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Pearson Edexcel
Level 3 GCE

Centre Number

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Candidate Number

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Biology B
Advanced
Paper 3: General and Practical Principles
in Biology

Sample Assessment Material for first teaching September 2015
Time: 2 hours 30 minutes

Paper Reference
9BI0/03

You may need a ruler, a pencil and a calculator.

Total Marks

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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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Answer ALL questions.

Write your answers in the spaces provided.

- 1** The photograph below shows a mosquito net which is used in areas where malaria is common.



(Source: <http://malariaanomore.org.uk/news/uk-leads-fight-against-malaria-in-southern-sudan>)

- (a) State **two** other methods that can be used to reduce the number of new cases of malaria.

(2)

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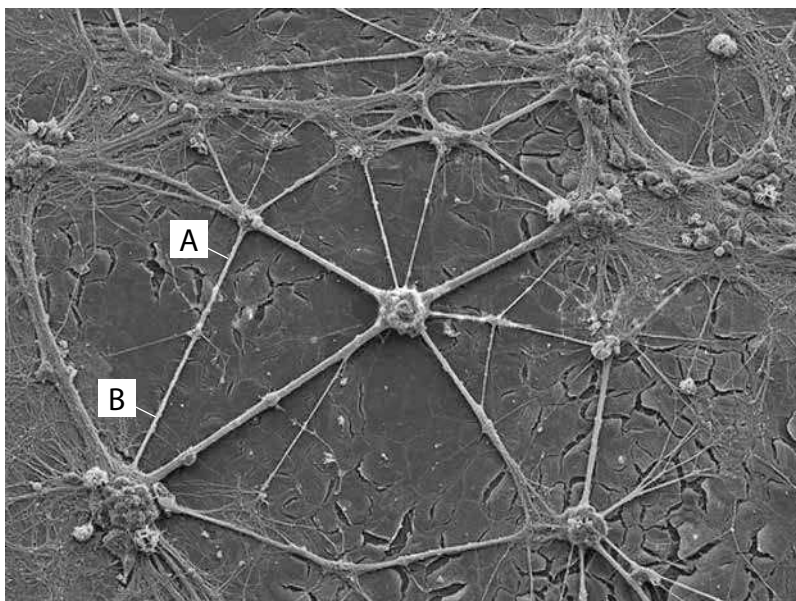
- (b) Malaria causes serious problems for pregnant women. They often suffer from a condition known as anaemia in which the ability of the blood to carry oxygen is significantly reduced.

Explain how malaria causes anaemia.

(2)

(Total for Question 1 = 4 marks)

2 The photomicrograph below shows myelinated neurones.



© C016/7131 David Scharf/Science Photo Library

Magnification $\times 226$

- (a) The time taken for an impulse to travel between two electrodes placed at the points labelled **A** and **B** was measured as 0.02 milliseconds.

Calculate the speed of the impulse.

(3)

Answerms⁻¹

- (b) The neurones of the retina are not usually myelinated. However in some eye conditions, myelination does occur.

Explain why the presence of myelinated neurones in the retina might mean that a clear image will not be formed.

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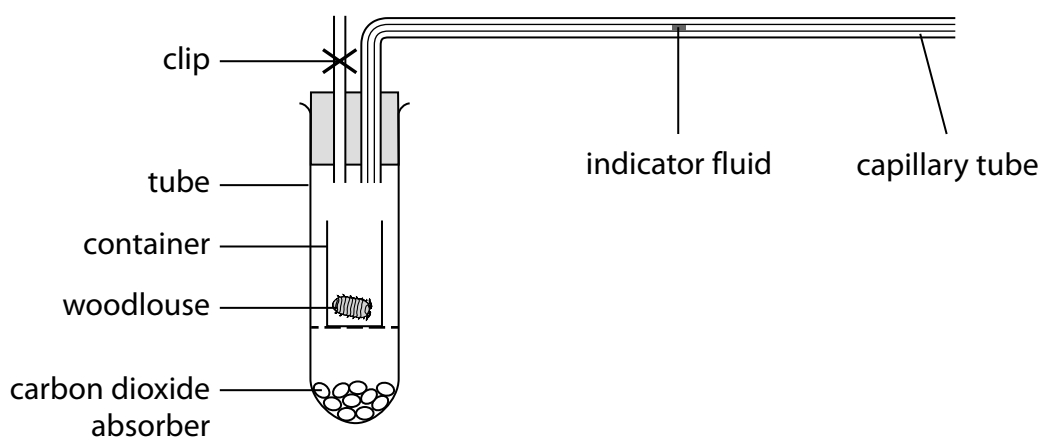
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(Total for Question 2 = 6 marks)

- 3** The diagram below shows a simple respirometer used by a student to measure the rate of respiration of a small invertebrate called a woodlouse.

The rate was measured by observing the distance the indicator fluid moved in a known time.



- (a) Give one way in which the student could modify the procedure to obtain a better measurement of the rate of respiration.

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- (b) Explain what would happen to the indicator fluid after five hours if a culture of green algae was added to the container and the tube was completely covered in light-proof paper.

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- (c) (i) The student wanted to compare the rate of respiration of a mouse with that of a woodlouse.

Explain how you could modify the procedure used to measure the rate of respiration of the woodlouse so that it could be used to compare with the rate of respiration of a mouse.

Your answer should explain the reasons for the modifications and include reference to the ethical treatment of the animal, and show how you could produce valid results.

(5)

- (ii) Comment on how the results you would expect to obtain for a mouse would differ from the results for a woodlouse.

(2)

(Total for Question 3 = 12 marks)

4 The photographs below show three mammals.

Tasmanian wolf (*Thylacinus cynocephalus*)



© The Zoological Society

Grey wolf (*Canis lupus*)



(Source: http://www.animalgalleries.org/Large-Land-Mammals/Wolf/Grey+Wolf+Mexican_Wolf_065+Canis+Lupus.jpg.php)

Dunnart (*Sminthopsis crassicaudata*)



5 cm

(Source: apscience.org.au)

The evolutionary relationships between these three mammals were investigated. The DNA base sequence of part of the gene for 12S ribosomal RNA from each mammal was analysed.

Tasmanian wolf	CCTGGCCTTACTGTTAATTCTTATTAGACCTAC
Grey wolf	CCTAGCCTTCCTATTAGTTTTTAGTAGACTTAC
Dunnart	CCTAGCCTTACTGTTAATTTTTATTAGACCTAC

- (a) Explain which two of these mammals are most closely related in their evolutionary history.

(2)

- (b) The Tasmanian wolf is a marsupial mammal. In marsupials, the young are born in a tiny, immature form and move into a pouch on the abdomen of the mother to develop further.

The grey wolf is a placental mammal. The fetus develops inside the uterus and the larger young are born in a more mature form.

The ancestors of Tasmanian wolves and grey wolves once shared similar habitats.

Explain why grey wolves and their close relatives are now found in many parts of the world but Tasmanian wolves only survived on isolated islands.

(3)

(Total for Question 4 = 5 marks)

5 Streak plating is used in microbiology to separate individual species of bacteria from a mixed liquid culture.

(a) Describe how streak plating can be used to isolate individual bacterial colonies from a mixed liquid culture.

You may use a diagram in your answer.

(5)

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(b) Explain why agar plates should be incubated below 30°C in a school laboratory.

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(Total for Question 5 = 7 marks)

- 6 A student carried out an investigation to test the hypothesis that the surface area to mass ratio of leaves is affected by the amount of light they receive.

A nettle plant growing in sunlight and a second nettle plant growing in shade in a wood were selected.

The surface area and mass of several leaves were measured and the surface area to mass ratio was calculated. The table below shows the results.

Leaf	Surface area to mass ratio / $\text{cm}^2 \text{g}^{-1}$	
	Nettle plant growing in sunlight	Nettle plant growing in shade
1	114.5	118.9
2	114.0	117.8
3	115.2	118.1

- (a) Explain how the data shows how nettle plant leaves grown in the shade are adapted to growing in low light intensities.

(3)

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- (b) The student was told that his method was not valid and that some biotic and abiotic variables may not be controlled.

Give five ways in which the student could modify the investigation to address these concerns.

(5)

[illegible]

(Total for Question 6 = 8 marks)

- 7 An investigation was carried out to determine the effect of substrate concentration on the initial rate of an enzyme-controlled reaction.

The substrate used was powdered milk, which is made up of a protein called casein. A solution of powdered milk is a cloudy white colour.

Protease enzymes will break down the casein in powdered milk to form a clear solution.

A colorimeter can be used to measure the amount of light absorbed by a solution in a tube. A cloudy solution absorbs more light.

5 cm³ of 0.1% solution of powdered milk was added to a colorimeter tube and mixed with 0.1 cm³ of a protease enzyme. The mixture was quickly placed in the colorimeter and the absorption of the solution was then recorded every 10 seconds for 30 seconds.

This was then repeated using different concentrations of casein.

- (a) Explain why it is important to measure the initial rate of enzyme-catalysed reactions.

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- (b) A student carrying out this investigation recorded the data shown in the table below.

Casein concentration (%)	Absorption (arbitrary units)			
	0 s	10 s	20 s	30 s
0.1	0.15	0.10	0.05	0.05
0.2	0.44	0.34	0.23	0.15
0.3	0.67	0.49	0.32	0.16
0.4	0.87	0.65	0.43	0.22
0.5	0.98	0.75	0.52	0.26

- (i) Explain why using all of the absorption data from every concentration of casein would not give a valid comparison of initial rates.

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- (ii) Explain how the results obtained could be used in the design of an investigation to compare the activity of proteases from different mammals.

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(Total for Question 7 = 7 marks)

- 8 A student investigating the factors affecting the heart rate of humans carried out a trial to find out the most reliable method of counting the number of heartbeats in one minute.

She counted the number of pulses in one minute of a single subject in identical conditions using two different methods.

Method A – she counted the number of pulses for 15 seconds and multiplied the result by 4.

Method B – she counted the number of pulses continuously for one minute.

The table below shows the results of six trials for each method.

Method	Pulse rate / beats min ⁻¹						Mean pulse rate / beats min ⁻¹	Standard deviation
A	64	60	68	76	64	72	67.3	5.9
B	63	59	69	58	71	74	65.7	

- (a) The student calculated the standard deviation for method A using the following formula:

$$\sigma = \sqrt{\frac{\sum [x - \bar{x}]^2}{n - 1}}$$

Calculate the standard deviation for method B.

(3)

Answer

(b) Explain why standard deviation is used for analysing the data.

(3)

(c) Explain why both methods **A** and **B** can lead to inaccuracies.

(3)

(Total for Question 8 = 9 marks)

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9 Antibiotics have been developed to control bacterial infections.

(a) Name **one** bacterium which causes symptoms of infection by producing exotoxins.

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(b) Explain how an antibiotic has a bacteriostatic effect on bacteria.

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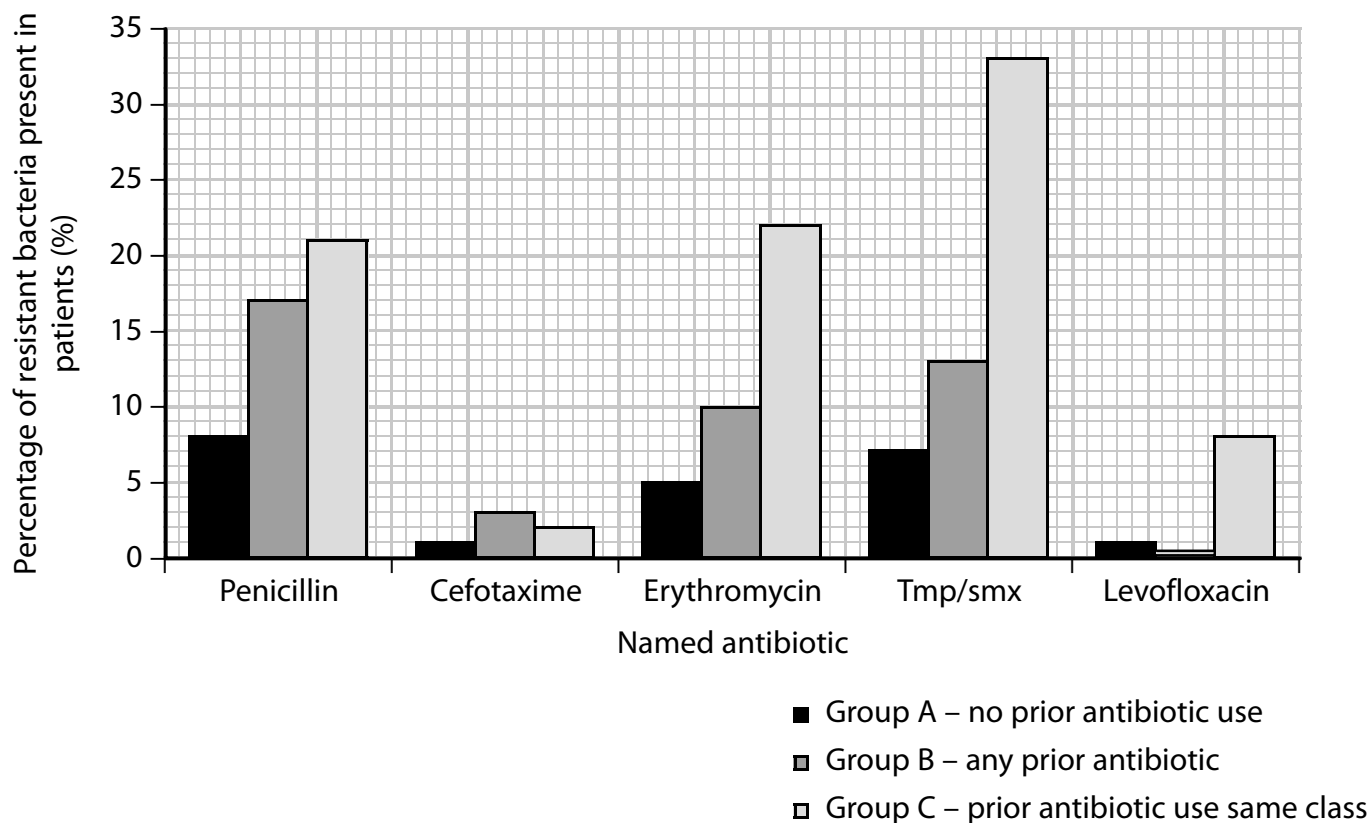
*(c) Bacterial resistance to common antibiotics is an increasingly serious problem facing doctors treating a wide range of infections.

The graph below shows the percentage of resistant bacteria in patients being treated with antibiotics for *Streptococcus pneumoniae* infections.

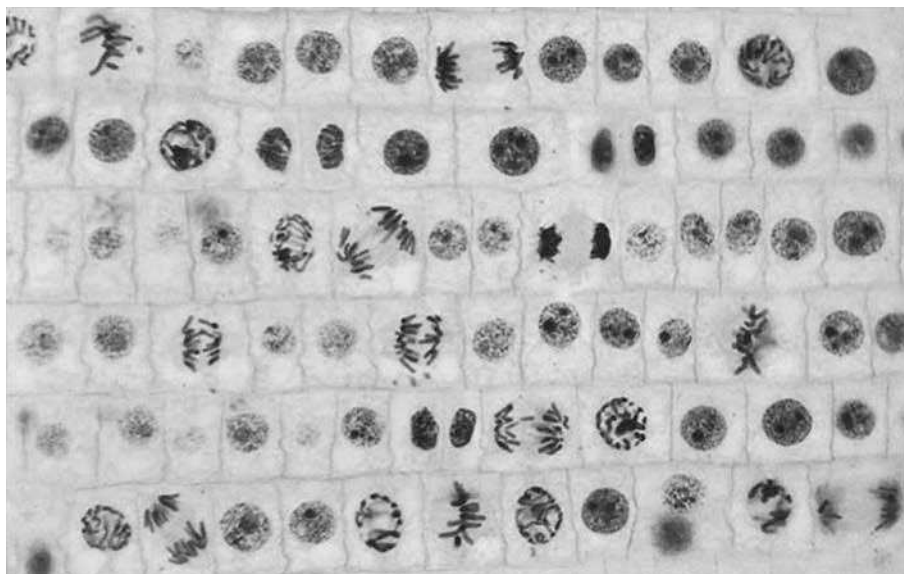
Group A had never been given antibiotics.

Group B had been previously treated with other antibiotics.

Group C had been previously treated with the named antibiotic.



10 The photomicrograph below shows a stained squash preparation of an onion root tip.



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- (a) Describe how you would prepare a root tip squash to observe the stages of mitosis under the light microscope.

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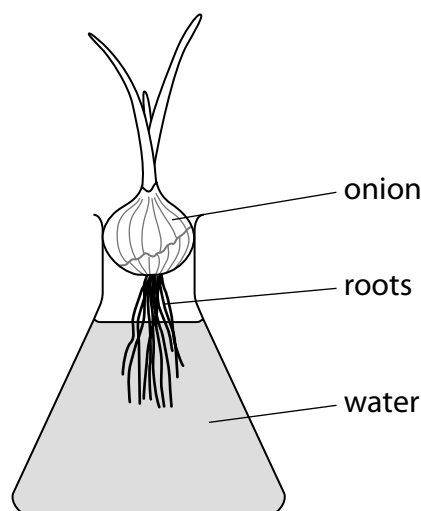
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- (b) A student decided to investigate how many cells were undergoing cell division in different areas of a root. She grew some onion roots in a conical flask containing water, as shown in the diagram below.



She examined a root tip squash and counted the number of cells undergoing mitosis and the total number of cells in the field of view and calculated the mitotic index using the following formula.

$$\text{Mitotic index in \%} = \frac{\text{Number of cells undergoing mitosis}}{\text{Total number of cells viewed}} \times 100$$

The student determined the mitotic index of cells at five distances from an onion root tip. She repeated this procedure six times.

Her results are shown in the table below.

Distance from root tip / mm	Mitotic index (%)							Standard deviation (SD)
	Root tip						Mean	
	1	2	3	4	5	6		
0.1	11.5	11.0	10.7	10.6	11.7	10.9	11.1	0.4
0.3	9.4	8.9	7.8	9.9	9.7	8.9	9.1	0.8
0.5	8.1	8.9	7.6	7.7	8.4	7.5	8.0	0.5
0.9	4.0	3.9	3.6	4.2	4.4	3.7	4.0	0.3
1.1	3.0	2.9	3.2	3.3	2.7	2.9	3.0	0.2

The student concluded that there is a negative correlation between the mitotic index and the distance from the root tip in plants.

However, this conclusion may not be valid because the investigation has limitations.

- (i) Give one way in which the student could modify her procedure to reduce the effect of a named limitation.

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- (ii) Weeds reduce the yield of commercial crops that grow in fields. Some herbicides that are sprayed onto soil kill weeds by preventing mitosis.

Explain how the student could modify her investigation to find the herbicide concentration that is most effective at preventing mitosis.

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- (c) In an investigation to determine the quantity of DNA in the nucleus of different cells from the plant *Tradescantia paludosa*, squash preparations of each tissue were stained for DNA in an identical manner.

The quantity of DNA in the nucleus of several cells was found by measuring the amount of light absorbed when the microscope was focused on a small area of the nucleus.

The results of this investigation are shown in the table below.

Nucleus of	Mean nuclear absorption / arbitrary units
Root tip cells in prophase	16.2
Root tip cells undergoing cytokinesis	8.3
Nucleus of pollen tube	4.2
Nucleus of endosperm	12.8

Analyse the data to explain the difference in the mean nuclear absorption of the nucleus of the different cells.

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(Total for Question 10 = 13 marks)

11 A student investigated the rate of uptake of nitrate ions (NO_3^-) into plant cells.

Discs of carrot were cut and half of them were immersed in a solution containing $10 \mu\text{mol dm}^{-3}$ nitrate ions. The other half were placed in the same nitrate ion solution to which 2,4-dinitrophenol (DNP) was added.

DNP inhibits the process of oxidative phosphorylation.

The nitrate ion concentration of the discs was determined every five minutes.

The student failed to pre-treat the carrot discs before placing them in the solution.

(a) Explain how the carrot discs should be pre-treated.

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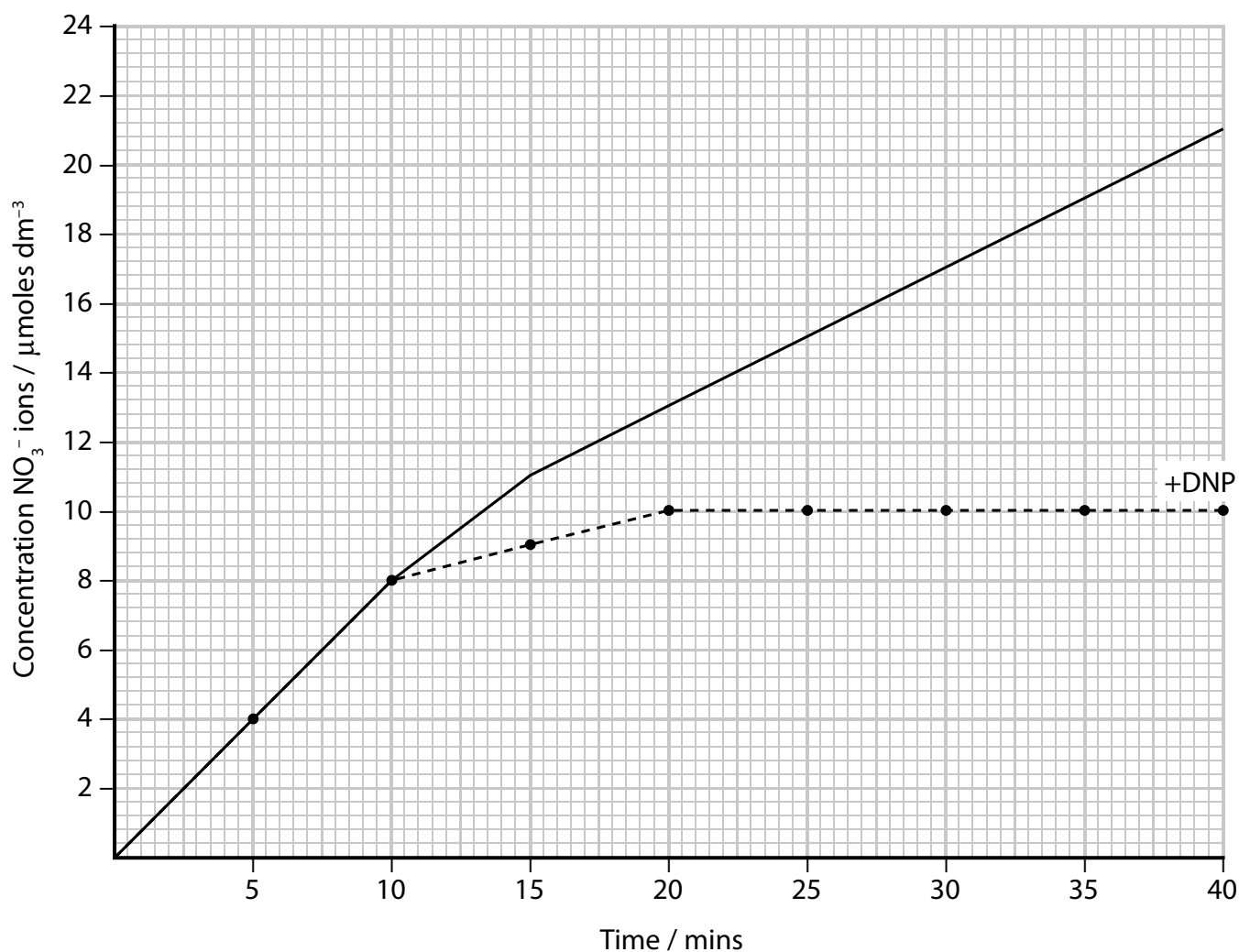
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The graph below shows the results of this investigation after the carrot discs were pre-treated.



(b) Calculate the mean rate of nitrate ion uptake of the carrot discs placed in the nitrate ion solution without DNP between 5 and 10 minutes.

(3)

Answer

(c) Analyse the data to explain the effect of DNP on the nitrate ion uptake of the carrot tissue between 0 to 10 minutes and 20 to 30 minutes.

(3)

(d) DNP acts by rapidly transferring protons (H^+ ions) across biological membranes.

Explain how this action will bring about the effect of DNP on oxidative phosphorylation.

(3)

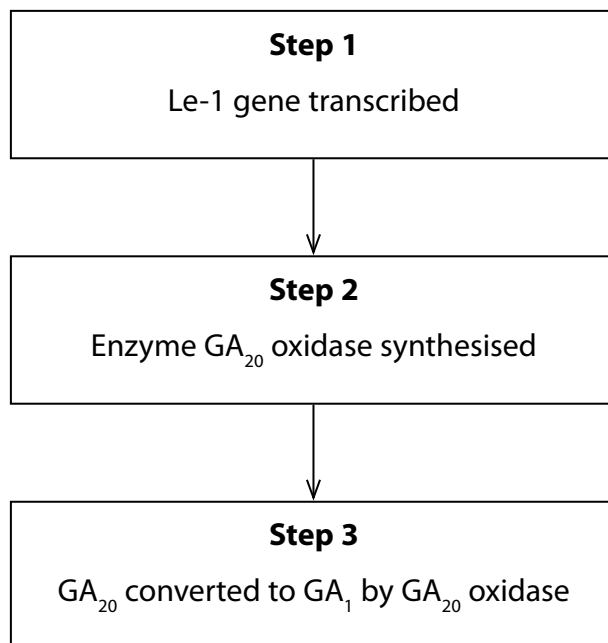
(Total for Question 11 = 12 marks)

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Turn over for question 12

- 12** 'DELLA' proteins normally prevent transcription factors from binding to important growth-stimulating genes in the cells of plant stems.

The diagram below shows part of the biochemical pathway leading to the synthesis of an active plant growth substance called gibberellin (GA_1). GA_1 reduces the effect of 'DELLA' proteins.



- (a) The Le-1 gene codes for the enzyme GA_{20} oxidase. A mutation of this gene forms a recessive allele which, when translated, leads to a single amino acid change in this enzyme. This change significantly reduces the activity of GA_{20} oxidase.

Explain how a single amino acid change can bring about a change in the structure and activity of GA_{20} oxidase.

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(b) (i) Explain why homozygous recessive plants will have short stems.

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(ii) An ecological survey of a stable population of one species of plant found that 36% had short stems.

Calculate the percentage of heterozygous individuals in this population.
Assume that there are only two alleles for this gene.

(4)

Answer

(Total for Question 12 = 12 marks)

13 The photograph below shows limpets *Patella vulgata* living on a rocky seashore.

Limpets are snail-like animals with a conical shell. The limpets live on a part of the shore which is covered by the sea twice each day. They feed on algae when the rocks are covered with sea water.

When they are uncovered at low tide they clamp against the rock to prevent desiccation.



A student investigated the relationship between the size of the limpets and their location on the shore.

A 40 m transect was used, beginning at the low water mark and extending up a sloping rocky shore. A 1 m² quadrat was placed every 5 m along this transect and the diameter of 10 randomly selected limpets was measured.

The table below shows data collected from this investigation.

Distance from low water mark / m	Rank of distance	Mean diameter of limpets / mm	Rank of diameters	Difference in the two ranks (D)	D ²
0	9	19.8	3	6	36
5	8	20.2	1	7	49
10	7	19.6	4	3	9
15	6	18.8	5	1	1
20	5	20.1	2	3	9
25	4	17.4	6	-2	4
30	3	16.1			
35	2	16.9	8	-6	36
40	1	17.2			

(a) Complete the table on the previous page to show the missing data.

(2)

(b) (i) To test the strength of the relationship between these two variables, the student decided to apply a Spearman's rank correlation test.

Calculate the Spearman's rank correlation coefficient for these two variables.

(3)

$$r_s = 1 - \frac{6(\sum D^2)}{n(n^2 - 1)}$$

Answer

- (ii) A student formed the hypothesis that the size of the limpets would decrease as the distance up the shore increased.

The table below shows critical values of r_s at different significance levels.

Number of pairs	Significance levels			
	10%	5%	2%	1%
8	0.643	0.786	0.833	0.881
9	0.600	0.683	0.783	0.833
10	0.564	0.648	0.746	0.794

Use the calculated value of r_s and this table to comment on whether the student's hypothesis can be accepted.

(3)

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(c) The student carrying out the investigation wrote a further hypothesis:

'The limpets lower on the shore have a longer time to feed and will grow bigger.'

Design a laboratory experiment to test this hypothesis.

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(Total for Question 13 = 13 marks)

TOTAL FOR PAPER = 120 MARKS

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