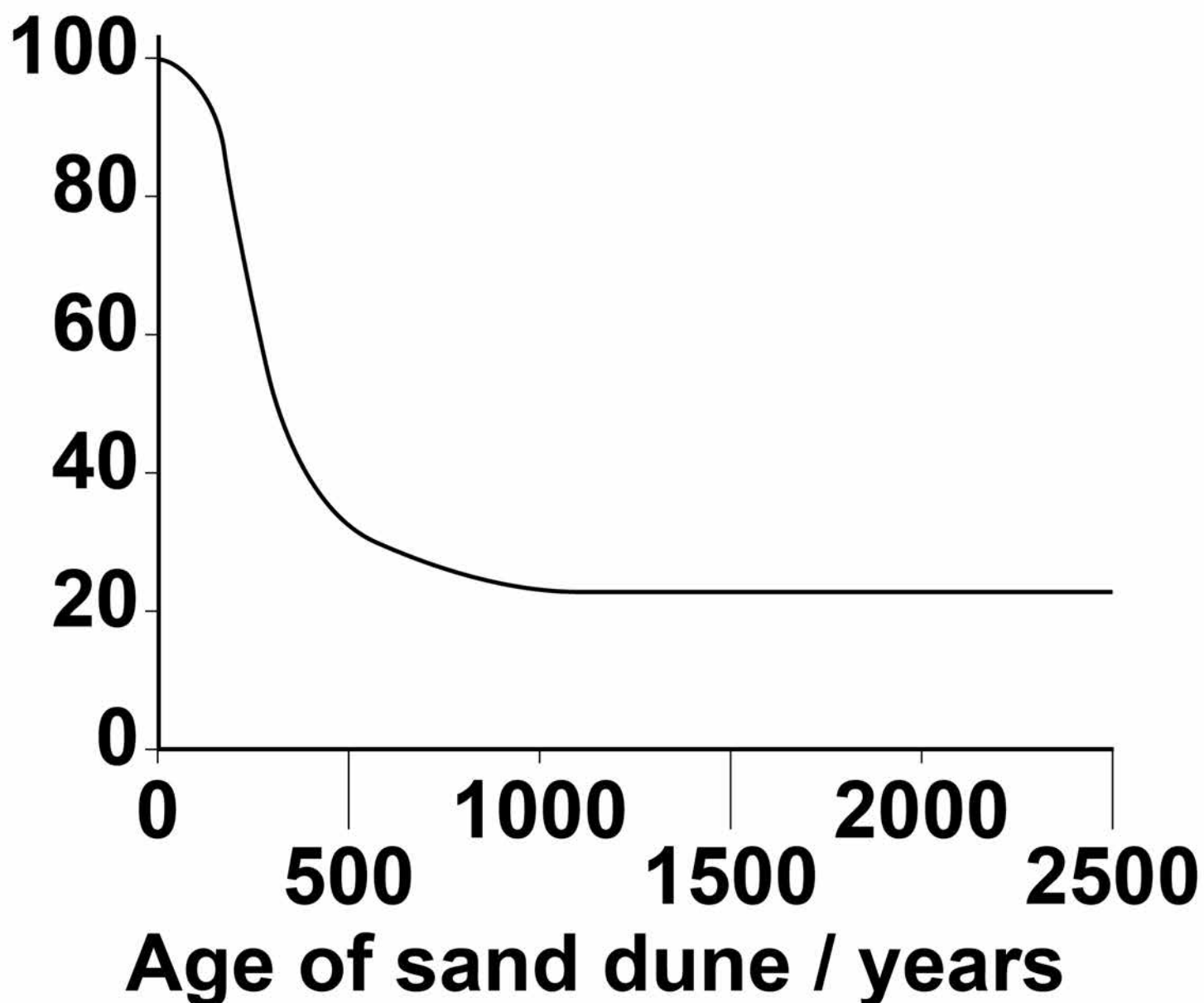


[Turn over]

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

**Percentage
of full
sunlight
reaching
the ground**



0 4 . 3 Use **FIGURE 5**, on page 27, to explain the results in **FIGURE 6**.
[1 mark]

[Turn over]

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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]

[Turn over]

10



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 / cm³ (± 2 standard deviations)
A (furosemide)	1980 (± 152)
B (CVT)	1201 (± 119)
C (placebo)	312 (± 57)

[Turn over]



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05.2 Using TABLE 1, on page 37, 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]

[Turn over]

BLANK PAGE

[Turn over]



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 / $\text{cm}^3 \text{min}^{-1}$
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

[Turn over]

9



06.1

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

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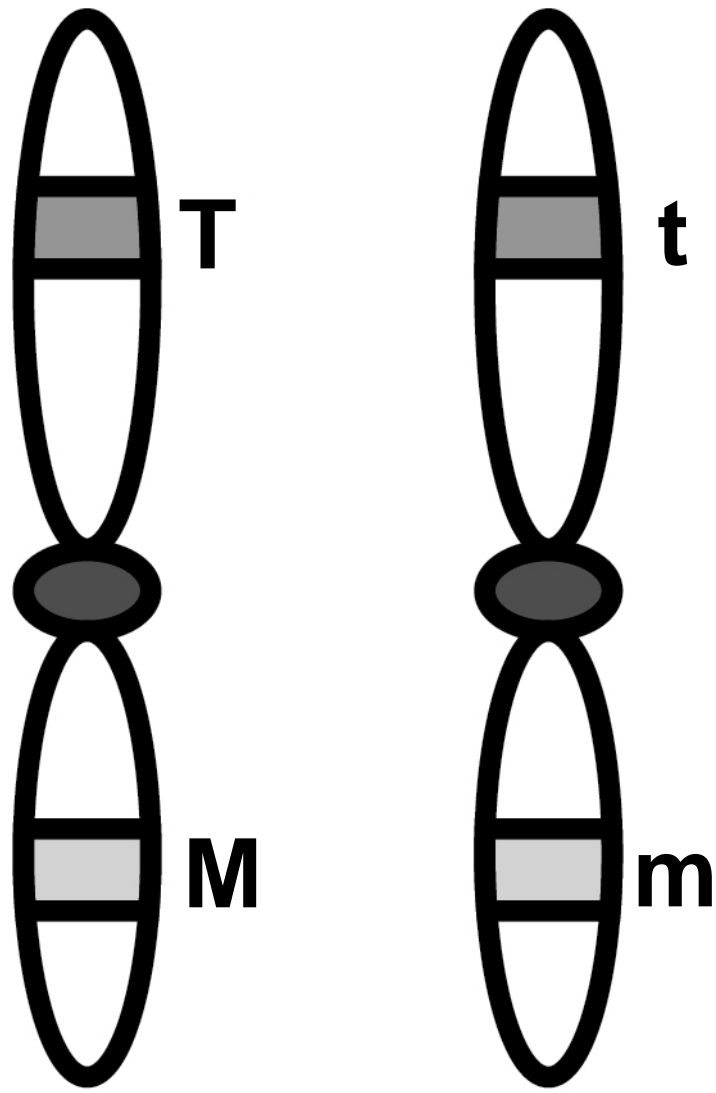
[Turn over]



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, on page 49. The phenotypes and number of offspring produced are shown in TABLE 3 on page 50.

FIGURE 7



[Turn over]

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

06.2 What would be the genotype of the offspring with dwarf plants and mottled leaves? [1 mark]

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06.4 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

[Turn over]



07.1

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]

07.2

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]

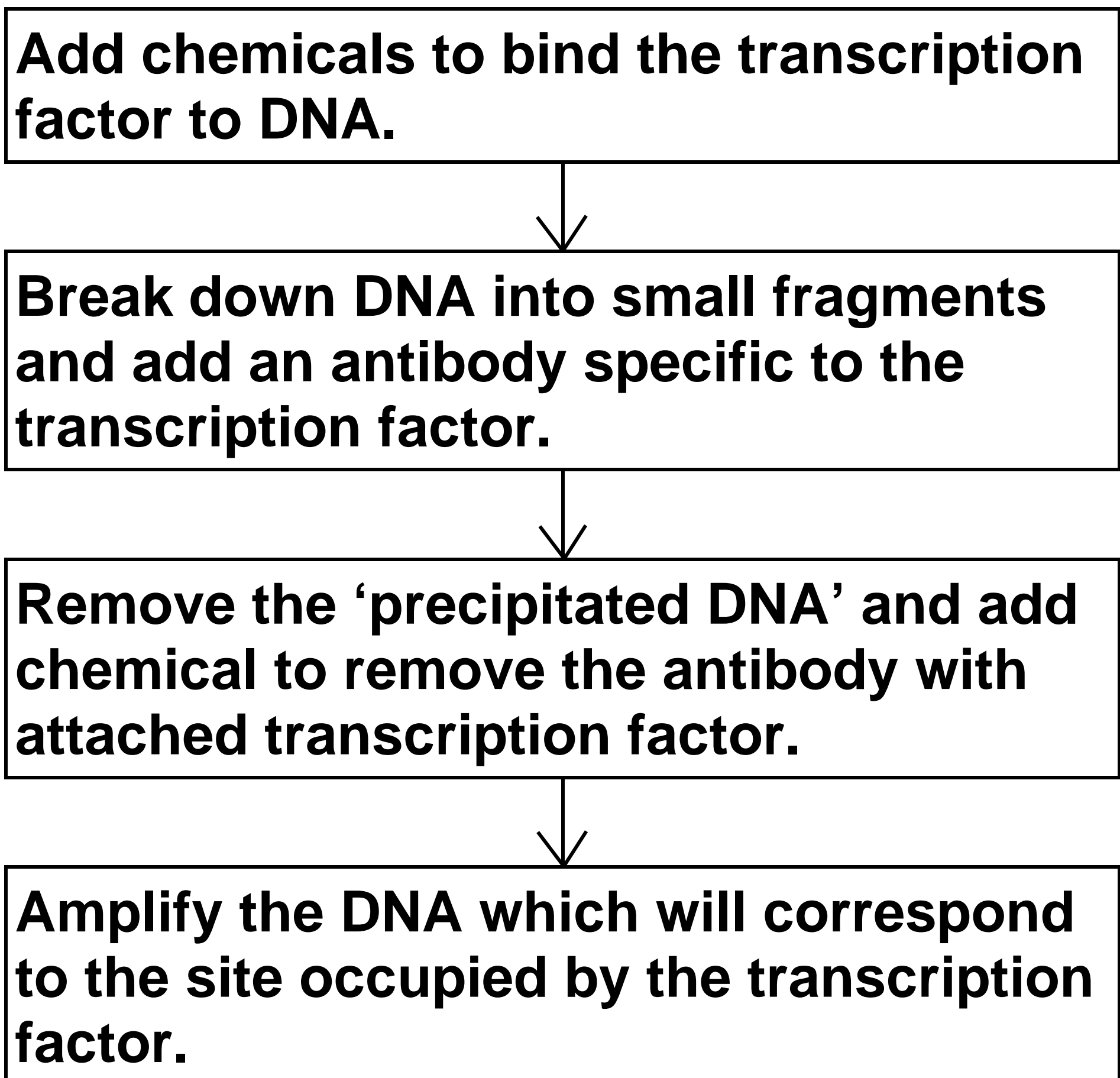
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8

0 8 . 1 What is meant by a genome?
[1 mark]

[Turn over]

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



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]

[Turn over]



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.



08.4 Suggest how single-stranded cDNA could prevent transcription of the *P34* gene. [1 mark]

[Turn over]

08.5

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 _____

[Turn over]



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08.6

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

[Turn over]



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]

[Turn over]



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]

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]

[Turn over]

8



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. 5

People with complete achromatopsia have difficulty in seeing detail. Complete achromatopsia is caused by an autosomal 10

recessive allele and is usually very rare in populations with only one in 40 000 being affected.

However on the Pacific 15 island of Pingelap ten percent of the population are affected.

One form of red-green colour blindness is caused 20 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.

25

30

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

35

40

[Turn over]



form of gene therapy is **45**
 worthwhile. No clinical trials
 of this procedure have been
 carried out on humans.
 Current research into the
 treatment of red-green **50**
 colour blindness involves
 the use of induced
 pluripotent stem cells (iPS
 cells). The use of iPS cells
 could have advantages over **55**
 the use of gene therapy.

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

10.1 People with complete
 achromatopsia have difficulty in
 seeing detail (lines 6–8).

Explain why. [3 marks]



10.2 Ten percent of the population on the Pacific island of Pingelap are affected by complete achromatopsia (lines 9–18).

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 19–23).

Explain why. [2 marks]

[Turn over]

1 0 . 6

The use of iPS cells could have advantages over the use of gene therapy to correct red-green colour blindness (lines 54–56).

Using the information from the passage, suggest and explain reasons why. [3 marks]

There are no questions printed on this page

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Question	Mark
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