Write your name here

Surname	Other names

Pearson Edexcel Level 3 GCE

Centre Number	Candidate Number

Biology B

Advanced
Paper 3: General and Practical Principles in Biology

Monday 18 June 2018 – Morning **Time: 2 hours 30 minutes**	Paper Reference **9BI0/03**

You must have:
Calculator, HB pencil, ruler

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Show your working in any calculation questions and include units in your answer where appropriate.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*
- You may use a scientific calculator.
- In question(s) marked with an **asterisk** (*), marks will be awarded for your ability to structure your answer logically showing how the points that you make are related or follow on from each other where appropriate.

Information

- The total mark for this paper is 120.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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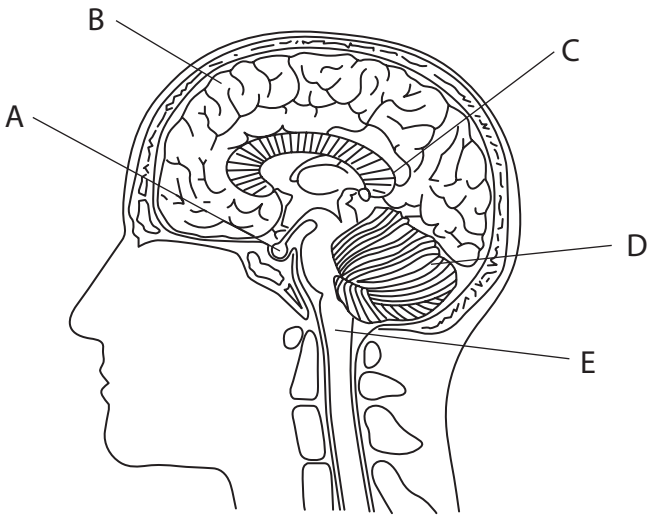
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Answer ALL questions.

Write your answers in the spaces provided.

1 The human brain controls many functions.

The diagram shows a section through a human brain with parts labelled A to E.



(a) Which letter labels the part of the brain that controls heart rate?

(1)

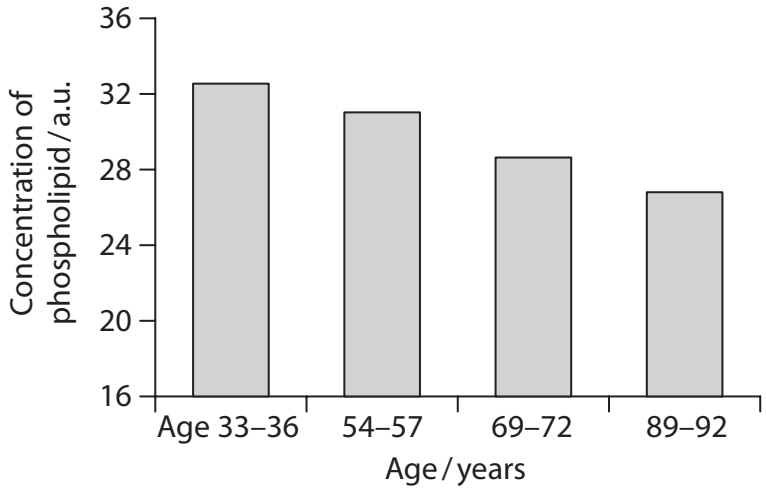
(b) The human brain consists of 100 billion neurones.

The function of these neurones is affected by many factors.

The concentration of phospholipid in neurones from one part of the brain was measured.

This was carried out in people from different age ranges.

The graph shows the results.



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Explain how age might affect the structure of a neurone and the speed of transmission of an impulse.

(3)

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(c) Poisons can also affect the function of neurones in the brain.

The photograph shows a pufferfish, a traditional food delicacy in Japan.



Pufferfish have to be carefully prepared by a chef to remove a poison called tetrodotoxin. This poison causes muscle paralysis.

Neurones were placed in a solution containing tetrodotoxin and in a control solution.

The neurones were stimulated and the potential difference across the axon membrane was measured.

The table shows the results.

Solution	Potential difference after stimulation / mV
tetrodotoxin	–70
control	+40

Analyse the data to explain the effect of tetrodotoxin on the neurone.

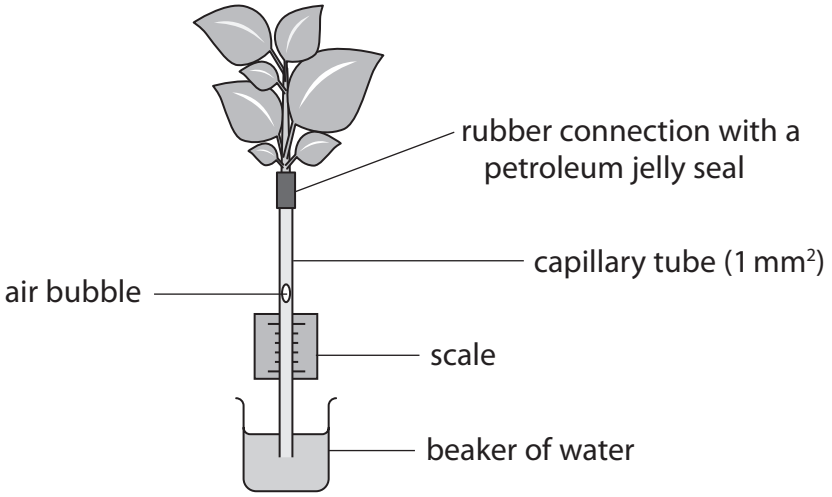
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(Total for Question 1 = 8 marks)

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2 A student investigated the effect of moving air on transpiration in a leafy shoot.

The diagram shows the potometer used by the student.



(a) In this investigation, a leafy shoot was cut from a plant.

The leafy shoot was then put under water and the stem inserted into the rubber connection.

Explain how this procedure should be modified to produce accurate readings.

(2)

(b) During the investigation, the air bubble moved off the scale very quickly.

Explain how this potometer could be modified to obtain repeat readings.

(2)

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(c) The student measured the distance in millimetres that the air bubble moved during a five-minute period in moving air and in still air.

(i) Explain how the student could convert these readings into a transpiration rate using the units $mm^3\ cm^{-2}\ min^{-1}$.

(3)

(ii) The table shows the mean results and standard deviations of this investigation.

Mean rate of transpiration / $mm^3\ cm^{-2}\ min^{-1}$	
In moving air	**In still air**
3.2 ± 0.3	0.8 ± 0.2

Explain the results of this investigation.

(2)

(Total for Question 2 = 9 marks)

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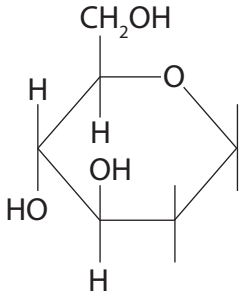
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3 Glucose and fructose are monosaccharides.

(a) Complete the diagram to show the structure of alpha glucose.

(1)



(b) The makers of sweet tasting drinks use the enzyme glucose isomerase to convert glucose into fructose.

Fructose is a monosaccharide that tastes much sweeter than glucose.

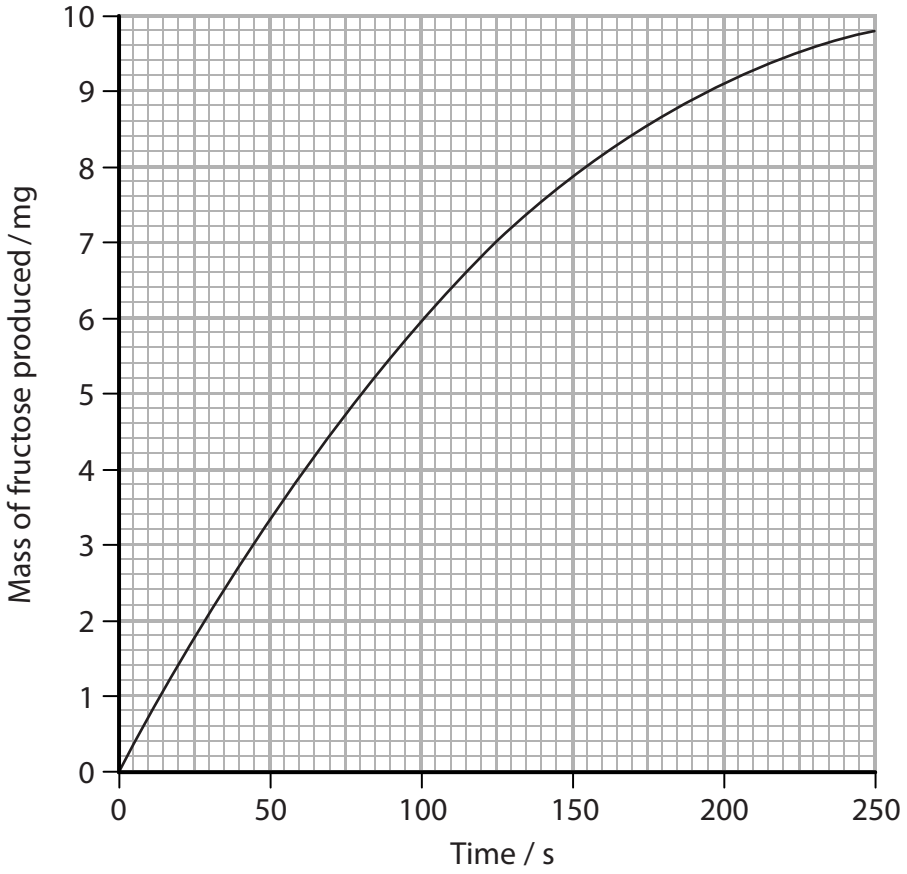
(i) Explain a possible health benefit of converting glucose into fructose for use in sweet tasting drinks.

(2)

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(ii) A student investigated the activity of glucose isomerase.

The graph shows the results of this investigation.



Determine the initial rate of the reaction.

(1)

Answer .....

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(iii) Cofactors are non-protein molecules that help enzymes to function.

Magnesium ions act as cofactors for some enzymes.

Devise an experiment to investigate the effect of magnesium ions on the initial rate of this reaction.

(5)

(Total for Question 3 = 9 marks)

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4 Photosynthetic pigments are found in plant leaves.

(a) Describe how you could use chromatography to separate these pigments.

(3)

(b) A scientist investigated the effect of lead pollution by cars on the chlorophyll content of plant leaves.

Quadrat sampling was used to collect leaves from a plant species.

Leaf samples were collected from an area with little car traffic and from an area with heavy car traffic.

The leaf samples were tested for lead content and chlorophyll content.

The table shows the results of this investigation.

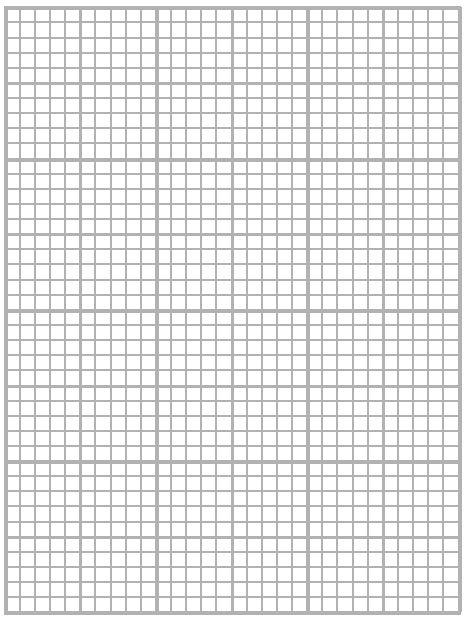
Area	Mean lead content of leaves / $\mu g\, g^{-1}$	Mean chlorophyll content of leaves / $\mu g\, g^{-1} \times 10^2$
Little traffic	1.28 ± 0.64	64.00 ± 4.00
Heavy traffic	3.11 ± 0.31	22.50 ± 3.00

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(i) Plot a graph to show the data for mean chlorophyll content.

(2)

Mean chlorophyll content of leaves / $\mu g\,g^{-1} \times 10^2$



(ii) Explain how the quadrat sampling should have been carried out.

(3)

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(iii) The scientist concluded that lead pollution from cars reduces the photosynthesis of plants.

Criticise the validity of this conclusion.

(2)

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(Total for Question 4 = 10 marks)

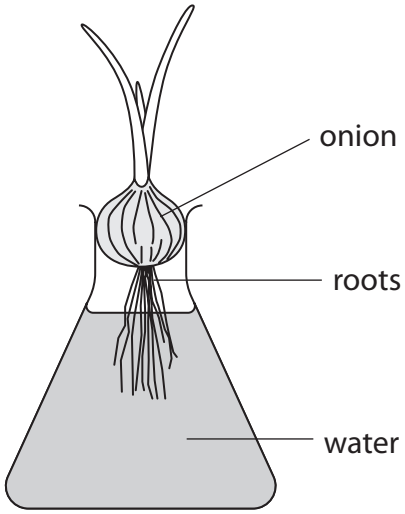
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5 A student read that some plants do not grow well in waterlogged soil.

The student formed the following hypothesis:

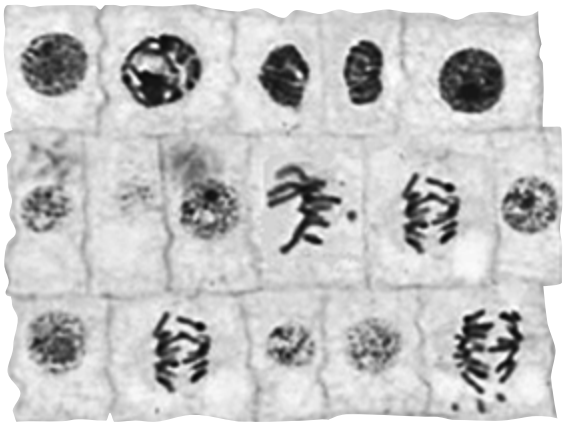
Adding water to soil inhibits mitosis in root cells.

To test this hypothesis, the student grew onion roots in the apparatus shown.



The tips of the onion roots were removed and observed for stages of mitosis.

The photomicrograph shows a preparation from one onion root tip.



(a) Calculate the percentage of cells in this photomicrograph in anaphase.

(2)

Answer .....

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(b) Describe how to prepare a microscope slide of root tissue to show stages of mitosis.

(4)

(c) Devise a method the student should use to investigate the effect of waterlogged soil on mitosis in root cells.

(4)

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(d) Waterlogged soil lacks oxygen.

Explain why a lack of oxygen in waterlogged soil could reduce the growth of a plant.

(4)

(Total for Question 5 = 14 marks)

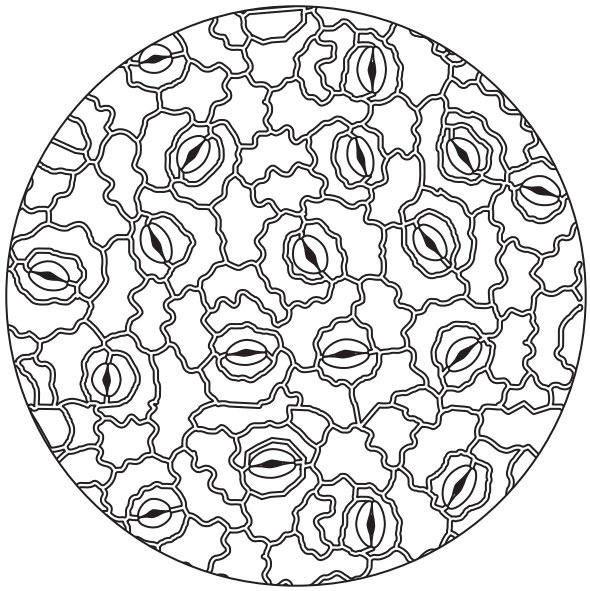
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6 A student investigated the effect of light intensity on the development of stomata in coffee plant leaves.

The following method was used:

- young coffee seedlings were separated into two groups
- one group was grown in bright light and the other group was grown in dim light
- leaves were selected from each group and their surfaces were painted with nail varnish
- the nail varnish was allowed to dry and then peeled off the leaf surface
- each nail varnish peel was observed using a light microscope.

The diagram shows an example of the field of view seen by the student when using the high power lens.



(a) Describe how a microscope should be used to observe the stomata using the high power lens.

(3)

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(b) The diameter of the field of view is 0.4 mm.

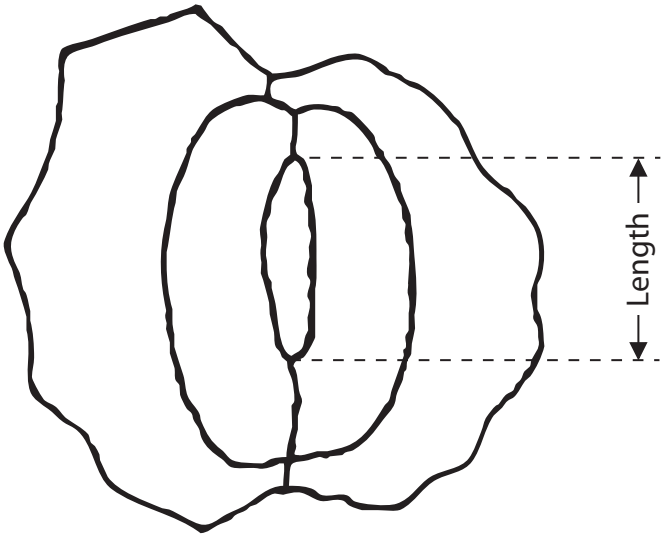
Calculate the number of stomata per mm^2 on the leaf surface.

The area of a circle is πr^2, where π is 3.142.

(2)

Answer ..... mm^{-2}

(c) The diagram shows one of the stomata drawn by the student.



The actual length of this stoma is 20 μm.

Calculate the magnification of this drawing.

(2)

Answer .....

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(d) The results of this investigation are shown in the table.

Leaf sample	Number of stomata mm^{-2}	
	Leaves in bright light	Leaves in dim light
1	184	143
2	190	138
3	182	140
4	185	132
5	192	136
Mean ($\bar{x}$) and SD	186.6 ± 4.2	137.8

(i) Calculate the SD for the leaves in dim light.

Use the formula

$$\text{SD} = \sqrt{\frac{\Sigma(x - \bar{x})^2}{n - 1}}$$

(2)

Answer .....

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(ii) Describe how these nail varnish peel samples should be taken to allow a valid comparison between the mean numbers of stomata.

(2)

(iii) Analyse the data to explain how fewer stomata might affect the growth of coffee plants.

(3)

(Total for Question 6 = 14 marks)

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7 Malaria is caused by *Plasmodium*, a pathogenic microorganism.

Vaccination is one of many methods being used to control malaria.

In a study, the effectiveness of a vaccine for malaria was tested.

The following method was used:

- samples of *Plasmodium* were exposed to radiation and used to make a vaccine
- two groups of people, A and B, were given different doses of the vaccine
- a third group of people, C, was used as a control
- one month after vaccination, all three groups of people were exposed to mosquitoes known to contain live *Plasmodium*
- the number of people in each group with malaria was recorded.

The results are shown in the table.

Group	Treatment with the vaccine	Number of people in each group	Number of people with malaria
A	low dose	17	16
B	high dose	6	0
C	control	12	11

(a) (i) Explain why the samples of *Plasmodium* were exposed to radiation.

(2)

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(ii) State the control treatment that was given to people in group C.

(1)

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(iii) It was claimed that this vaccine was 100% effective.

Analyse the data to criticise the validity of this claim.

(3)

(iv) Describe how vaccination enabled the people in group B to have active artificial immunity against malaria.

(5)

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(b) Anti-malarial drugs can be used to protect people from malaria.

These drugs are not always effective because *Plasmodium* develop resistance.

Explain how drug-resistant *Plasmodium* may evolve.

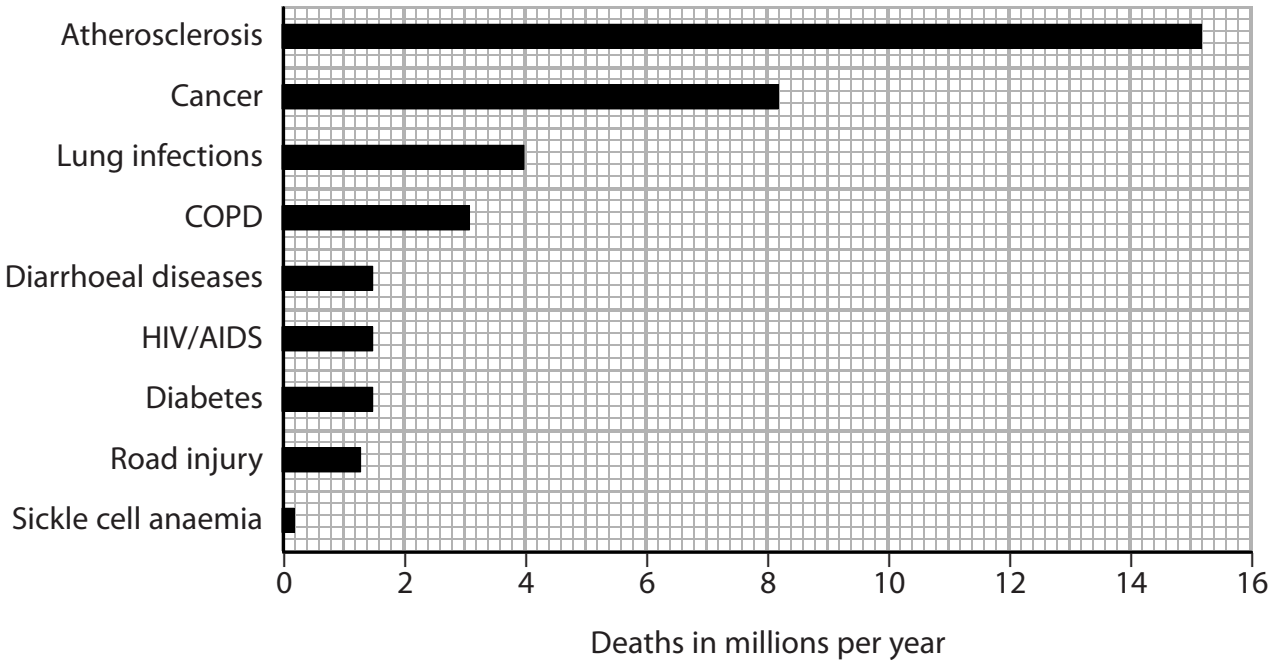
(3)

(Total for Question 7 = 14 marks)

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8 There are many disorders that affect the health of people.

The graph shows the number of people in the world who die each year from different health disorders.



(a) The graph shows that atherosclerosis kills more people than any of the other disorders.

This is mainly due to its development in the coronary arteries.

(i) State the number of deaths caused by atherosclerosis.

Give your answer in standard form.

(1)

Answer .....

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(ii) Describe how atherosclerosis develops in the coronary arteries.

(3)

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*(b) Some health disorders, such as sickle cell anaemia, have a genetic basis.

People who are at risk of these disorders can be identified using genetic tests.

Hospital managers need to predict the future cost of treating people with health disorders.

It has been claimed that the Hardy-Weinberg equation ($p + q = 1$ or $p^2 + 2pq + q^2 = 1$) could be used to predict the number of people who would need treatment for health disorders.

Discuss the validity of this claim.

(9)

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(Total for Question 8 = 13 marks)

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9 Last year, eight million Christmas trees were bought in the UK.

There are many Christmas tree farms that supply these trees.

The photograph shows young Christmas trees growing on a farm.



Christmas tree farmers remove the other plants (weeds) in order to increase tree growth.

A farmer investigated two methods of removing weeds:

- removing weeds by hand
- spraying herbicides that inhibit weed growth.

The table shows the mean height of Christmas trees using each method, over a five-year period.

Year	Mean height of trees / cm	
	Removing by hand	Using herbicide
0	20	20
1	50	60
2	70	100
3	90	130
4	110	160
5	130	200

(a) (i) Calculate the difference between the mean rate of growth of these trees over the five years.

(2)

Answer .....

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(ii) Analyse the data to explain the difference in the mean height of the trees at the end of the five-year period.

(2)

(iii) Explain two biotic variables that need to be controlled to allow a valid comparison of the effect of each method on tree growth.

(2)

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(b) A student read that some herbicides work by inhibiting electron transport in photosynthesis.

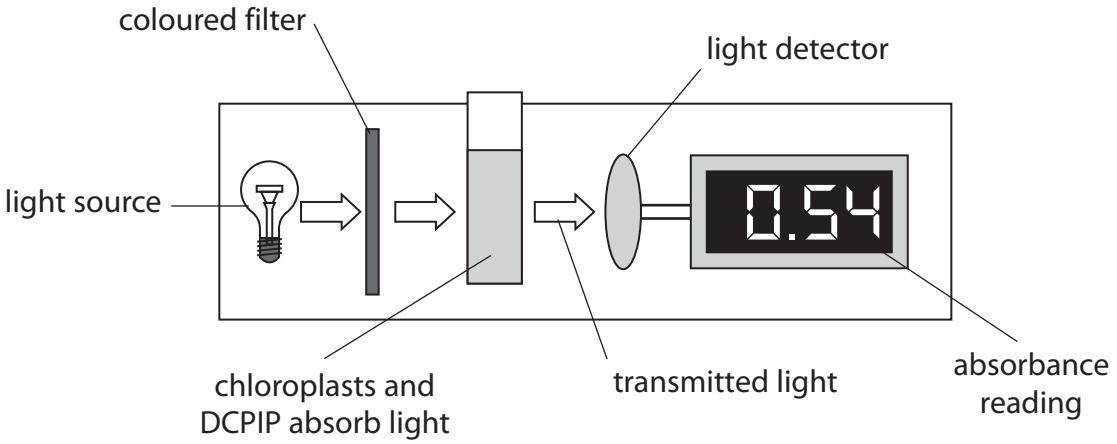
The student investigated this using the indicator DCPIP.

This indicator changes from blue to colourless when it is reduced.

The student used the following method:

- chloroplasts were suspended in two tubes, each containing a solution of DCPIP
- herbicide was added to one of the tubes and no herbicide was added to the other tube
- both tubes were exposed to light
- a colorimeter was used to measure the absorbance in each tube at five minute intervals for 20 minutes.

The diagram shows details of the workings of the colorimeter used by the student.



As DCPIP changes from blue to colourless, the absorbance of light decreases.

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(i) Explain how the student used this method to collect valid data.

(4)

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The table shows the results.

Time / min	Absorbance / a.u.	
	With herbicide	Without herbicide
0	0.53	0.54
5	0.54	0.31
10	0.54	0.24
15	0.54	0.20
20	0.53	0.16

(ii) Analyse the data to explain the effect of this herbicide on the growth of weeds.

(4)

(Total for Question 9 = 14 marks)

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10 Antibiotics can affect bacteria.

The table describes the mode of action of four antibiotics.

Antibiotic	Mode of action
benzylpenicillin	disrupts peptidoglycan structure
streptomycin	binds to 70 S ribosomes
ciprofloxacin	inhibits enzymes involved in prokaryotic DNA replication
rifamycin	inhibits prokaryotic RNA polymerase

(a) (i) Name the antibiotic that affects Gram positive bacteria only.

(1)

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(ii) Give one reason why these antibiotics will not affect human cells.

(1)

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(b) Explain how rifamycin prevents the growth of bacteria.

(3)

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(c) Mutations in the DNA of bacteria can enable them to be resistant to antibiotics.

(i) A single bacterium can produce 2×10^{10} new cells per day by cell division.

The mean mutation rate in one day is 1 in 10 million new cells produced.

Calculate the mean number of bacteria with mutations that could be produced in one day from a single bacterium.

(2)

Answer .....

(ii) Explain how bacteria may become resistant to streptomycin if a mutation changes the primary structure of a protein.

(3)

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(d) A student compared the effectiveness of these four antibiotics on the growth of bacteria.

Devise a method that the student could use to obtain valid results.

(5)

(Total for Question 10 = 15 marks)

TOTAL FOR PAPER = 120 MARKS

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