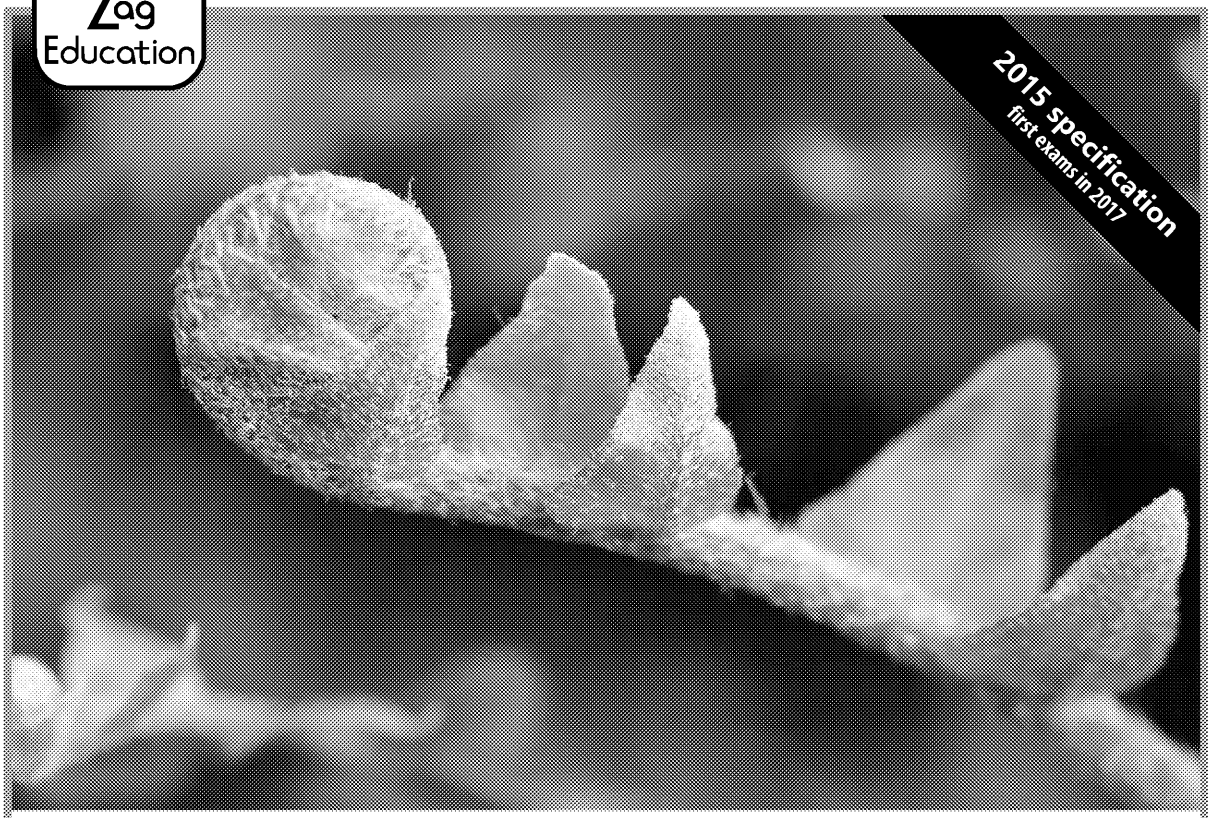
Zig Zag Education

Biology **A Level | AQA | 7402**



Practice Exam Papers for A Level AQA Biology

Paper 3

zigzageducation.co.uk **POD 8267**

Contents

Teacher's Introduction

This pack contains **four practice Paper 3s** for the **AQA A Level Biology** specification (7402, first teaching September 2015). The papers and corresponding mark schemes in this pack are modelled on the sample assessment material provided by the board.

A Level Biology Paper 1 covers:

- Module 1: Biological molecules
- Module 2: Cells
- Module 3: Organisms exchange substances with their environment
- Module 4: Genetic information, variation and relationships between organisms

Remember!
Always check the exam board website for new information, including changes to the specification and sample assessment material.

A Level Biology Paper 2 covers:

- Module 5: Energy transfers in and between organisms.
- Module 6: Organisms respond to changes in their internal and external environment
- Module 7: Genetics, populations, evolutions and ecosystems
- Module 8: The control of gene expression

A Level Biology Paper 3 covers all modules, with an emphasis on practical skills, data analysis and scientific methodology.

These papers are designed so they can be used as either mock examinations or revision activities. In structure, the mark scheme resembles those produced by AQA in their sample assessment material. Additionally, the mark scheme is designed with both students and teachers in mind, allowing students to mark their own work and assess their progress.

Each practice paper contains both short and longer questions in proportion to the sample assessment material. These include factual recall, explanation and evaluation questions. Papers have been designed to ensure that the mathematical and practical skills specified in the new syllabus are assessed.

Across the three practice paper packs (Papers 1, 2 and 3), coverage of the specification is thorough and varied. Although maths and practical skills marks are distributed throughout the three papers, they make up a higher proportion of Paper 3 than Paper 1 and Paper 2, as per the specimens.

The authors have aimed to include in each paper a spread of material from the relevant topics, allowing teachers to obtain an overview of their students' knowledge and understanding for each unit. A specification analysis grid is also included, enabling teachers to identify relevant questions for tests and exam-technique activities, or for homework assignments.

I hope you and your students find this pack useful.

April 2018

Specification Cross-Referenc

		Paper 3A							Paper 3B							
		1	2				6	Total	1	2	3	4	5	6	7	Total
1	**Biological molecules**				0	0	0	**3**	0	0	0	0	0	2	0	**2**
1.1	Monomers and polym[illegible]s							1								0
1.2	Ca[illegible]tes							0								0
1.3								0								0
1.4								0						2		2
1.5	Nucleic acids are important information-carrying molecules	1						1								0
1.6	ATP	1						1								0
1.7	Water							0								0
1.8	Inorganic Ions							0								0
2	**Cells**	1	0	13	0	0	0	**14**	0	1	0	0	0	0	0	**1**
2.1	Cell structure	1						1								0
2.2	All cells arise from other cells			13				13								0
2.3	Transport across cell membranes							0								1
2.4	Cell recognition and the immune system							0								0
3	**Transport systems**	0	0	0	[illegible]			0	10	3	0	0	0	0	0	**13**
3.1	Surface area to volume ratio							0								0
3.2	Gas exchange							0								0
3.3	Digestion and absor[illegible]							0		3						3
3.4.1	Mass tr[illegible]ani[illegible]s							0								0
3.4.2	Mass transport in plants							0	10							10
4	**Genetic information, variation and relationships between *organisms***	4	0	0		0	0	**4**	0	0	0	0	2	2	0	**4**
4.1	DNA, genes and chromosomes							0								0
4.2	DNA and protein synthesis	4						4								0
4.3	Genetic diversity can arise as a result of mutation or during meiosis							[illegible]					2			2
4.4	Genetic diversity and apatation							0								
4.5	Species and taxonomy							0								0
4.6	Biodiversity within a community							0								
4.7	Investigating diversit[illegible]							0						2		2

		Paper 3A							Paper 3B							
		1	2	3	4	5	6	Total	2	3	4	5	6	7	Total
5	**Energy transfers in and between organisms**	0	11	0	0	2		0	0	0	0	0	0	0	**0**
5.1	Photosynthesis							0							0
5.2	Respiration							11							0
5.3	Energy and ecosystem					2		2							0
5.4	N… cycle							0							0
6	**Orga… to change… internal and external environments**	0	0	0	8	0	0	**8**	0	2	0	10	0	2	0	14
6.1	Stimuli, both internal and external, are detected and lead to a response							0				10		2		12
6.2	Nervous coordination							0								0
6.3	Skeletal muscles are stimulated to contract by nerves, and act as effectors							0								0
6.4.1-2	Homeostasis and blood glucose concentration				8			8								2
6.4.3	Control of blood water potential							0								0
7	**Genes, populations, volution and ecosystems**	0	0				0	**5**	0	0	0	0	10	0	0	**10**
7.1	Inheritance															0
7.2	Pop… tion…															0
7.3	Evo… lea…												5			5
7.4	Populati… ecosystems												5			5
8	**The control of gene**	0	0	0	0	6	0	**6**	0	1	6	0	0	2	0	**9**
8.1	Alteration of the sequence of bases in DNA can alter the structure of proteins							0			1			2		3
8.2	Gene expression is controlled by a number of features							0		1	5					6
8.3	Genome projects							0								0
8.4.1	Recombinant DNA technology					6										0
8.4.2-3	DNA probes and genetic fingerprinting							0								0
	Total		11	13	8	13	25	**78**	10	7	6	10	12	8	25	**78**

A Level Biology

Practice Pape

Name	

Time allowed
2 hours

Instructions
- Answer **all** of the questions and use the space provided.
- Use black ink. You may use an HB pencil for graphs and diagrams.
- Show your working for questions that require calculations.

Information
- The total number of marks available for this paper is **78**.
- Use of an electronic calculator may be permitted.

1.1 DNA is a polymer, made up of many smaller subunits joined together. Give monomers which make up DNA.

.....

1.2 The enzyme DNA polymerase synthesises a new strand of DNA, which is co existing strand. When it adds new nucleotide subunits, it uses a modified ve ATP (adenosine triphosphate), CTP (cytosine triphosphate), GTP (guanosine TTP (thymine triphosphate).

Explain how these molecules would have to be altered in order to add them and suggest why this stage might be useful.

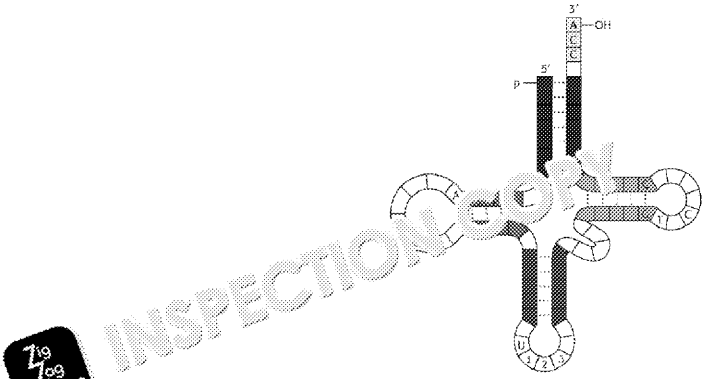
.....

.....

.....

.....

Figure 1



1.3 As well as coding for proteins, DNA also codes for the type of molecule sho Name the type of molecule, and briefly explain its role in translation.

.....

.....

.....

.....

.....

1.4 The antibiotic tetracycline kills bacteria by binding to the small subunit of t cannot enter the ribosome. Why would this be beneficial to bacterial cells?

.....

.....

1.5 Suggest why tetracycline is able to kill bacteria without damaging human b

.....

.....

2.1 The four sentences below relate to the products of respiration. Pick the co
the list:

A	The main purpose of respiration is to produce ATP; carbon dioxide a
B	The main purpose of respiration is to produce ATP; carbon dioxide i recycled.
C	The main purpose of respiration is to pr[illegible] ADP; carbon dioxide a
D	The main purpose of respirati[illegible] t[illegible]oduce ADP; carbon dioxide i recycled.

Your answer: [ ]

2.2 All of t[illegible]molecules referenced in **2.1** are either inputs or products in the K
acetyl group from acetylcoenzyme A is used to produce citrate.

Describe the remaining stages of the Krebs cycle.

.....

.....

.....

.....

.....

.....

2.3 Sodium fluoroacetate is a resp[illegible]ry poison found in some South African p
by cells into fluorocitr[illegible]hich inhibits aconitase, an enzyme which usuall
intermediate [illegible] in the Krebs cycle.

Resea[illegible] are studying how fluorocitrate's inhibitory effect changes at di

- Different concentrations of citrate solution are added to a test tube co
- 1 ml of 50 µMol dm^{-3} fluorocitrate solution is then added.
- The mixture is allowed to react for five minutes.
- The quantity of the product (cis-aconitate) is later measured.

State **two** variables that should be controlled in this investigation.

.....

.....

.....

.....

2.4 Each reaction is allowed to continue for five minutes. The results of the ex

Table 2

Citrate concentration (mMol dm^{-3})	cis-aconitate pr
10	34
20	38
30	49
40	65
50	102

Calcu e ... cis-aconitate production at 20 mMol dm^{-3} citrate con
answ andard form.

.....

.....

.....

.....

2.5 Use the data and the information you have read to evaluate whether sodi
could be used as an effective pesticide on crop plants.

.....

.....

.....

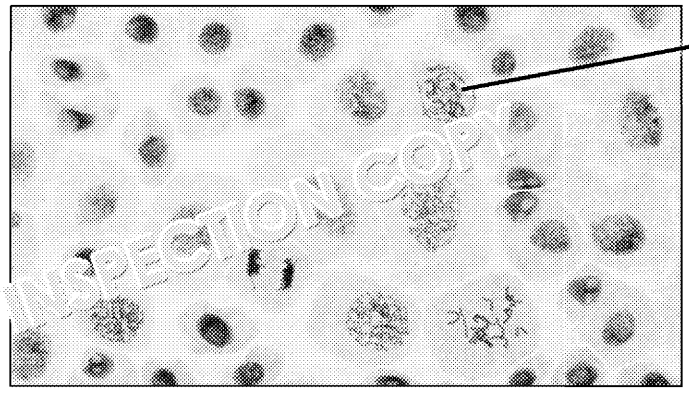
.....

.....

.....

3 **Figure 3.1** shows part of a light micrograph of plant cells in root meristem t
undergoing mitosis.

Figure 3.1



3.1 Which stage of mitosis is cell X undergoing?

.....

3.2 Briefly, outline how a plant tissue like the one shown in **Figure 3.1** is prepa
light microscope.

.....

.....

.....

.....

.....

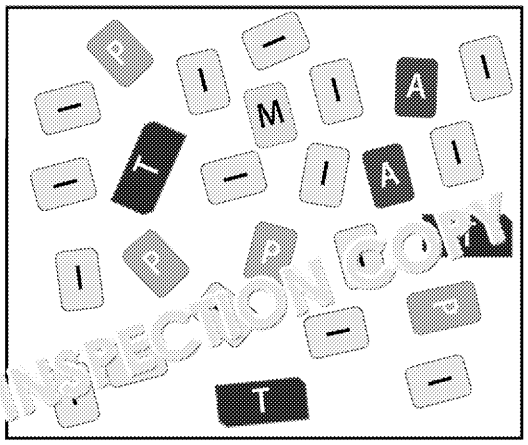
.....

.....

.....

.....

Figure 3.2



K
I = Inter
P = Proph
M = Meta
A = Anap
T = Telop

3.3 **Figure 3.2** is a diagrammatic representation of a plant meristem tissue san
the equation below, calculate the mitotic index of the tissue sample.

$$\text{Mitotic index} = \left(\frac{\text{Number of cells in mitosis}}{\text{total number of cells}}\right) \times 100$$

Mitotic inc

3.4 When studying a rainforest flowering plant, scientists identify an alkaloid p
substance Y. This substance binds to extended spindle fibres, preventing t

Describe how this affects the cell cycle.

.....

.....

.....

.....

3.5 Suggest why substance Y might be of interest to scientists developing new

.....

.....

3.6 Substance Y is used in the production of Drug A, an anti-cancer drug. The d
stage, and is tested in volunteer cancer patient[illegible] compared to Drug B,
treatments. Some of the results are shown in Table 3.

Table 3

	Number of trained individuals	Average reduction in tumour size after 28 days (%)
Drug A	28	85
Drug B	31	81

A researcher argues that 'these results show that Drug A is more effective
treatment'. Do you agree? Justify your answer.

.....

.....

.....

.....

.....

.....

4.1 Explain why it is important to maintain blood glucose levels within a narro

.....

.....

.....

.....

4.2 People with diabetes cannot regulate their blood sugar levels effectively. A
glucose in their urine. It is possible to test for glucose by adding Benedict's
heating in a water bath – if there is glucose present, Benedict's reagent wi
to red (positive result).

Is this a quantitative or qualitative test? Explain your answer.

.....

.....

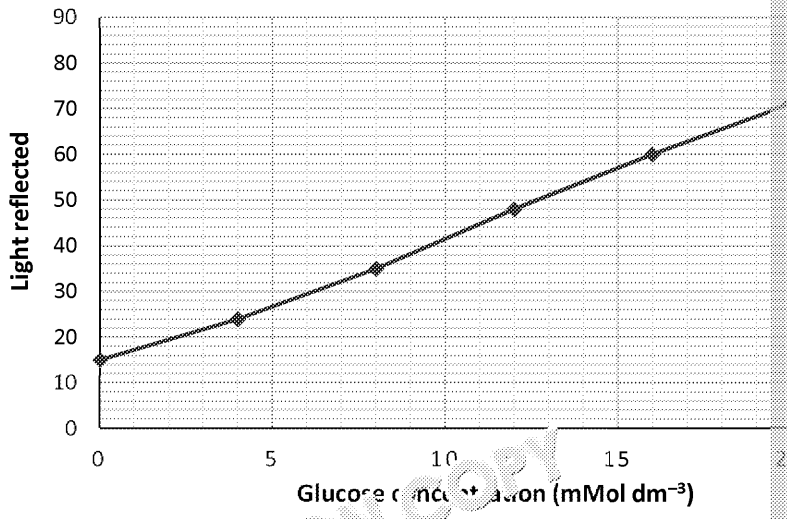
Small amounts of glucose may be present in the urine of healthy, non-diabetic in
To give a more confident diagnosis, a calibration curve can be used.

Different amounts of glucose solution are added to water to produce solutions o
12 mMol dm^{-3}, 16 mMol dm^{-3}, 20 mMol dm^{-3} and 24 mMol dm^{-3}; a control conta
specific Benedict's reagent is added, and the samples are heated before placing i
passed through each sample; the more the reagent reacts with glucose, the redc
therefore, the more light will be reflected, instead of being absorbed. This mean
and reach the other side of the sample.

Results of this process are shown in Figure 4.

Figure 4:

Glucose concentration – calibration cur



4.3 Suggest one improvement to the drawing of this graph.

.....

.....

4.4 A glucose level of more than 13 mMol dm^{-3} of glucose in the urine strongly
sample taken from patient X produces a colorimeter reading of 55 % light

Do you think patient X has diabetes? Explain your answer.

.....

.....

.....

.....

4.5 The patient is asked to return for an identical test at a later date. Use you
scientific process to explain why.

.....

.....

.....

.....

5

Figure 5

5.1 Saffron crocuses (*Crocus sativus*, **Figure 5**) with a dominant allele for gene E in the flowers, but flowers with two recessive alleles have light blue pigment to B, and crocuses with a dominant allele for gene F always have white flowers.

Two crocuses that are doubly heterozygous for genes B and F are crossed to generation, which consists of 91 crocus flowers. To the nearest whole number many F_1 crocuses will have purple flowers (you may use a diagram to help y

.....

.....

.....

.....

.....

.....

.....

.....

.....

5.2 Gene **F** codes for an enzyme which is active in the flower. Suggest what th

.....

.....

5.3 When collected and dried, the stigmas (female reproductive organs) of *C. s* They have a vivid red colour, caused by the pigment α-crocin.

Saffron is grown as a commercial crop. However, the crop yield is very low squared of farmland per year (182 kg km^{-2} y^{-1}).

Calculate the biomass of saffron produced by 1 m^2 of saffron crocus crop i answer in standard form.

.....

5.4 Bacteria are genetically modified to produce a cheaper version of the saffr
bacteria are transformed using genes coding for enzymes from the saffron
This allows the bacterial cells to produce α-crocin from one of their own re

The scientists also insert an additional gene, YFP, which produces yellow fl
Suggest the purpose of the additional gene.

.....

.....

.....

.....

.....

.....

5.5 Other organisms besides bacteria can be modified to produce useful produ
crop plants may be genetically modified to produce naturally occurring pe

Using this example, explain why genetic modification is controversial, and
with its use.

.....

.....

.....

.....

.....

.....

Write an essay on **one** of the topics below.

6.1 Protein structure and function.

OR

6.2 The role of membranes in cells.

A Level Biology

Practice Paper 3

Name	

Time allowed
2 hours

Instructions
- Answer **all** of the questions and use the space provided.
- Use black ink. You may use an HB pencil for graphs and diagrams.
- Show your working for questions that require calculations.

Information
- The total number of marks available for this paper is **78**.
- Use of an electronic calculator is permitted.

1.1 Xylem and phloem tissue are both adapted for mass transport in plants. Xy
transpiration, while phloem is adapted for translocation of sugars.

Give one difference between the structures of xylem and phloem, and exp
this observation.

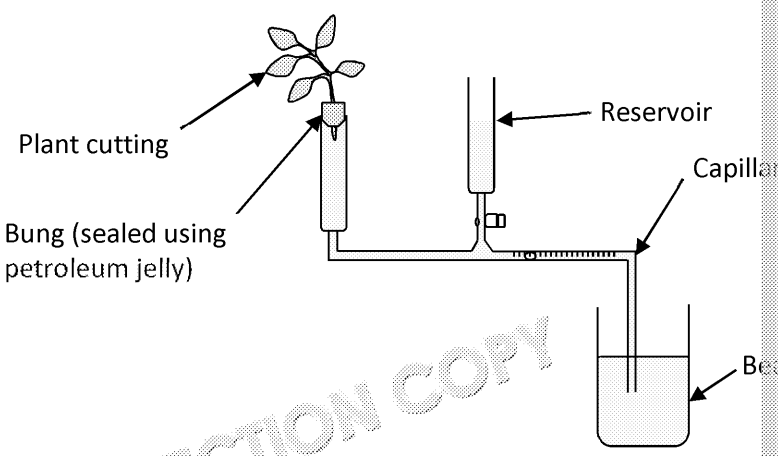
.....

.....

.....

.....

Figure 1: Simple potometer



1.2 A sim to ater is set up to measure the rate of transpiration in a plan
The e he stem is inserted into a capillary tube via a hole in a rubber b
petroleum jelly.

The plant draws water up the capillary tube, which is replenished by wate
bubble can be introduced at the end of the capillary tube – its movement a
calculate the rate of transpiration.

What is the purpose of the petroleum jelly?

.....

.....

.....

.....

1.3 The capillary tube is circular in cross section, with a diameter of 0.6 cm. Ca
water has been transpired at each stage, and fill in the values in **Table 1**.

Table 1: Transpiration over time

Time (min)	Bubble movement (cm)	Volume of water t
0	0	
3	[illegible]	
	4.2	
9	6.3	
12	8.5	
15	10.5	
18	12.7	

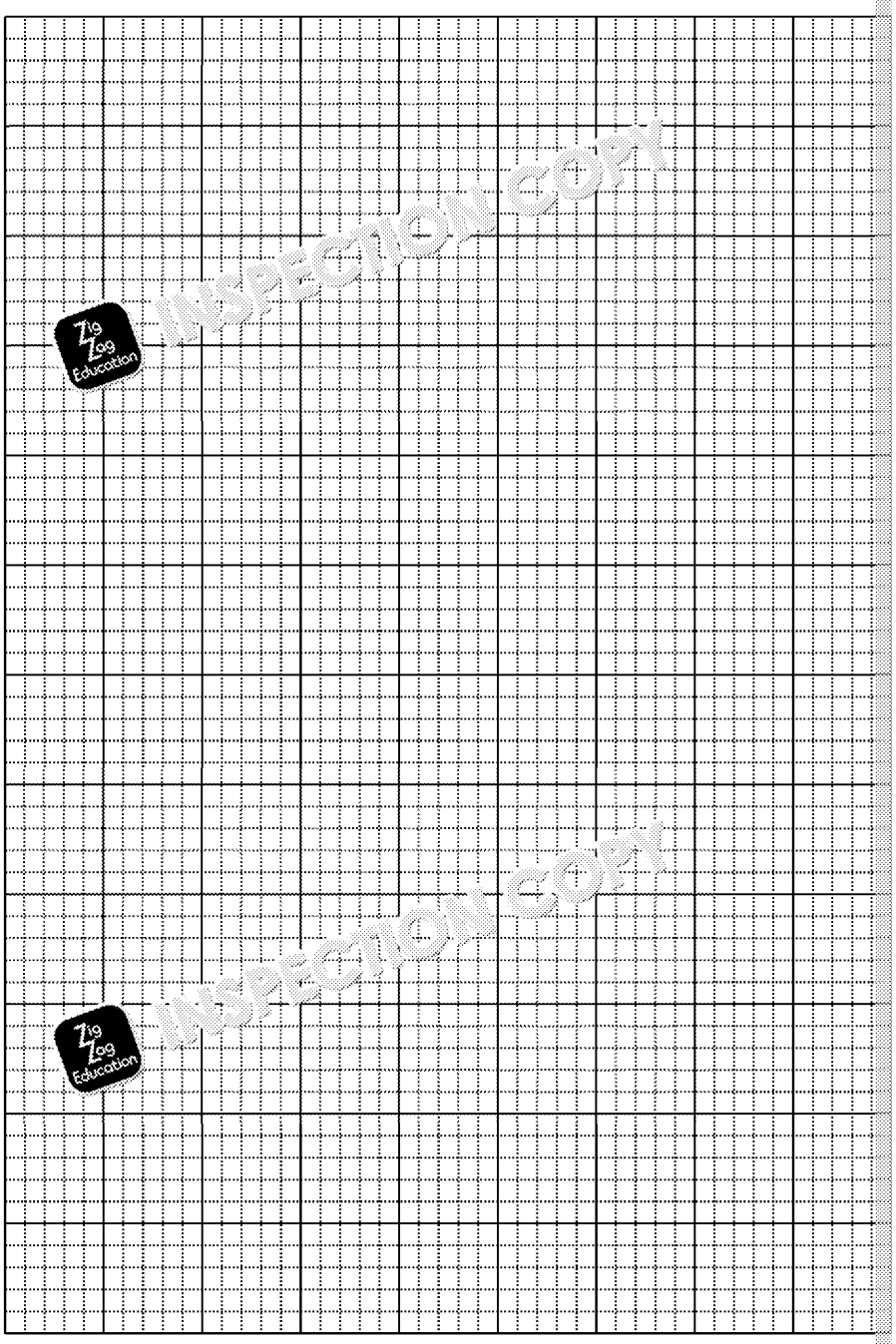
.....

.....

.....

.....

1.4 Use the graph paper below to plot a graph which shows the volume of wa
by the plant over time. Include a line or curve of best fit for the data.



1.5 Use the graph to calculate the average rate of transpiration shown by the p
appropriate units.

.....

.....

Rate: .....

2.1 Meals have varying amounts of glucose; when we consume food, the body
glucose as possible into the blood across the epithelium of the ileum. Gluc
membrane of the ilear epithelium by cotransport. Briefly describe this pro

.....

.....

.....

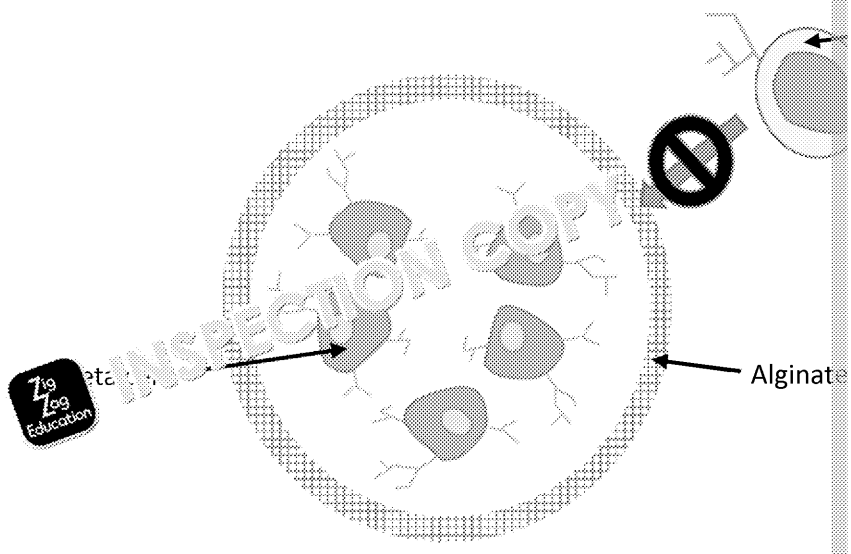
.....

.....

.....

2.2 The hormone insulin regulates blood glucose levels, particularly after meal
cannot produce insulin. One potential treatment involves implanting patie
produced from stem cells. However, the cells may first be surrounded by a
selectively permeable.

Figure 2



Based on **Figure 2** and your own knowledge, suggest the purpose of the al

.....

.....

.....

.....

2.3 The method described in **question 2.2** is tested in mice with diabetes. In G
the alginate gel capsule, while in Group B, cells are implanted with no caps
under normal conditions for days 1–14.

On day 15 of the trial, the two groups of mice are not fed for 12 hours, and
food. The two groups are compared for the rate of insulin production and
normal blood sugar after eating. The results are shown below, in **Table 2**.

Table 2

	Mean rate of insulin production (pg L^{-1} min^{-1})	Standard deviation	Mean baseline
Group A	16.4	3.7	
Group B	9.7	1.5	

Describe an appropriate way to graphically present this data.

.....

.....

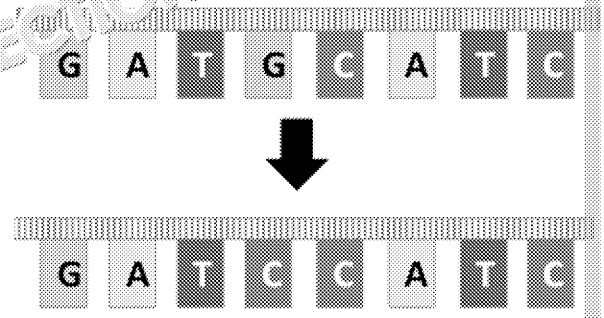
2.4 Explain why the treatment described in **2.3** would not be effective for trea

.....

.....

3 An error during DNA replication causes a change in the base pair sequence

Figure 3



3.1 Name the type of mutation which is shown in **Figure 3**.

.....

3.2 The mutated protein is thought to be linked to the occurrence of cancer w
A medicine is designed to reduce the risk of cancer, based on the action of
RNA (siRNA).

Suggest how this medicine would wo

.....

.....

.....

.....

.....

3.3 Tumour cells typically undergo a process of 'reverse differentiation'. Sugg
occur in terms of the shape of the cells or tissue, and the proteins produce

.....

.....

.....

.....

4.1 Organ ave many behavioural responses to stimuli. These include tax
What is the difference between a taxis response and a kinesis response?

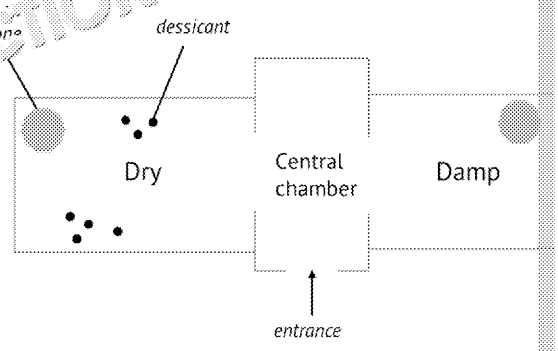
.....

.....

An experiment is conducted into response to the environment in earthwo

- Fifty earthworms are placed into a central chamber which leads to tw
- One is dry and contains pellets of desiccant scattered at two location
- The other has been made damp, and has been covered with a dark cl
by light and heat.
- After 30 minutes, the earthworms in the dry chamber and in the damp
abundance is recorded.
- The experiment is repeated three times by three g ups of students, pr

igure 4 (to scale)



4.2 Suggest two flaws in this methodology.

.....

.....

.....

.....

4.3 The data from the experiment is shown in **Table 4.1**.

Table 4.1

Repeat number	1	2	3	4	5	6
Earthworms in dry chamber *(after 30 mins)*	7	11	13	24	9	15
Earthworms in damp chamber *(after 30 mins)*	30	31	1[illegible]	20	28	33

Calculate the standard d[illegible]ati[illegible] the number of earthworms in the damp 30 minutes. The [illegible]or standard deviation is given below.

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

.....

.....

Standard deviation

4.4 Earthworms instinctively retreat into a burrow when the ground trembles, be near. Students place earthworms into a vivarium containing porous so stimulus by gently shaking the vivarium, and record how long it takes the fully into a burrow. They repeat this process several times; the results are

Table [illegible].2

Repeat number	1	[illegible]	3	4	5
Time taken for median earthworm to retreat (s)	1	2.0	2.4	2.7	2.5

Suggest [illegible]ex[illegible]n for the pattern seen in the results.

.....

.....

.....

.....

4.5 The earthworm's burrowing response is carried out via a reflex arc. Huma which allow quick responses to harmful stimuli.

Describe the reflex response which occurs when a person touches a hot pl

.....

.....

.....

.....

.....

.....

5 Evolution has allowed organisms to adapt to changes in their environment. long fur to allow them to withstand the coldest winters. Maximum fur leng individual to individual, and can take on many possible values.

Figures 5.1 and 5.2 show the change in Arctic fox coat colour linked to sea

Figure 5.1: Arctic fox, summer fur

Figure 5.2: Arc

5.1 What does this suggest about the number of genes acting on fur length? E

.....

.....

.....

.....

5.2 Describe how rising Arctic temperatures might cau . . ectional selection fur length.

.....

.....

.....

.....

.....

.....

5.3 Describe two ways in which meiosis allows Arctic fox parents to have highl

.....

.....

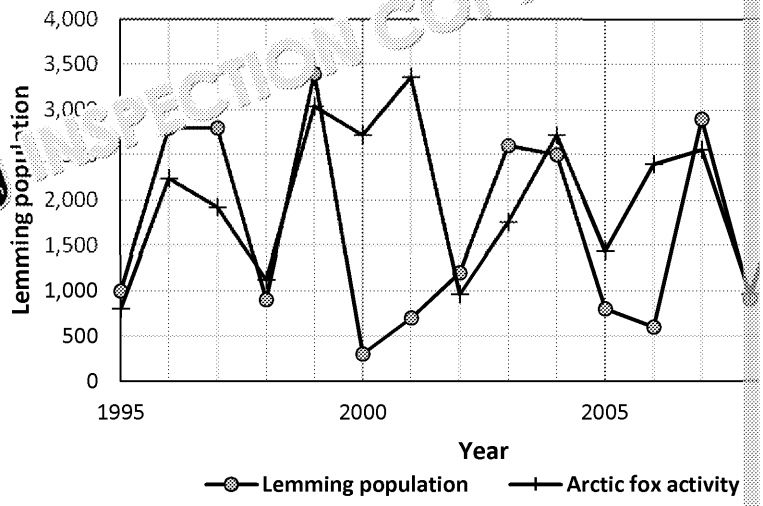
.....

.....

5.4 **Figure 5.3** shows information about Arctic fox activity (measured by dropp
lemmings, a common prey animal for the Arctic fox. Both sets of data are

Figure 5.3

Population of lemmings and Arctic fox activity (Vic



Calculate the percentage increase in the lemming population from 2000 to

.....

.....

.....

.....

5.5 Scient ave suggested that there is a strong predator–prey relationship
and lemmings.

Does **Figure 5.3** support this theory? Explain your answer using data from

.....

.....

.....

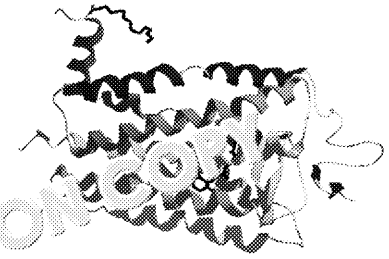
.....

.....

.....

6.

Figure 6.1



6.1 **Figu**[illegible] ho[illegible] the rod cell protein pigment, rhodopsin, which contains v[illegible] non-p[illegible] component. When light hits vitamin A, it slightly alters the ar[illegible] within the molecule, setting off a chain of reactions which leads to signal g[illegible]

Based on this information, explain what would happen to the vision of son[illegible] vitamin A deficiency, and why.

.....

.....

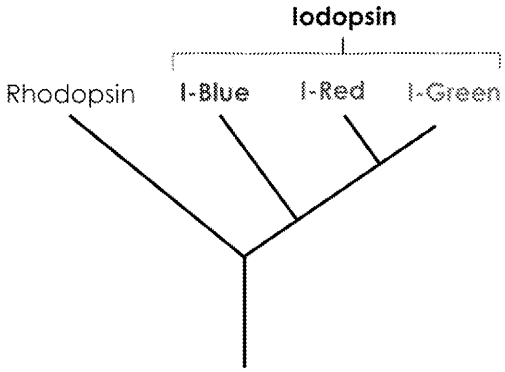
.....

.....

6.2 A mutation in the gene that codes for rhodopsin can le[illegible]d to visual impairm[illegible] causes the sulfur-containing amino acid cystei[illegible]e replaced by tyrosin[illegible] contain sulfur.

Briefly, explain how this ch[illegible] could affect the function of rhodopsin.

Figure 6.2



.....

.....

.....

.....

.....

.....

6.3 Scientists studying the proteome of the eye have concluded that all the m
originally produced by the same gene.

Suggest how the evolution of different pigments shown in **Figure 6.2** migh

.....

.....

.....

.....

6.4 Expla scientists would use evidence to produce **Figure 6.2**.

.....

.....

Write an essay on **one** of the topics below.

7.1 Why exchange surfaces are important in cells and organisms.

OR

7.2 Energy transfers in organisms and ecosystems.

A Level Biology

Practice Paper 3

Name	

Time allowed
2 hours

Instructions
- Answer **all** of the questions and use the space provided.
- Use black ink. You may use an HB pencil for graphs and diagrams.
- Show your working for questions that require calculations.

Information
- The total number of marks available for this paper is **78**.
- Use of an electronic calculator is permitted.

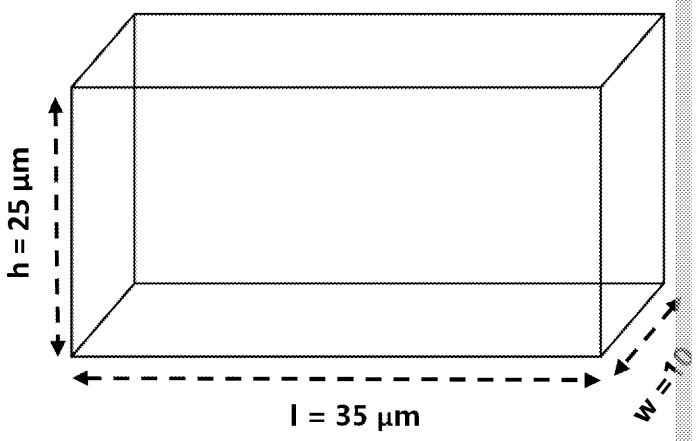
1.1 Fill in the gaps to show the higher levels of organisation which a palisade c

Palisade cell → ..... → *Leaf*

CELL **TISSUE** .....

1.2 A palisade cell can be modelled as a cuboid.

Figure 1.1



Calculate the surface area to volume ratio of the cuboid in **Figure 1.1**.

.....

.....

.....

.....

.....

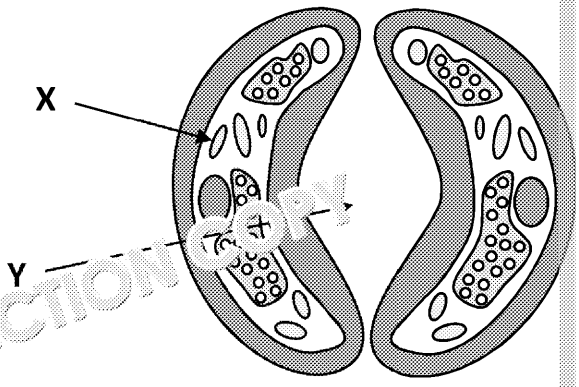
.....

1.3 Describe the importance of surface area to volume ratio in maintaining the larger organisms.

.....

.....

Figure 1.2



1.4 **Figure 1.2** is a representation of part of the leaf which is responsible for ga
correct names for X and Y.

X: .....

Y: .....

A chromatography experiment is carried out to assess the different pigme
tolerant and shade-intolerant plants.

- Four leaves each from Swiss chard (shade-tolerant) and *Rudbeckia* (sh
produce leaf samples.
- A few drops of solvent are added to each sample.
- Each mixture is dotted onto a thin-layer chromatography strip at the
- The strip is submerged into the solvent up to line Y.
- The solvent is absorbed up the paper as far as point Z.
- The results of the experiment are shown in **Figure 1.3**; R_f values are gi

Figure 1.3

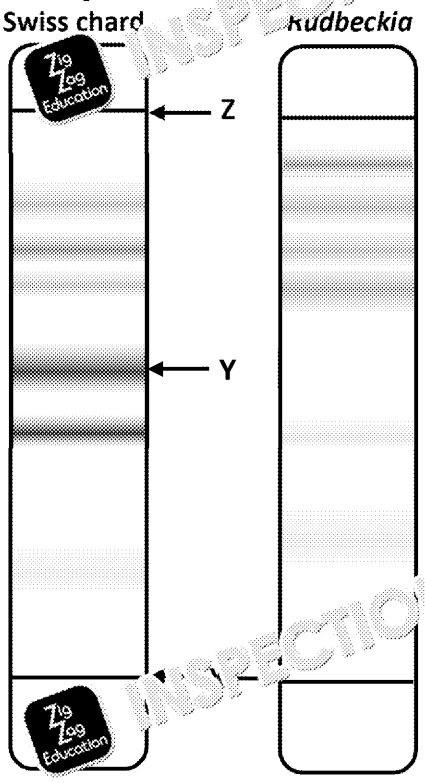


Table 1: R_f valu

Pigment
Anthocyanin
Anthocyanidi
β-carotene
Chlorophyll a
Chlorophyll b
Flavoxanthin

1.5 Suggest the purpose of drawing line X before adding the sample to the str

.....

1.6 Show, with a calculation, what pigment Y is.

.....

.....

.....

.....

1.7 Pigment Y is a deep red purple colour. Explain why having pigments of different colours is especially valuable to species such as chard.

.....

.....

.....

.....

2.1 Lipids such as fats and oils are an essential part of the diet for humans. We use lipids for a number of different purposes, including phospholipids for cell membranes and triglycerides as a long-term respiratory substrate. We also store lipids as part of adipose (fatty) tissue.

Give two reasons why triglycerides are an effective energy store.

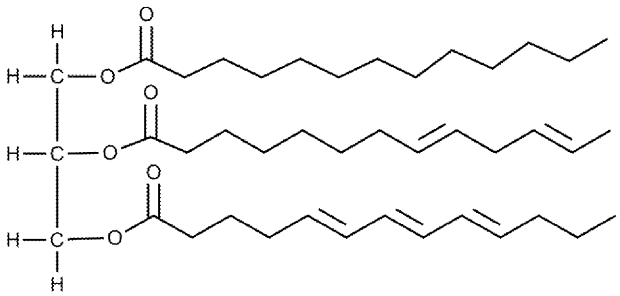
.....

.....

.....

.....

Figure 2



A: .....

B: .....

C: .....

2.2 **Figure 2** shows a triglyceride. Label the fatty acids as 'saturated' and 'unsaturated'. Explain your answers.

.....

.....

.....

.....

2.3 During digestion, large droplets of fat and oil are emulsified into smaller p
Lipase enzymes then break down individual triglycerides into glycerol and
are absorbed across the small intestine's epithelial cell membrane throug
However, there are no protein channels for fatty acid absorption. Explain

.....

.....

Different fats and oils may be emul[illegible]an[illegible]bsorbed in different ways b
carried out to model the eff[illegible]ary bile salts on the action of the en
different fats and [illegible] substrates.

Twel[illegible]tu[illegible]s are heated to 30 °C in a water bath. In each test tube, 1
adde[illegible]m^3 of water. The test tubes are divided into four sets of three
dietary lipid source added:

Set 1: 2 cm^3 butter
Set 2: 2 cm^3 coconut butter
Set 3: 2 ml olive o
Set 4: 2 ml sunflo

For each set of test tubes, bile salts are added to two of the tubes at differ
has no bile salts added. As lipase acts on the various lipids, fatty acids are
test tube decreases. The rate at which the pH decreases can be used to co
The rates for each test tube are converted into arbitrary units which are e

2.4 Suggest the purpose of the tube with no bile salts added.

.....

.....

.....

.....

2.5 The r[illegible]of [illegible]periment are shown in **Table 2**.

Table 2

Lipid source	Main fatty acid type	Action of lipas	
		No bile salts	*Bile sal (low concent*
Butter	Saturated	1.0	1.2
Coconut butter	Saturated	1.3	1.6
Sunflower oil	Unsaturated	1.4	4.0
Olive oil	Unsaturated	1.2	3.6

A student states that 'bile salts help with the digestion of unsaturated fats
saturated fats'. Evaluate this conclusion, using the evidence above and yo

.....

.....

.....

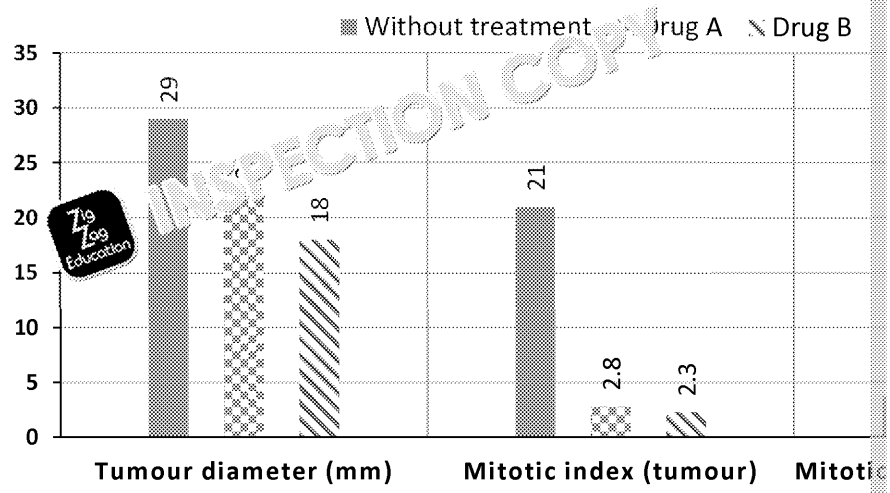
.....

.....

.....

3 A new anticancer drug is being compared with an existing drug. The drug is which have developed tumours. Results are shown in **Figure 3**.

Figure 3



3.1 What is the absolute reduction in tumour diameter caused by Drug B?

.....

.....

.....

3.2 A group of 750 cells is stud... mouse tumour treated with Drug B.

On aver... cells in the sample would you expect to be current... Give ... to the nearest whole number.

.....

.....

.....

3.3 Compare and evaluate the actions of Drug A and Drug B in the trial, based ... provided in **Figure 3**. You should ensure you support your answer with qu...

.....

.....

.....

.....

.....

.....

.....

.....

3.4 Drug A is active on the histone proteins associated with tumour suppresso
Suggest how Drug A works to combat cancer.

.....

.....

.....

.....

4.1 The li[illegible] stage of photosynthesis releases energy, which is use
Firstl[illegible]nergy is used by ATP synthase to produce ATP.

Describe ATP synthase, and explain how it works to produce ATP.

.....

.....

.....

.....

.....

.....

4.2 The energy transferred through the light-dependent [illegible]ction is also used i
NADP to produce reduced NADP, which is u[illegible]e light-independent re
of NADP is carried out by an enzym[illegible]edoxin NADP$^+$ reductase.

Zinc (Zn^{2+}) ions reduce t[illegible]eac[illegible]n rate of ferredoxin NADP$^+$ reductase wi
but the ions d[illegible]d [illegible] the active site of the enzyme.

Wha[illegible]e zinc ions acting as in this reaction?

.....

.....

4.3 DCPIP can be used to accept electrons from the electron transport chain, i
When it accepts electrons (and, therefore, becomes reduced), DCPIP turns
This means that DCPIP can be used to observe and measure the rate of the

An experiment is carried out into the effect of zinc on the rate of the light-
- A few leaves are gently ground for 15 seconds with a pestle and mort
- 1 ml of this suspension is pipetted into each of five boiling tubes cont
- The test tubes are placed into a water bath at 30 °C.
- Different concentrations of zinc hydroxide [illegible]), solution are adde
- Then, 0.5 ml DCPIP is added to e[illegible]
- The tubes are left for fi[illegible] and any change in colour is observe

Suggest why the [illegible] ground gently, and only for a short time.

.....

.....

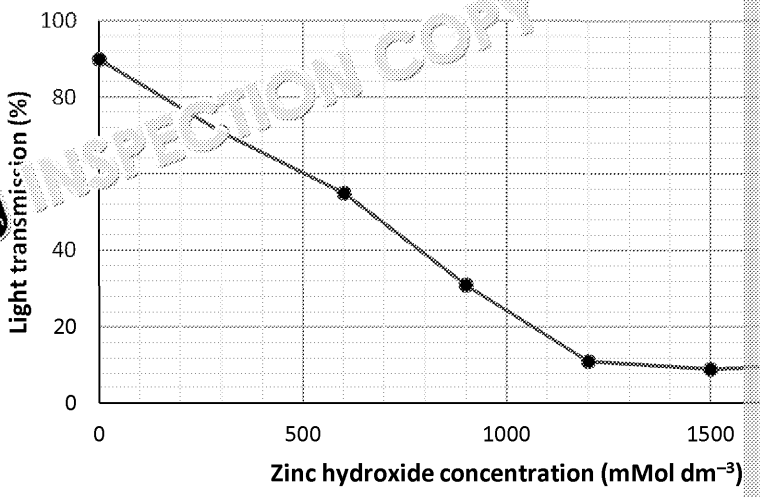
.....

.....

4.4 To produce quantitative data, a sample from each test tube is taken and p
red filter. The amount of light passing through is shown in **Figure 4**.

Figure 4:

**Transmission of light through leaf suspension and D
mixture**



Using the information you have read and your own knowledge, explain the
the data.

.....

.....

.....

.....

.....

.....

.....

.....

4.5 The light transmission at 600 mMol dm^{-3} zinc hydroxide concentration wa
as 0.55 ± 0.018.

Calculate the percentage uncertainty of this measurement. Give your ans
number of significant figures.

.....

.....

.....

.....

5 An action potential is achieved in the cell body of a myelinated motor neu

5.1 Describe how an action potential passes along the cell axon towards a neu

.....

.....

.....

.....

5.2 The n... described in 5.1 is 90 cm long and the impulse travels a...
How ...es the impulse take to travel the length of the neuron?

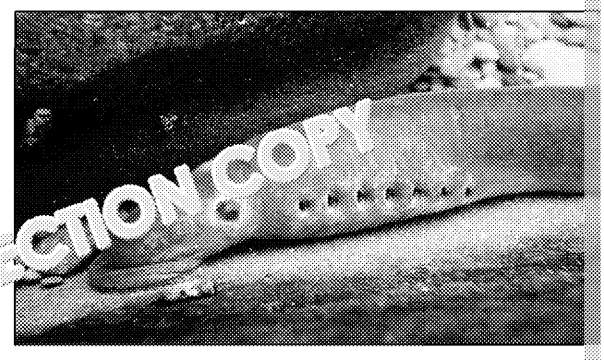
.....

.....

.....

.....

Figure 5.1



5.3 Certain fish, such as lampreys (**Figure 5.1**), do not have myelinated neuron...
unmyelinated neurons might make an organism more vulnerable to preda...

.....

.....

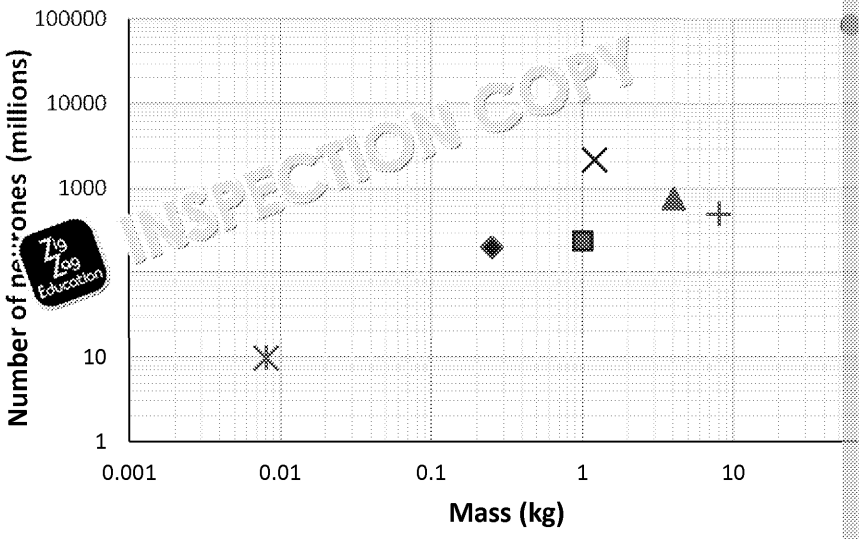
.....

.....

5.4 **Figure 5.2** shows the relationship between neuron number and mass in se

Figure 5.2

Body mass and neurone number in different animals



Suggest why logarithmic scales are used to plot the data.

.....

.....

5.5 A researcher suggests that **Figure 5.2** ca b us d to predict the number o newly discovered animal speci has , ending on its mass.

Discuss whether th r is correct. Give reasons for your answer.

.....

.....

.....

.....

.....

.....

Write an essay on **one** of the topics below.

6.1 How organisms are adapted to their external environment.

OR

6.2 Why cell specialisation is essential for complex organisms.

A Level Biology

Practice Paper 3

Name	

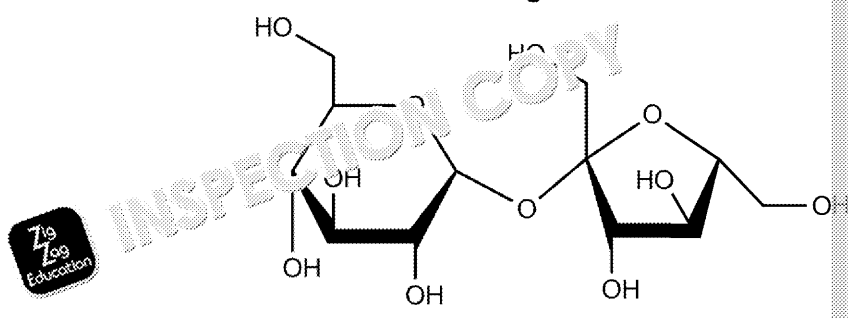
Time allowed
2 hours

Instructions
- Answer **all** of the questions and use the space provided.
- Use black ink. You may use an HB pencil for graphs and diagrams.
- Show your working for questions that require calculations.

Information
- The total number of marks available for this paper is **78**.
- Use of an electronic calculator is permitted.

1.1 **Figure 1** is a representation of sucrose.

Figure 1



Describe the reaction that would be used to split this molecule into its con monosaccharides, and name the molecules produced.

.....

.....

.....

.....

1.2 Plant cells regularly carry out the reaction described i .1. One of the mo stored as starch. State and explain **two** pro e starch which make it storage molecule.

.....

.....

.....

.....

1.3 An experiment is carried out to test for the presence of sucrose in three sa plant tissues:

- Extracts are produced by liquidising tissues.
- 2 cm^3 of each tissue extract is poured into a boiling tube.
- 5 cm^3 dilute hydrochloric acid is added to each sample.
- The mixtures are heated in a water bath at 80 °C for five minutes, and (sodium hydroxide).
- 2 cm^3 Benedict's reagent is added to each mix and the mixtures a at 80 °C.
- The colour change in each mi observed and recorded.

Suggest **two** reas n the plant tissue is liquidised.

.....

.....

.....

.....

1.4 Give one advantage of using an electric water bath instead of a beaker of w
Bunsen burner.

.....

.....

1.5 The experiment outlined in **1.3** is described as 'e... qu...ntitative'. Explain
into a quantitative experiment.

.....

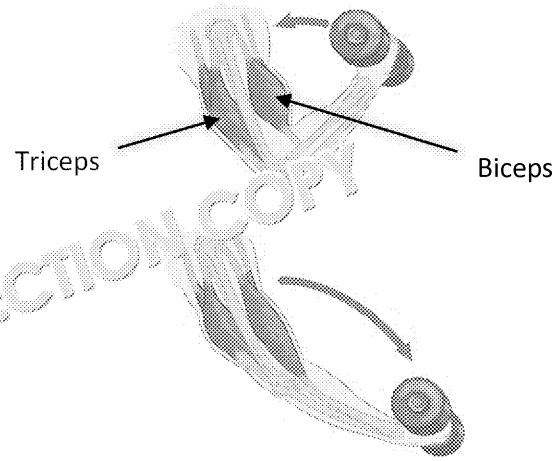
.....

.....

.....

2 Muscles are attached to an incompressible skeleton, and are commonly de
antagonistic pairs.

Figure 2



2.1 Describe what the above sentence means, with reference to **Figure 2**.

.....

.....

2.2 An action potential passes along a motor neuron in the arm and arrives at a
junction with the biceps muscle.

Explain how an action potential in a motor neuron can cause a change in e
the biceps muscle.

.....

.....

.....

.....

.....

.....

2.3 Skeletal muscle cells are highly adapted to their role. State **two** adaptations on the cellular level.

.....

.....

.....

.....

2.4 Substance X is a [illegible] compound which occurs in the leaves of some

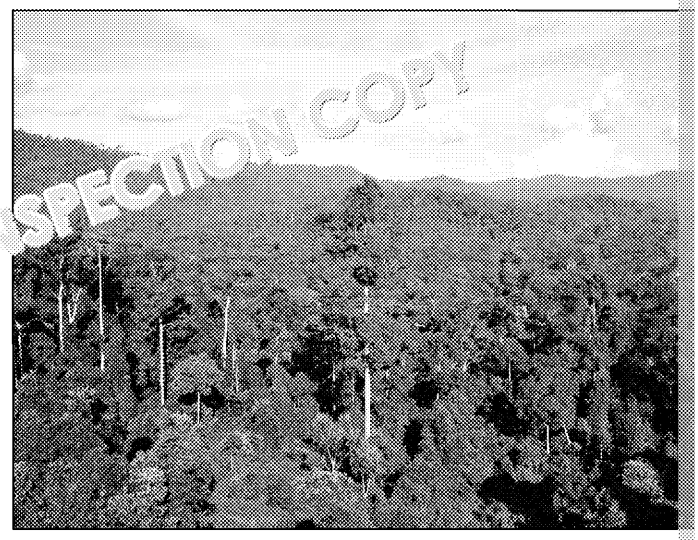
An investigation is carried out to discover whether Substance X causes muscles to become [illegible]. A group of healthy volunteers is given a low dose of Substance X. A group is given a placebo.

State the null hypothesis in this investigation.

.....

.....

Figure 3



3.1 **Figure 3** shows a tropical forest ecosystem. Suggest an abiotic factor which is likely to have a high biomass.

.....

.....

3.2 Explain why biomass, in a sample area of tropical forest, is much easier to measure than for consumers.

.....

.....

.....

.....

3.3 Gross primary production (GPP) is defined as the chemical energy produce
biomass.

The GPP of a 100 m^2 area of tropical forest F is 18 000 kJ day^{-1}. 32 % of th
in respiration.

Calculate the net primary production of 1 m^2 of the tropical forest.

.....

.....

.....

.....

.....

.....

3.4 An investigation is carried out into the changing plant biodiversity in two s
Forest G has been designated a National Park and protected from all deve
Forest F has not.

Eight areas are sampled within each forest, and a mean species richness is
compared to similar results from 25 years previously using a t-test; the res

Table 3

Forest	Mean species richness (1993)	Mean s richness (2018)
F	42.5	32
G	37.5	31.125

Expla t can be concluded from the data about the effectiveness of th
prese g and increasing biodiversity.

.....

.....

.....

.....

.....

.....

4.1 The aorta carries oxygenated b d body from the heart, under high pre
aorta is adapted to th nditions.

.....

.....

.....

.....

4.2 A personal trainer is monitoring the heart rate of a subject who wants to i

The subject attaches a smartwatch with a fitness monitor to their wrist. T
on the subject over eight minutes of light exercise. A graph of heart rate i

Figure 4

Heart rate as tr d by monitor

Over this time, the subject's average cardiac output is 12.2 dm^3 min^{-1}. Cal
average stroke volume.

.....

.....

.....

.....

.....

.....

4.3 The method described in **4.2** was also used to measure and calculate the s
Explain why this method gives a more accurate value than simply recordin
for a single minute.

.....

.....

4.4 In the absence of any external nervous communication, a 'natural' heart ra
per minute. However, this is not equivalent to a typica' person's resting h

Suggest two conclusions that can be drawn fro t information about th
nervous control of the heartbeat i g individuals.

.....

.....

.....

.....

5.1 Marine biologists are investigating a sample of deep-sea water from the Se
unicellular organism that they believe to be a eukaryote.

They initially observe the organism while using a light microscope, and the
transmission electron microscope (TEM).

Suggest one advantage and one disadvantage of using a TEM to visualise t

.....

.....

.....

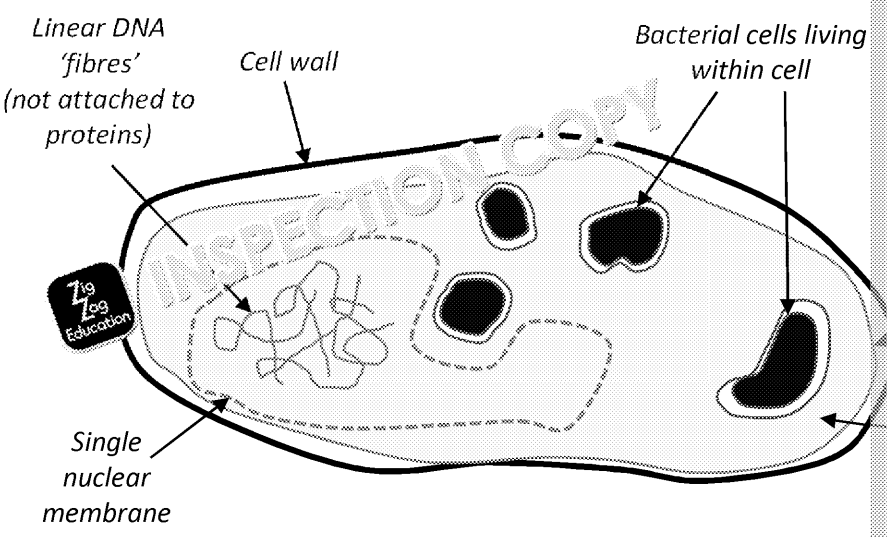
.....

5.2 The micrograph produced using the TEM has a width of 120 mm, while the
as 8.15 µm in length. Calculate the magnification used to view the cell.

.....

.....

Figure 5



5.3 Explain whether you think this organism should be classified as a eukaryot
Justify your answer using evidence from **Figure 5**.

.....

.....

.....

.....

5.4 The i ra n is given a binomial name, *Parakaryon myojinensis*. Sugg
the or n to have a binomial name even before its broader classificatio

.....

.....

5.5 An enzyme involved in glycolysis has a highly conserved amino acid sequen
for three species: *P. myojinensis*, the bacterium *Escherichia coli*, and a hum
The amino acids in this sequence which differ between the species are sho

Table 5

Organism / Amino Acid	Position						
	35	39	87	88	4	109	111
P. myojinensis	Ser	Asp	Ty	Pr	Phe	Val	His
E. coli	Thr		Tyr	Ser	Phe	Val	Arg
H.	Ser	Asp	Trp	Gly	Tyr	Gly	Pro

What conclusions can be drawn from this data about the relationship of *P.* eukaryotes and bacteria?

.....

.....

.....

.....

.....

5.6 Suggest and explain two other things which scienti ight investigate to relationship of *P. myojinensis* to Eukarya ar Bacteria.

.....

.....

.....

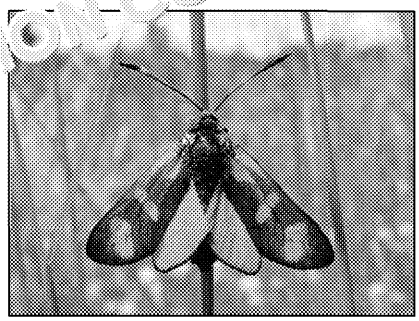
.....

6 The six-spot burnet moth has a red wing coloration. The moth exists throu
was introduced to an island community in 1980, and over time two differe
emerged, caused by a single nucleotide polymorphism.

- Moths with the dominant *R* allele have highly visible, bright red patch
- Moths with two recessive *r* alleles have dull, deep red-brown wings.

Both alleles existed at a roughly stable level for several years; the moth ini

Figure 6.1: Mo th with the dominant *R* allele



6.1 84 % of all moths have bright red wing patches. Using the Hardy–Weinber
the proportion of heterozygotes in the population.

.....

.....

.....

.....

.....

Propor

6.2 Give t sumptions made when using the Hardy–Weinberg equation.

.....

.....

6.3 Six-spot burnet moths produce hydrogen cyanide, and are poisonous to ne
chance mutation occurred in the genome of a sight-hunting bird which is a
mutation meant that the bird became able to tolerate the poison, and beg

The first example of this behaviour is recorded in 1989.

Describe the implications of this mutation for the moth population.

.....

.....

.....

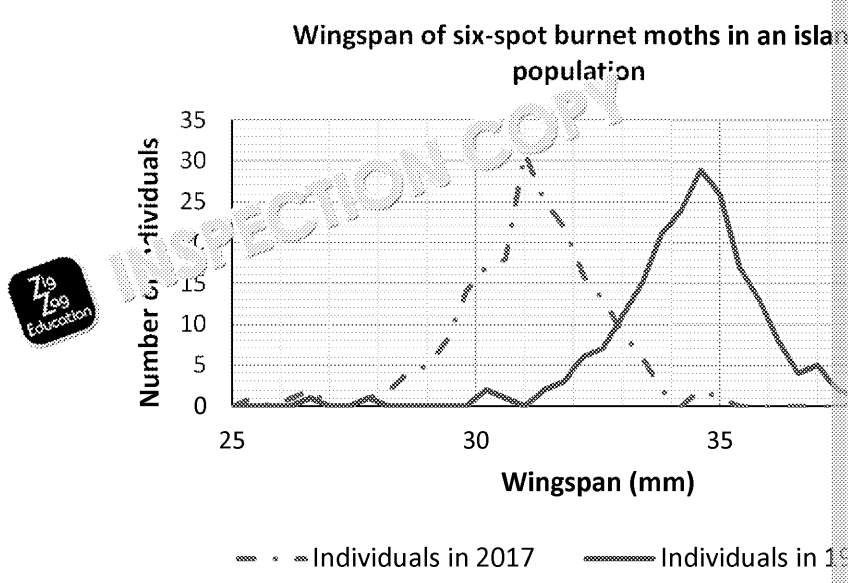
.....

.....

.....

6.4 A detailed study of the moth population is conducted in 1987, and again in characteristics are observed and measured. Data on wingspan is shown in

Figure 6.2:



A report concludes that predation by the bird population is causing selecti in the six-spot burnet moths. Do you agree with this conclusion? Explain y

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Write an essay on **one** of the topics below.

7.1 Technology in modern genetics.

OR

7.2 The role of ions in animals and plants.

A Level Biology

Practice Pape

Time allo
2 hours

Instructions
- Answer **all** of the questions and use the space provided.
- Use black ink. You may use an HB pencil for graphs and diagrams.
- Show your working for questions that require calculations.

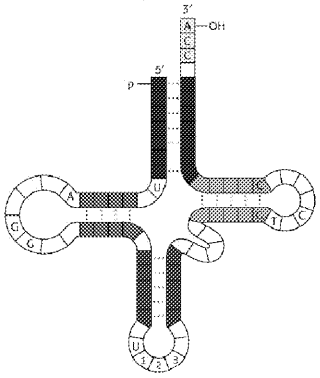
Information
- The total number of marks available for this paper is **78**.
- Use of an electronic calculator is permitted.

1.1 DNA is a polymer, made up of many smaller subunits joined together. Give monomers which make up DNA.

1.2 The enzyme DNA polymerase synthesises a new strand of DNA, which is co existing strand. When it adds new monomers, it uses a modified ve ATP (adenosine triphosphate), CTP (cytosine triphosphate), GTP (guanosine TTP (thymine triphosphate)

Explain how these molecules would have to be altered in order to add the and suggest why this stage might be useful.

Figure 1



1.3 As well as coding for proteins, DNA also codes for the type of molecule sho Name the type of molecule, and briefly explain its role in translation.

1.4 The antibiotic tetracycline kills bacteria by binding to the small subunit of t cannot enter the ribosome. Why would this be lethal to bacterial cells?

1.5 Suggest why tetracycline is able to kill bacteria without damaging human b

2.1 The four sentences below relate to the products of respiration. Pick the co the list:

A	The main purpose of respiration is to produce ATP; carbon dioxide
B	The main purpose of respiration is to produce ATP; carbon dioxide recycled.
C	The main purpose of respiration is to produce ADP; carbon dioxide
D	The main purpose of respiration is to produce ADP; carbon dioxide recycled.

2.2 All of the molecules referenced in 2... either inputs or products in the K acetyl group from acetyl coenzyme A is used to produce citrate.

Describe the following stages of the Krebs cycle.

2.3 Sodium fluoroacetate is a respiratory poison found in some South African p
by cells into fluorocitrate, which inhibits aconitase, an enzyme which usua
intermediate molecule in the Krebs cycle.

Researchers are studying how fluorocitrate's inhibitory effect changes at di

- Different concentrations of citrate solution are added to a test tube co
- 1 ml of 50 µMol dm^{-3} fluorocitrate solution is then added.
- The mixture is allowed to react for five minutes.
- The quantity of the product (cis-aconitate) is later measured.

State **two** variables that should be controlled in this investigation.

2.4 Each reaction is allowed to continue for five minutes. The results of the ex

Table 2

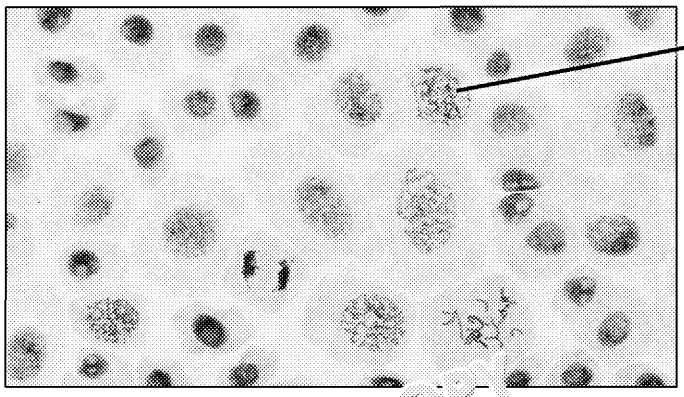
Citrate concentration (mMol dm^{-3})	cis-aconitate pr
10	34
20	38
30	49
40	65
50	102

Calculate the rate of cis-aconitate production at 20 mMol dm^{-3} citrate con
answer in standard form.

2.5 Use the data and the information you have read to evaluate whether sodiu
could be used as an effective pesticide on crop plants.

3 **Figure 3** shows a light micrograph of plant cells in root meristem t
under mitosis.

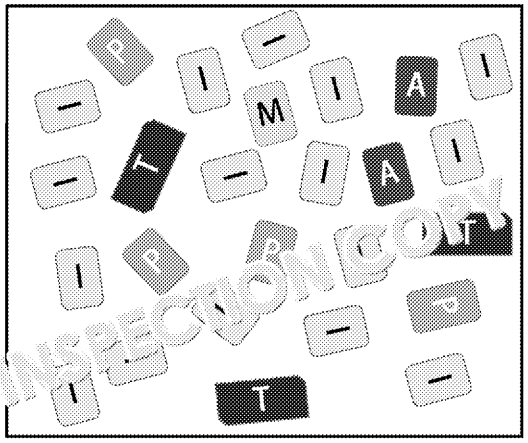
Figure 3.1



3.1 Which stage of mitosis is cell X undergoing?

3.2 Briefly, outline how a tissue like the one shown in **Figure 3.1** is prepar
light microscope.

Figure 3.2



Key
I = Interp
P = Proph
M = Meta
A = Anap
T = Telop

3.3 **Figure 3.2** is a diagrammatic representation of a plant meristem tissue sam the equation below, calculate the mitotic index of the tissue sample.

$$\text{Mitotic index} = \left(\frac{\text{Number of cells in mitosis}}{\text{total number of cells}}\right) \times 100$$

3.4 When studying a rainforest flowering plant, scientists identify an alkaloid p substance Y. This substance binds to extended spindle fibres, preventing t

Describe how this could halt the cell cycle.

3.5 Suggest why substance Y might be of interest to scientists developing new

3.6 Substance Y is used in the production of Drug A, a ant cancer drug. The d stage, and is tested in volunteer canc at s, and compared to Drug B, treatments. Some of the re s shown in **Table 3**.

Table 3

	Number of trialled individuals	Average reduction in tumour size after 28 days (%)
Drug A	28	85
Drug B	31	81

A researcher argues that 'these results show that Drug A is more effective a treatment'. Do you agree? Justify your answer.

4.1 Explain why it is important to maintain blood glu levels within a narro

4.2 People with diabetes cannot re ate r blood sugar levels effectively. A glucose in their urine. It is pos le to test for glucose by adding Benedict's heating in a wate y- if there is glucose present, Benedict's reagent wi to re tiv esult).

Is this quantitative or qualitative test? Explain your answer.

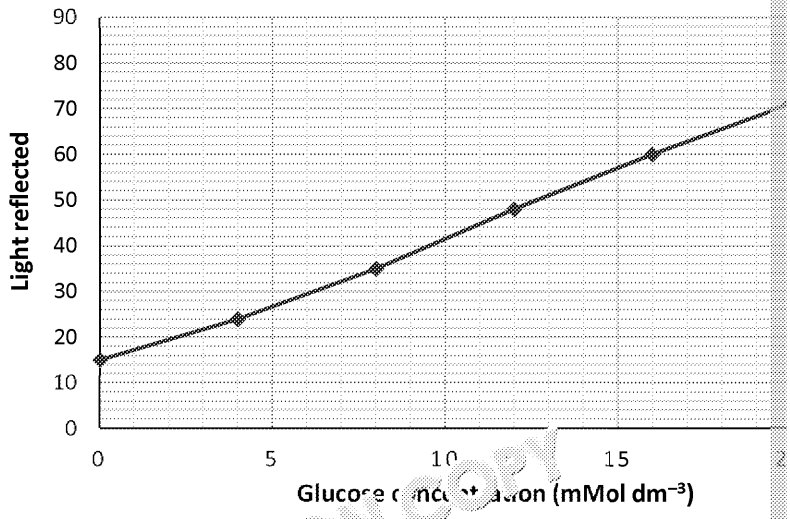
Small amounts of glucose may be present in the urine of healthy, non-diabetic in
To give a more confident diagnosis, a calibration curve can be used.

Different amounts of glucose solution are added to water to produce solutions o
12 mMol dm^{-3}, 16 mMol dm^{-3}, 20 mMol dm^{-3} and 24 mMol dm^{-3}; a control conta
specific Benedict's reagent is added, and the samples are heated before placing i
passed through each sample; the more the reagent reacts with glucose, the redd
therefore, the more light will be reflected, instead of being absorbed. This mean
and reach the other side of the sample.

Results of this process are shown in Figure 4.

Figure 4:

Glucose concentration – calibration cur



4.3 Suggest one improvement to the drawing of this graph.

4.4 A glucose level of more than 13 mMol dm^{-3} of glucose in the urine strongly
sample from patient X produces a colorimeter reading of 55 % light

Do you think patient X has diabetes? Explain your answer.

4.5 The patient is asked to return for an identical test at a later date. Use you
scientific process to explain why.

5

Figure 5

5.1 Saffron crocuses (*Crocus sativus*, **Figure 5**) with a dominant allele for gene E in their flowers, but flowers with two recessive alleles have light blue pigment to B, and crocuses with a dominant allele for gene F always have white flowers.

Two crocuses that are doubly heterozygous for genes B and F are crossed to generation, which consists of 91 crocus flowers. To the nearest whole number many F_1 crocuses will have purple flowers (you may use a diagram to help y

5.2 Gene **F** codes for an enzyme which is active in the flower. Suggest what the

5.3 When collected and dried, the stigmas (female reproductive organs) of *C. s* They have a vivid red colour, caused by the pigment α-crocin.

Saffron is grown as a commercial crop. However, the crop yield is very low squared of farmland per year (182 kg km^{-2} y^{-1}).

Calculate the biomass of saffron produced by 1 m² saffron crocus crop in answer in standard form.

5.4 Bacteria are genetically modified to produce a cheaper version of the saffron bacteria are transformed using genes coding for enzymes from the saffron This causes the bacterial cells to produce α-crocin from one of their own re

The scientists also insert an additional gene, YFP, which produces yellow flu Suggest the purpose of the additional gene.

5.5 Other organisms besides bacteria can be modified to produce useful produ crop plants may be genetically modified to produce naturally occurring pes

Using this example, explain why genetic modification is controversial, and w with its use.

Write an essay on **one** of the topics below.

6.1 Protein structure and function

OR

6.2 The ro membranes in cells.

A Level Biology

Practice Paper 3

Time allo
2 hours

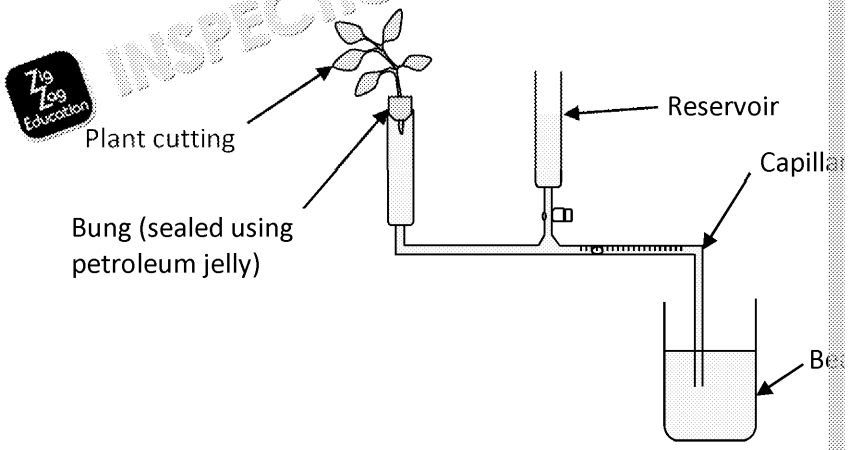
Instructions
- Answer **all** of the questions and use the space provided.
- Use black ink. You may use an HB pencil for graphs and diagrams.
- Show your working for questions that require calculations.

Information
- The total number of marks available for this paper is **78**.
- Use of an electronic calculator is permitted.

1.1 Xylem and phloem tissue are both adapted for mass transport in plants. Xy
transpiration, while phloem is adapted for translocation of sugars.

Give one difference between the structures of xylem and phloem, and exp
this observation.

Figure 1: Simple potometer



1.2 A simple potometer is set up to measure the rate of transpiration in a plan
The end of the stem is inserted into a capillary tube via a hole in a rubber b
petroleum jelly.

The plant draws water up the capill[illegible] be[illegible]hich is replenished by wate
bubble can be introduced at [illegible] the capillary tube – its movement a
calculate the rate of [illegible]ion.

Wha[illegible] pu[illegible]ose of the petroleum jelly?

1.3 The capillary tube is circular in cross section, with a diameter of 0.6 cm. Ca
water has been transpired at each stage, and copy and complete the value

Table 2: Transpiration over time

Time (min)	Bubble movement (cm)	Volume of water t
0	0	
3	2.0	
6	4.2	
9	6.3	
12	8.5	
15	10.5	
18		

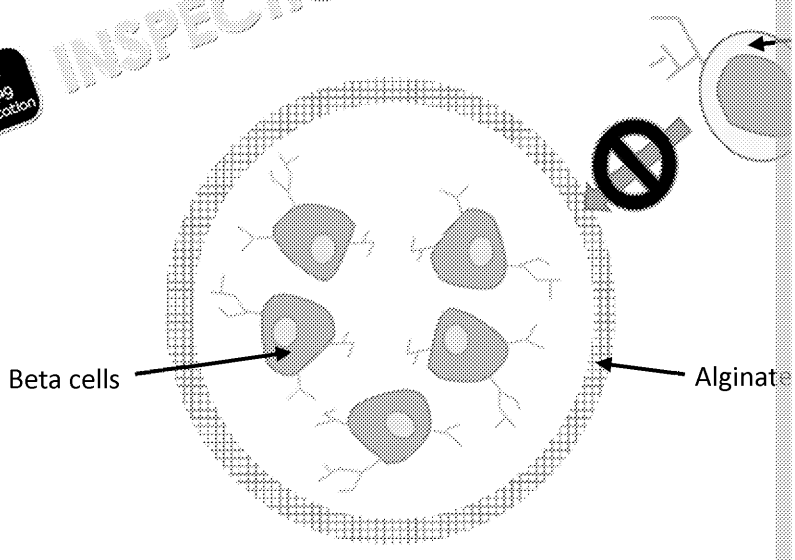
1.4 Use graph pa[illegible] graph which shows the volume of water transpi
by th[illegible] time. Include a line or curve of best fit for the data.

1.5 Use the graph to calculate the average rate of transpiration shown by the
appropriate units.

2.1 Meals have varying amounts of glucose; when we consume food, the body glucose as possible into the blood across the epithelium of the ileum. Gluc membrane of the ilear epithelium by cotransport. Briefly describe this pro

2.2 The hormone insulin regulates blood glucose levels, particularly after meal cannot produce insulin. One potential treatment involves implanting patie produced from stem cells. However, the cells may first be surrounded by a selectively permeable.

Figure 2



Based on **Figure 2** and your own knowledge, sug[illegible] purpose of the alg

2.3 The method described in **quest[illegible]** tested in mice with diabetes. In G the alginate gel capsule, while in Group B, cells are implanted with no caps under normal conditions for days 1–14.

On d[illegible] the trial, the two groups of mice are not fed for 12 hours, and food. The two groups are compared for the rate of insulin production and normal blood sugar after eating. The results are shown below, in **Table 2**.

Table 2

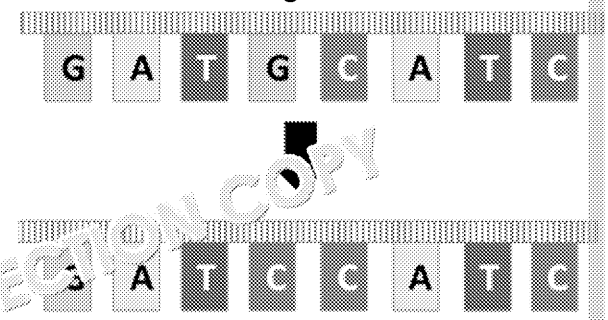
	Mean rate of insulin production (pmol L^{-1} min^{-1})	Standard deviation	Mean [illegible] baseline
Group A	16.4	3.7	
Group B	9.7	1.5	

Describe an appropriate way to graphically present this data.

2.4 Explain why the treatment described in **2.3** would not be effective for treat

3 An error during DNA replication causes a change in the base pair sequence

Figure 3



3.1 Name the type of mutation which is shown in **Figure 3**.

3.2 The mutated protein is thought to be linked to the occurrence of cancer w
A medicine is designed to reduce the risk of cancer, based on the action of
RNA (siRNA).

Suggest how this medicine would work.

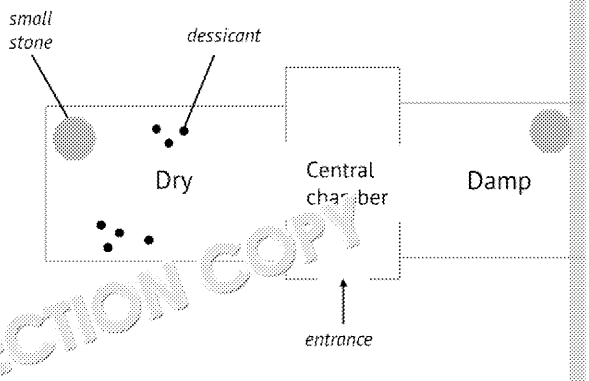
3.3 Tumour cells typically undergo a process of 'reverse differentiation'. Sugge
occur in terms of the shape of the cells or tissue, and the proteins produce

4.1 Organisms have many behavioural responses to sti . These include taxe
What is the difference between a taxis resp and a kinesis response?

An experiment is conducted into to the environment in earthworms.

- Fifty earthworms a to a central chamber which leads to two room
- One is pellets of desiccant scattered at two locations to ab
- The ot been made damp, and has been covered with a dark cloth to
light and heat.
- After 30 minutes, the earthworms in the dry chamber and in the damp cham
abundance is recorded.
- The experiment is repeated three times by three groups of students, producin

Figure 4 (to scale)



4.2 Sugg flaws in this methodology.

4.3 The data from the experiment is shown in **Table 4.1**.

Table 4.1

Repeat number	1	2	3	4	5	6
Earthworms in dry chamber *(after 30 mins)*	7	11	13	24	9	15
Earthworms in damp chamber *(after 30 mins)*	30	31	1	20	28	33

Calculate the standard d ati n the number of earthworms in the damp 30 minutes. The f or standard deviation is given below.

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

4.4 Earthworms instinctively retreat into a burrow when the ground trembles, be near. Students place earthworms into a vivarium containing porous so stimulus by gently shaking the vivarium, and record how long it takes the fully into a burrow. They repeat this process several times; the results are

Table 4.2

Repeat number	1	2	3	4	5
Time taken for median earthworm to retreat (s)	2.1	2.0	2.4	2.7	2.5

Suggest an explanation for the pattern seen in the re ts.

4.5 The earthworm's burrowing respons a out via a reflex arc. Huma which allow quick response stimuli.

Describe the ref e which occurs when a person touches a hot pl

5 Evolution has allowed organisms to adapt to changes in their environment long fur to allow them to withstand the coldest winters. Maximum fur len individual to individual, and can take on many possible values.

Figures 5.1 and 5.2 show the change in Arctic fox coat colour linked to sea

Figure 5.1: Arctic fox, summer fur

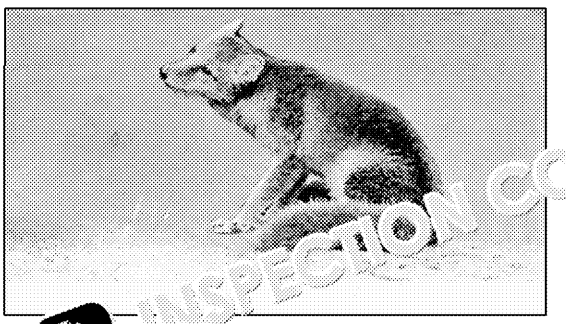
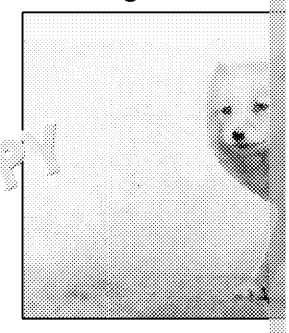


Figure 5.2: Arc



5.1 What this suggest about the number of genes acting on fur length? E

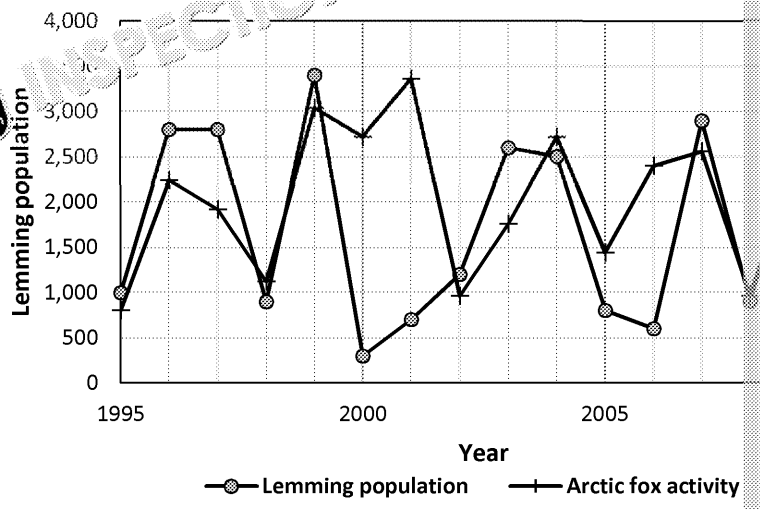
5.2 Describe how rising Arctic temperatures might cause directional selection fur length.

5.3 Describe two ways in which meiosis allows Arctic fox parents to have highly

5.4 **Figure 5.3** shows information about Arctic fox activity (measured by droppi
lemmings, a common prey animal for the Arctic fox. Both sets of data are f

Figure 5.3

Population of lemmings ... Arctic fox activity (Vic



Calculate the percentage increase in the lemming population from 2000 to

5.5 Scientists have suggested that there is a str... predator–prey relationship
and lemmings.

Does **Figure 5.3** sup... theory? Explain your answer using data from

6.

Figure 6.1

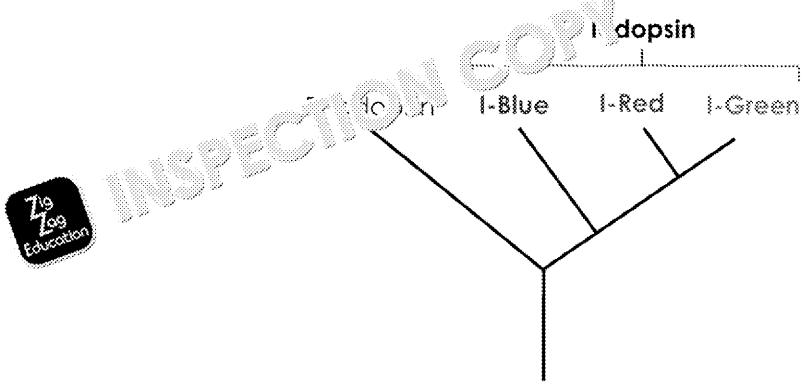
6.1 **Figure 6.1** shows the rod cell protein pigme... opsin, which contains v
non-peptide component. When li... vitamin A, it slightly alters the ar
within the molecule, settin... of reactions which leads to signal g

Based on this i... ion, explain what would happen to the vision of som
vitam... efi...ency, and why.

6.2 A mutation in the gene that codes for rhodopsin can lead to visual impairm causes the sulfur-containing amino acid cysteine to be replaced by tyrosin contain sulfur.

Briefly, explain how this change could affect the function of rhodopsin.

Figure 6.2



6.3 Scientists studying the proteome of the eye have concluded that all the m originally produced by the same gene.

Suggest how the evolution of different pigments shown in **Figure 6.2** migh

6.4 Explain how scientists would use evidence to produce **Figure 6.2**.

Write an essay on **one** of the topics below.

7.1 Why exchange surfaces are ... cells and organisms.

OR

7.2 Energy transfers in organisms and ecosystems.

A Level Biology

Practice Paper

Time allo
2 hours

Instructions
- Answer **all** of the questions and use the space provided.
- Use black ink. You may use an HB pencil for graphs and diagrams.
- Show your working for questions that require calculations.

Information
- The total number of marks available for this paper is **78**.
- Use of an electronic calculator is permitted.

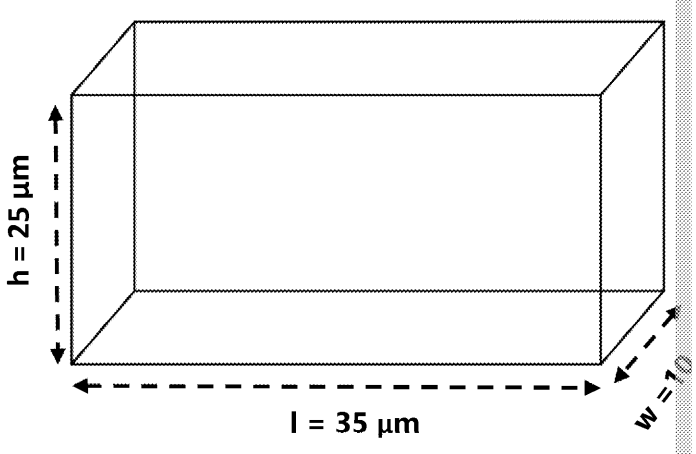
1.1 Copy and fill in the gaps to show the higher levels of organisation which a

Palisade cell → ..... → *Leaf*

CELL **TISSUE** .....

1.2 A palisade cell can be m[illegible] a cuboid.

Figure 1.1



Calculate the surface area to volume ratio of th[illegible] in **Figure 1.1**.

1.3 Describe the importance of surf[illegible] volume ratio in maintaining the larger organisms.

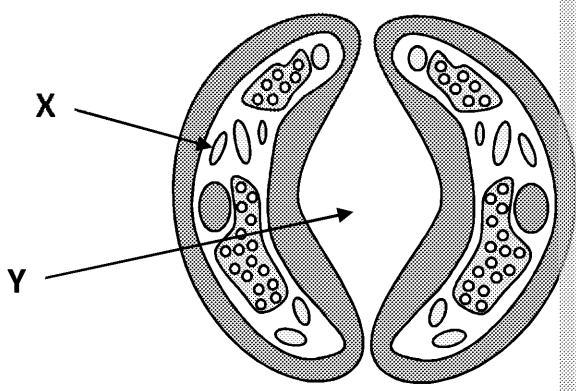


Figure 1.2

1.4 **Figure 1.2** is a representation of part of the leaf whi[illegible] responsible for ga[illegible] correct names for X and Y.

A chromatography experiment is carried out to assess the different pigments pre
tolerant and shade-intolerant plants.

- Four leaves each from Swiss chard (shade-tolerant) and *Rudbeckia* (shade-in
produce leaf samples.
- A few drops of solvent are added to each sample.
- Each mixture is dotted onto a thin-layer chromatography strip at the centre
- The strip is submerged into the solvent up to line X.
- The solvent is absorbed up the paper as far a
- The results of the experiment are shown in **Figure 1.3**; R_f values are given in

Figure 1.3

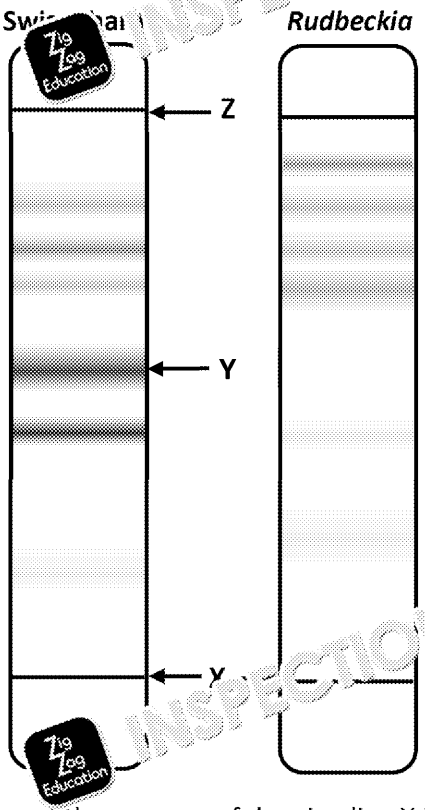


Table 1: R_f valu

Pigment
Anthocyanin
Anthocyanidi
β-carotene
Chlorophyll a
Chlorophyll b
Flavoxanthin

1.5 Suggest the purpose of drawing line X before adding the sample to the stri

1.6 Show, with a calculation, what pigment Y is.

1.7 Pigment Y is a deep red-purple colour. Explain why having pigments of dif
especially valuable for Swiss chard.

2.1 Lipids such as fats and oils are an essential part of the diet for humans. W
of different purposes, including phospholipids for cell membranes and trig
respiratory substrate. We also store lipids as part of adipose (fatty) tissue

Give two reasons why triglycerides are an effective energy store.

Figu

2.2 **Figure 2** shows a triglyceride. Classify the fatty acids as 'saturated' and 'un
Explain your answers.

2.3 During digestion, large droplets of fat and oil are emulsified into smaller pa
Lipase enzymes then break down individual triglycerides into glycerol and f
are absorbed across the small intestine's epithelial cell membrane through
However, there are no protein channels for fatty acid absorption. Explain t

Different fats and oils may be emulsified and absorbed in different ways by the b
out to model the effect of dietary bile salts on the action of the enzyme lipase, w
oils used as substrates.

Twelve test tubes are heated to 30 °C in a water bath. In each test tube, 1 cm^3 o
to 5 cm^3 of water. The test tubes are divided into four sets of three, and each se
source added:

Set 1: b[illegible]er
Set 2: coconut butter
Set 3: 2 ml olive o
Set 4: 2 ml sunflo

For each set of test tubes, bile salts are added to two of the tubes at different co
bile salts added. As lipase acts on the various lipids, fatty acids are produced, an
decreases. The rate at which the pH decreases can be used to compare the activi
The rates for each test tube are converted into arbitrary units which are easy to c

2.4 Suggest the purpose of the tube with no bile salts added.

2.5 The results of the experiment are shown in **Table 2**.

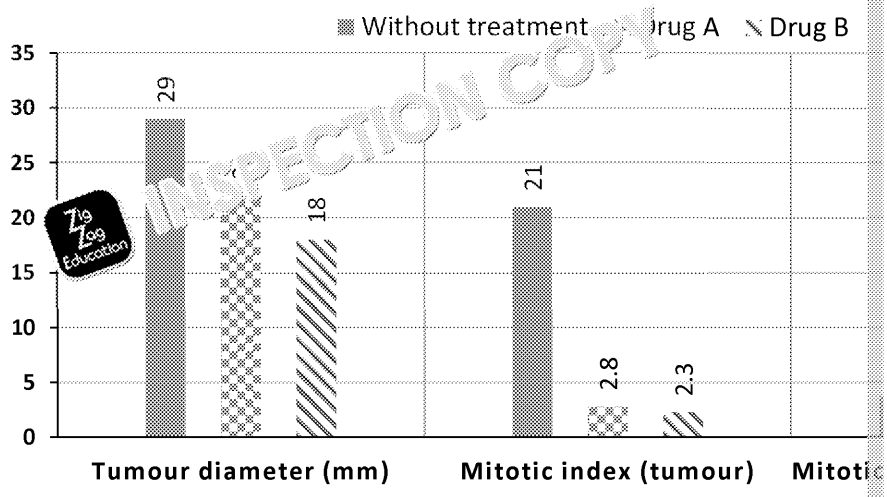
Table 2

		Action of lipas	
Lipid source	**Main fatty acid type**	*No bile salts*	*Bile sal (low concent*
Butter	Saturate	1.0	1.2
Coconut butter	Saturated	1.3	1.6
Sunflower oil	Unsaturated	1.4	4.0
[illegible]oil	Unsaturated	1.2	3.6

A stud[illegible] states that 'bile salts help with the digestion of unsaturated fats
saturated fats'. Evaluate this conclusion, using the evidence above and yo

3 A new anticancer drug is being compared with an existing drug. The drug is which have developed tumours. Results are shown in **Figure 3**.

Figure 3



3.1 What is the absolute reduction in tumour diameter caused by Drug B?

3.2 A group of 750 cells is studied from a mouse tumour treated with Drug B.

On average, how many cells in the sample would you expect to be current
Give your answer to the nearest whole number

3.3 Compare and evaluate the acti on of Drug A and Drug B in the trial, based o provided in **Figure 3**. You should ensure you support your answer with qua

3.4 Drug tiv on the histone proteins associated with tumour suppresso Sugge Drug A works to combat cancer.

4.1 The light-dependent stage of photosynthesis releases energy, which is use Firstly, the energy is used by ATP synthase to produce ATP.

Describe ATP synthase, and explain how it works to produce ATP.

4.2 The energy transferred through the light-dependent reaction is also used i NADP to produce reduced NADP, which is used in the light-independent re of NADP is carried out by an enzyme called ferredoxin $NADP^+$ reductase.

Zinc (Zn^{2+}) ions reduce the reaction rate of ferredo ADP+ reductase wi but the ions do not bind to the active site o e zyme.

What are the zinc ions acting th eaction?

4.3 DCPIP can be used to accept electrons from the electron transport chain, i
When it accepts electrons (and, therefore, becomes reduced), DCPIP turns
This means that DCPIP can be used to observe and measure the rate of the

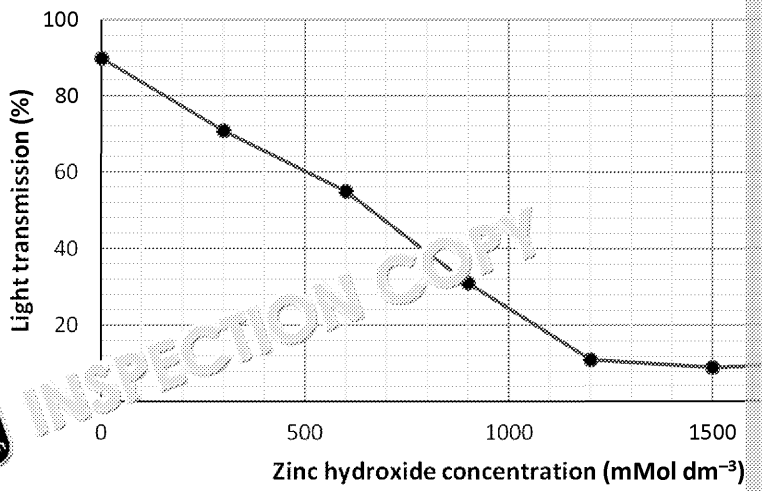
An experiment is carried out into the effect of zinc on the rate of the light-
- A few leaves are gently ground for 15 seconds with a pestle and mort
- 1 ml of this suspension is pipetted into each of fi boiling tubes cont
- The test tubes are placed into a water b a °
- Different concentrations of zinc h o. d $Zn(OH)_2$ solution are adde
- Then, 0.5 ml DCPIP is a tube.
- The tubes are h minutes and any change in colour is observe

Sugg t leaves are ground gently, and only for a short time.

4.4 To produce quantitative data, a sample from each test tube is taken and p
red filter. The amount of light passing through is shown in **Figure 4**.

Figure 4:

Transmission of light through leaf suspension and D mixture



Using the information you have read and your own knowledge, explain the
the data.

4.5 The light transmission at 600 mMol dm^{-3} zinc hydroxide concentration wa
as 0.55 ± 0.018.

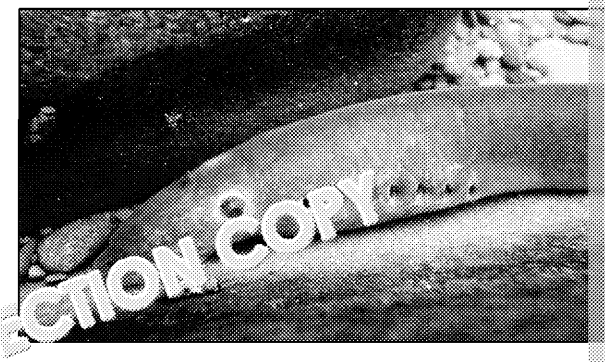
Calculate the percentage uncertainty of this measurement. Give your ans
number of significant figures.

5 An action potential is achieved in the cell body of a myelinated motor neu

5.1 Describe how a potential passes along the cell axon towards a neu

5.2 The m neuron described in 5.1 is 90 cm long and the impulse travels a
How long does the impulse take to travel the length of the neuron?

Figure 5.1

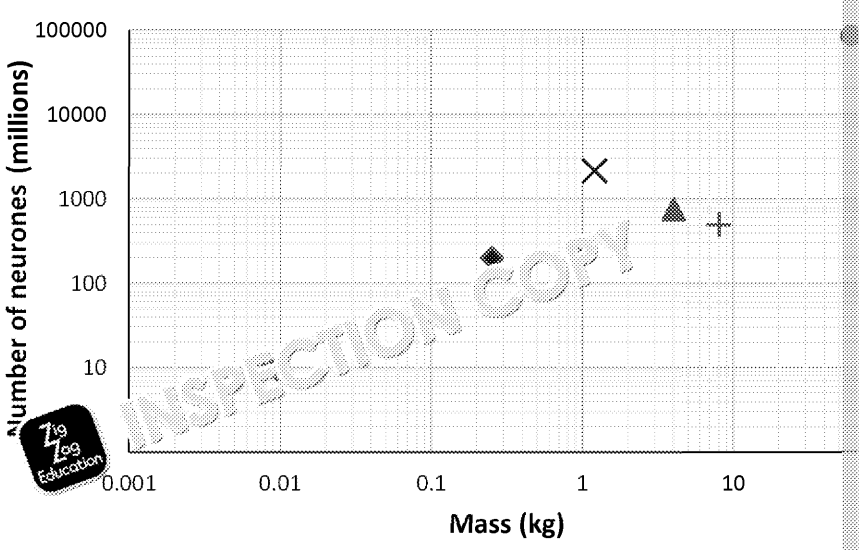


5.3 Certa... such as lampreys (**Figure 5.1**), do not have myelinated neuron... unmy...ated neurons might make an organism more vulnerable to preda...

5.4 **Figure 5.2** shows the relationship between neuron number and mass in se...

Figure 5.2

Body mass and neurone number in different animals



Suggest why logarithmic scales are used to plot the data.

5.5 A researcher suggests that **Figure 5.2** can be used to predict the number o... newly discovered animal species has, depending on its mass.

Discuss whether the researcher is correct. Give reasons for your answer.

Write an essay on **one** of the topics below.

6.1 How organisms are ... their external environment.

OR

6.2 Why cell specialisation is essential for complex organisms.

A Level Biology

Practice Paper 3

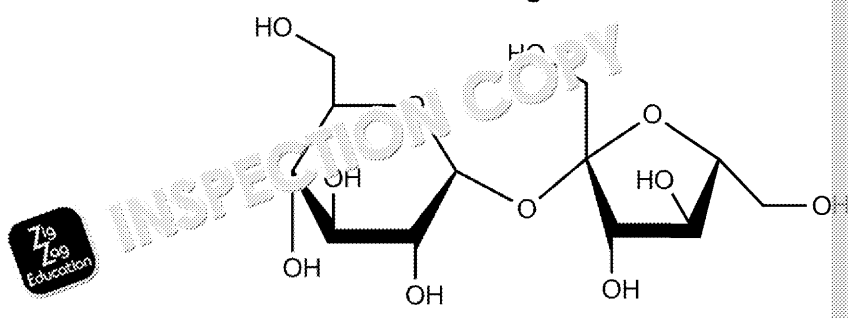
Time allo
2 hours

Instructions
- Answer **all** of the questions and use the space provided.
- Use black ink. You may use an HB pencil for graphs and diagrams.
- Show your working for questions that require calculations.

Information
- The total number of marks available for this paper is **78**.
- Use of an electronic calculator is permitted.

1.1 **Figure 1** is a representation of sucrose.

Figure 1



Describe the reaction that would be used to split this molecule into its com
monosaccharides, and name the molecules produced.

1.2 Plant cells regularly carry out the reaction described in **1.1**. One of the mo
stored as starch. State and explain **two** properties of starch which make it
storage molecule.

1.3 An experiment is carried out to test for the presence of sucrose in three sa
plant tissues:

- Extracts are produced by liquidising tissues.
- 2 cm^3 of each tissue extract is poured into a boiling tube.
- 5 cm^3 dilute hydrochloric acid is added to each sample.
- The mixtures are heated in a water bath at 80 °C for five minutes, and
(sodium hydroxide).
- 2 cm^3 Benedict's reagent is added to each mixture, and the mixtures a
at 80 °C.
- The colour change in each mixture is observed and recorded.

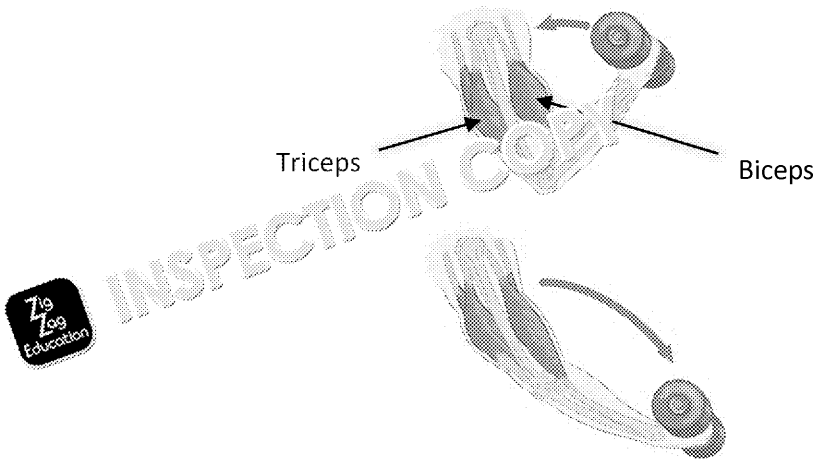
Suggest **two** reasons why the plant tissue is liquidised.

1.4 Give one advantage of using an electric water bath instead of a beaker of w
Bunsen burner.

1.5 The experiment outlined in **1.3** is described as 'semi-quantitative'. Explain
into a quantitative experiment.

2 Muscles are attached to an incompressible skeleton, and are commonly de
antagonistic pairs.

Figure 2



2.1 Describe what the above sentence means, with reference to **Figure 2**.

2.2 An action potential passes along a motor neuron in the arm and arrives at a
junction with the biceps muscle.

Explain how an action potential in a motor neuron can cause a change in e
the biceps muscle.

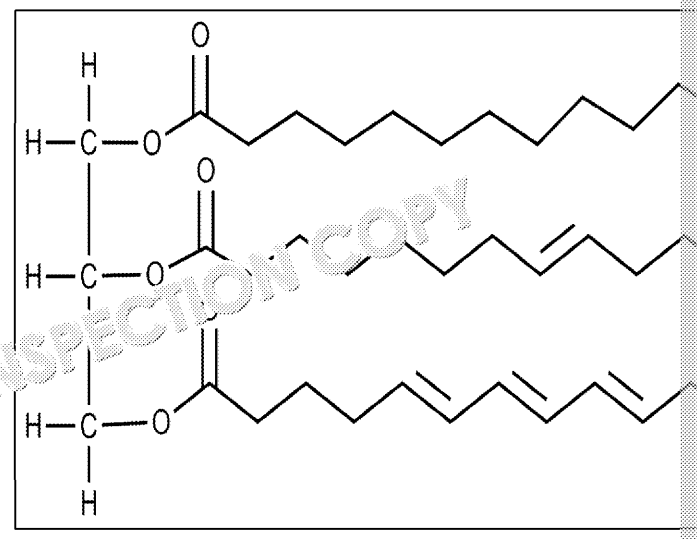
2.3 Skeletal muscle cells are highly adapted to their role. State **two** adaptatio
on the cellular level.

2.4 Substance X is a mildly toxic comp[illegible] which occurs in the leaves of some

An investigation is car[illegible] to discover whether Substance X causes muscl
become slow[illegible] group of healthy volunteers is given a low dose of Substa
grou[illegible] placebo.

State the null hypothesis in this investigation.

Figure 3



3.1 **Figure 3** shows a tropical forest ecosystem. Suggest an abiotic factor which to have a high biomass.

3.2 Explain why biomass, in a sampled area of tropical forest, is much easier to than for consumers.

3.3 Gross primary production (GPP) is defined as the chemical energy produced biomass.

The GPP of a 100 m^2 area of tropical forest F is 18 000 kJ day^{-1}. 32 % of this in respiration.

Calculate the net primary production (NPP) of the tropical forest.

3.4 An investigation was carried out into the changing plant biodiversity in two similar Forests, F and G. Forest F was designated a National Park and protected from all development. Forest G was not.

Eight areas are sampled within each forest, and a mean species richness is calculated. compared to similar results from 25 years previously using a t-test; the results are shown in

Table 3

Forest	Mean species richness (1993)	Mean species richness (2018)
F	42.5	32
G	37.625	31.125

Explain what can be concluded from the data about the effectiveness of the preserving and increasing biodiversity.

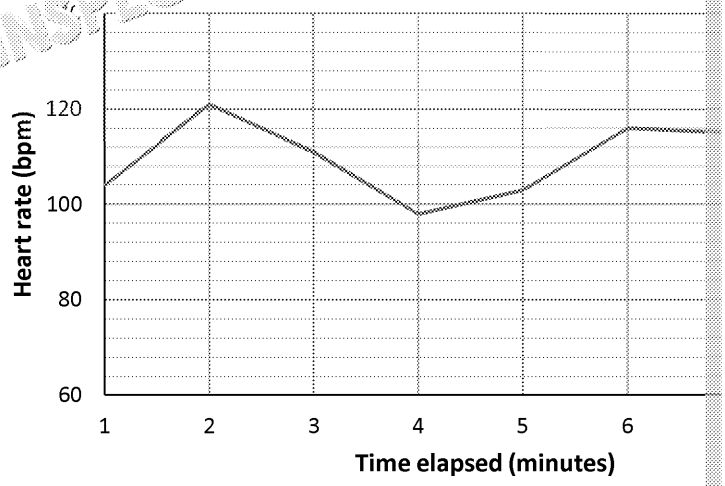
4.1 The aorta carries oxygenated blood directly from the heart, under high pre
aorta is adapted to these conditions.

4.2 A personal trainer is monitoring the heart rate of a subject who wants to i

The subject attaches a smartwatch with a fitness monitor to their wrist. T
on the subject over eight minutes of light exercise. A graph of heart rate i

Figure 4

Heart rate as tracked by monitor



Over this time, the subject's average cardiac output is 12.2 dm^3 min^{-1}. Cal
average stroke volume.

4.3 The method described in **4.2** w d to measure and calculate the s
Explain why this meth ore accurate value than simply recordin
for a single mi

4.4 In the ce of any external nervous communication, a 'natural' heart ra
per minute. However, this is not equivalent to a typical person's resting he

Suggest two conclusions that can be drawn from this information about th
nervous control of the heartbeat in resting individuals.

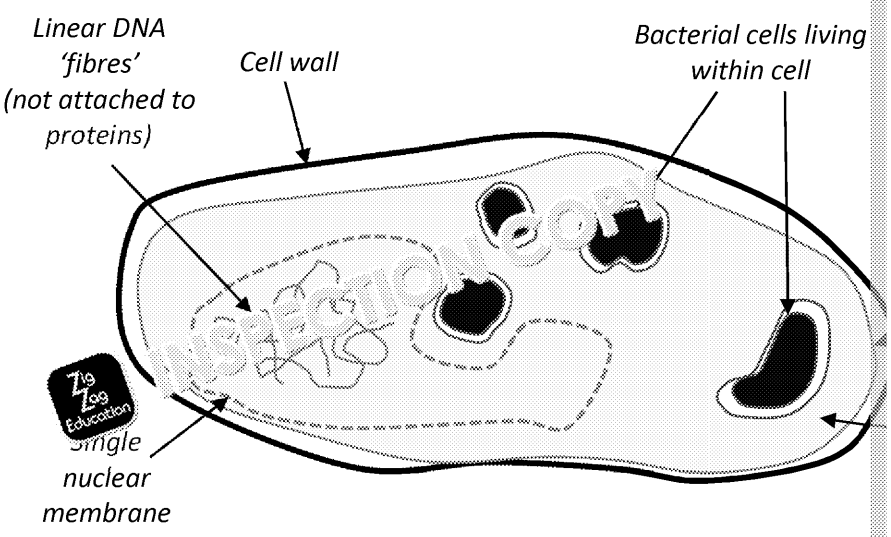
5.1 Marine biologists are investigating a sample of deep-sea water from the Se
unicellular organism that they believe to be a eukaryote.

They initially observe the organism while using a light microscope, and the
transmission electron microscope (TEM).

Suggest one advantage and one disadvanta g a TEM to visualise t

5.2 The micrograph produced sing EM has a width of 120 mm, while the
as 8.15 µm in len e the magnification used to view the cell.

Figure 5



5.3 Explain whether you think this organism should be classified as a eukaryot
Justify your answer using evidence from **Figure 5**.

5.4 The new organism is given a binomial name, *Parakaryon myojinensis*. Sugg
the organism to have a binomial name even before its broader classificatio

5.5 An enzyme involved in glycolysis has a highly conserved amino acid sequer
for three species: *P. myojinensis*, the bacterium *Escherichia coli*, and a hun
The amino acids in this sequence which differ betwe[illegible]he species are sho

Table 5

Organism / Amino A	Position						
	[illegible]	39	87	88	94	109	111
m[illegible]s	Ser	Asp	Tyr	Pro	Phe	Val	His
E. coli	Thr	Asn	Tyr	Ser	Phe	Val	Arg
H. sapiens	Ser	Asp	Trp	Gly	Tyr	Gly	Pro

What conclusions can be drawn from this data about the relationship of *P.*
eukaryotes and bacteria?

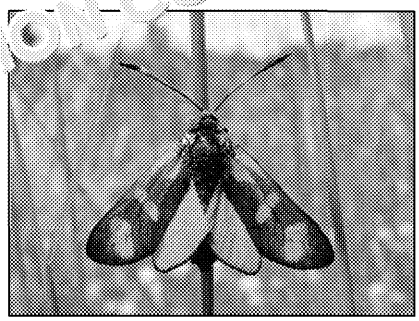
5.6 Suggest and explain two other things which scientists might investigate to
relationship of *P. myojinensis* to Eukarya and Bacteria.

6 The six-spot burnet moth has a red wing coloration. The moth exists throu
was introduced to an island community in 1980, and over time two differe
emerged, caused by a single nucleotide polymorphism.

- Moths with the dominant *R* allele have highly visible, bright red patch
- Moths with two recessive *r* alleles have dull, deep red-brown wings.

Both alleles existed at a roughly stable level for several years; the moth ini

Figure 6.1: Mo ith the dominant *R* allele



6.1 84 % of all moths have bright red wing patches. Using the Hardy–Weinber
the proportion of heterozygotes in the population.

6.2 Give **two** assumptions made when using the Hardy–Weinberg equation.

6.3 Six-spot burnet moths produce hydrogen cyanide, and are poisonous to ne
chance mutation occurred in the genome of a sight-hunting bird which is a
mutation meant that the bird became able to tolerate the poison, and beg

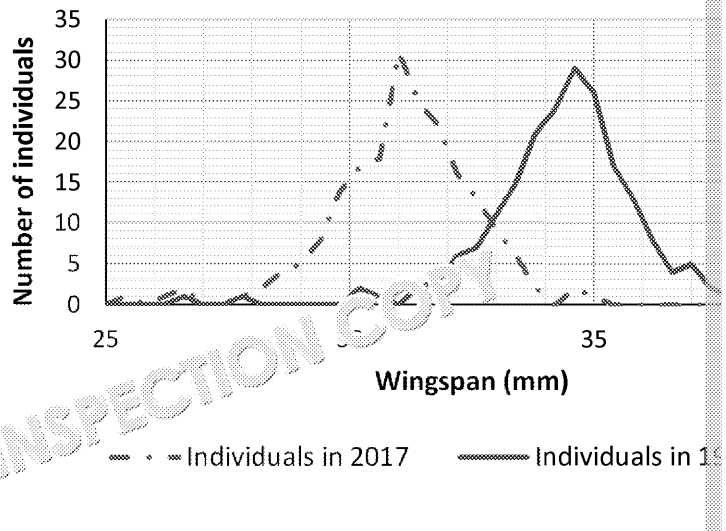
The first example of this behaviour is record d n 39.

Describe the implications of th ut for the moth population.

6.4 A detailed stud moth population is conducted in 1987, and again in
char ics e observed and measured. Data on wingspan is shown in

Figure 6.2:

**Wingspan of six-spot burnet moths in an isla
population**



A report concludes that predation by the bird population is causing selecti
in the six-spot burnet moths. Do you agree with this conclusion? Explain y

Write an essay on **one** of the topics below.

7.1 Technology in modern genetics.

OR

7.2 The role of ions in animals and plants.

Practice Paper 3A

Question part	Answers	Extra inform
1.1	Nucleotides.	
1.2	• Remove two phosphate groups. • Breaking bonds between phosphate groups **releases energy**, which can be used to join nucleotides together / for condensation reactions / to form phosphodiester bonds	
1.3	• tRNA. (Each carries a specific amino acid.) • A anticodon (temporarily) binds to a specific, complementary codon on mRNA. • Places a specific amino acid (in the correct position) on the forming sequence.	**ACCEPT** 'allows pe to form between a amino acids'.
1.4	Stops synthesis of essential proteins (as ribosome is the site of mRNA translation).	
1.5	Eukaryotic cells have larger, 80S ribosomes / differently structured ribosomes from bacterial cells.	**ACCEPT** 'human b have different/lar ribosomes than ba

Question part	Answers	Extra inform
2.1	B	
2.2	**ANY THREE from:** • A series of oxidation-reduction reactions in the Krebs cycle remove hydrogen ions and electrons from molecules, producing **reduced coenzymes**. • Carbon dioxide is released from molecules in the cycle. • Energy from these reactions is used to convert ADP (and Pi) into ATP / to produce ATP via substrate-level phosphorylation. • Oxaloacetate / a 4C molecule is regenerated.	**ACCEPT** reference dehydrogenase an decarboxylase enz removing hydroge
2.3	**Any TWO from:** • Temperature • pH of mixture • Volume of water added • Aconitase concentration	**ACCEPT** 'allowed t reaction'.
2.4	38 mg produced in 5 minutes. $\frac{38}{1\,000} = 0.038$ g $\frac{0.038}{5} = 0.0076$ g min^{-1} 7.6×10^{-3} g min^{-1}	**ACCEPT** mg min^{-1} first, then convers g min^{-1}. **ECF**
2.5	*Yes:* • General respiratory poison; would kill or harm a wide range of different animals ingested. • Poison inhibits respiration even in small quantities; therefore, could be very effective. *No:* • Risk of poisoning humans who eat crops. • Causes death of other desirable species such as pollinators / general wildlife. • Could leach into water and cause harm to aquatic ecosystems. • May inhibit respiration in the crop plant.	**1 mark** for each va to a total of 3 mar **MUST** have an arg each side for full m

Question part	Answers	Extra inform
3.1	Prophase.	**ACCEPT** 'late prop
3.2	**Any FOUR from:** • Cut (1–2 cm from) root tips and fix tissue using ethanoic acid. • Transfer to warmed hydrochloric acid. • Wash root tips in cold water and dry using filter paper. • Cut a thin slice of tissue using a scalpel. • Stain the tissue using a dye which specifically stains chromosomes / genetic material. • Cover the sample with a cover slip.	
3.3	4(P) + 1(M) + 2(A) + 3(T) = 10 Total number of cells = 26 $(\frac{10}{26}) \times 100 = 38.5$	
3.4	• During **anaphase**, spindle fibres shorten to pull chromatids to either pole (of the cell). • If this cannot happen, chromosomes cannot separate correctly / new nuclear envelopes cannot form / cytoplasm cannot divide **AND** cell division will halt at anaphase.	**ACCEPT** '... will not telophase'.
3.5	Cancer is caused by uncontrolled cell division, and the substance can halt cell division.	
3.6	**Any THREE from:** • Yes: Drug A shows 4 % greater reduction in tumour size – suggests more cancerous tissue has been destroyed. • Yes: in patients who had recurrence of cancer, this takes longer to happen with Drug A. • No: [illegible] don't say how many people did **not** have a recurrence of cancer with each drug. • No: median values for recurrence based on unknown group size; could be very small groups. • No: small overall sample size. • No: difference in reduction of tumour sizes may not be statistically significant.	**DO NOT ACCEPT** 'd numbers of individ trial group'.

Question part	Answers	Extra inform
4.1	• If blood glucose is too high, it affects water potential of blood, causing loss of water from cells (by osmosis). • If glucose levels are too low, tissues (such as brain) are starved of glucose for respiration.	
4.2	(Qualitative) The test only asses[illegible] presence of glucose, not the amount of glucose which is present.	**AW** **NO MARK** for qual without justifying
4.3	[illegible]ab[illegible] has no units – units should be % / % of ght.	

Question part	Answers	Extra inform
4.4	(Yes) • Reading from the graph, the line of best fit intercepts 55 % transmission at a glucose level of approx. 14.3 mMol dm^{-3}. • Suggests that the urine sample contains m[illegible] 13 mMol dm^{-3} glucose.	
4.5	• There is uncertainty in th[illegible] ea[illegible] ement because glucose levels c[illegible] be a[illegible]fected by previous meal content[illegible] ter measurements may vary / an[illegible] may be too small. • [illegible]eating the measurement will reduce uncertainty so doctor can be more confident (of correct diagnosis).	**1 mark** for any vali uncertainty. **1 mark** for repetiti experiment reduci uncertainty in resu

Question part	Answers	Extra inform
5.1	BF Bf bF bf BF: BBFF BBFf BbFF BbFf Bf: BBFf BBff BbFf Bbff bF: BbFF BbFf bbFF bbFf bf: BbFf Bb[illegible] [illegible] bbff [illegible]ffspring predicted to have purple flowers. $\frac{3}{16} \times 91 = 17.06$ 17 plants with purple flowers.	**ECF** **ALLOW** full marks answer is reached without Punnett s **1 mark** for correc genotypes). **1 mark** for correc (offspring phenot accept 15 out of 1 **1 mark** for correc of purple-flowere **1 mark** for correc
5.2	Breaks down the blue/purple pigment / modifies the pigment so it no longer produces a colour.	**AW**
5.3	182 kg = 182 000 g; 1 km = 1 000 000 m^2; 1 year = 365 days $\frac{182\,000 \div 1\,000\,000}{365} = 0.0004986$ 5.0×10^{-4} g m^{-2} d^{-1}	**ACCEPT** $\frac{182\,000 \div 365}{1\,000\,000}$ as alternative me **ECF**
5.4	• YFP is a **marker gene**. • Can be used to determine wh[illegible] ba[illegible]ia have taken up plasmids c[illegible] the crocus genes / have been t[illegible] • Bact[illegible] have successfully taken up the [illegible]es will produce a yellow light/fluorescence [illegible]ch can be observed.	**ACCEPT** 'fluoresc **ACCEPT** reverse a based on bacteria not taken up gen

Question part	Answers	Extra infor
5.5	**Any THREE from:** • Pesticides may also kill economically useful species such as pollinators. • May have long-term impacts on biodiversity by reducing numbers of other species. • Less external control over pesticide p[illegible] than if a pesticide is applied [illegible]. • GM may reduce ge[illegible], making crop plants mor[illegible] thus vulnerable to the [illegible] [illegible]ss-pollination may transfer genes to weeds, [illegible]aking them hardier. • Economic arguments: many GM crops have to be seedless by law, which benefits companies selling seed yearly. • Religious arguments: changing the genetic code is interfering with natural order.	

Essay Mark Scheme

Mark	Impression	Crite
0		No response or nothing relevant.
Level 1 (1–5)	Unfocused	List of biological facts which are desc The theme of the question is not adc Co ..tel is ..nsistently below A Leve A large number of errors and irreleva
Level 2 (6–10)	One or two themes covered but not related to each other	One or two topics which do relate to each other. Content is mostly below A Level com well, but others are not clearly expla terminology is used inconsistently. Some significant errors and several ir
Level 3 (11–15)	Several (three or four) themes covered but not related to each other	Several aspects of the question them linked together effectively. The content is mostly appropriate fo Terminology is generally consistent a explained clearly. Some significant errors, or multiple ir
Level 4 (16–20)	Related topics li.. or.. well	Answer co.. de.. s several interrelate an .in.. t..m somewhat effectively The content and level of detail are ge although one or two topics may be la consistent and correct, and language One major error or irrelevant topic.
Level 5 (21–25)	Extended information – five plus themes – and beyond the specific course content. Shows ability to think abstractly about concepts in biology.	Answer considers several aspects of t links them effectively to produce a h Detailed biology that is all A Level co consistently and correctly. Language and focused. No significant errors or irrelevant ma reading.

6.1 Protein structure and function

The indicative content includes topics that the student might plausibly discuss during the
and students will receive credit for any topic which connects structure and function in pr
Students should discuss at least five examples to gain access to the highest marking leve
as describing, and link paragraphs together.

Topics in bold have **major** relevance, and are more likely to be cov ed in each student's

Topic covered	Spec. reference	Topic co
Monomers an	3.1.1	DNA and prot
P teins	3.1.4.1	Investigatin
Many proteins are enzymes	3.1.4.2	Photosy
Inorganic ions	3.1.8	Respir
Structure of prokaryotic cells and of viruses	3.2.1.2	Survival an
All cells arise from other cells	3.2.2	**Control of blood glu**
Transport across cell membranes	3.2.3	Control of blood
Cell recognition and the immune system	3.2.4	Alteration of the sequer alter the struct
Digestion and absorption	3.3.3	**Regulation of transcri**
Mass transport in animals	3.3.4.1	Gene expressio
DNA, genes and chromosomes	3.4.1	

6.2 The role of membranes in cell

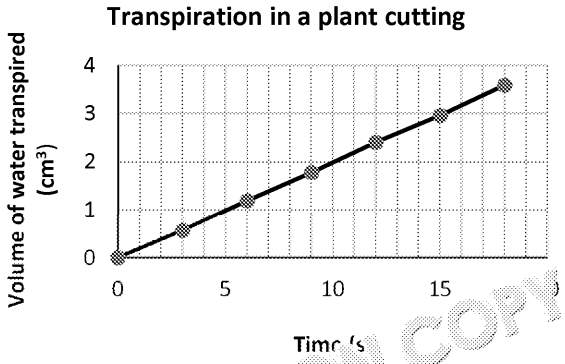
The indicative content include the student might plausibly discuss during the
and students will rece for any topic which discusses the functions of membrane
membrane s e w re appropriate.

Students should discuss at least five examples to gain access to the highest marking leve
as describing, and link paragraphs together.

Topics in bold have **major** relevance, and are more likely to be covered in each student's

Topic covered	Spec. reference	Topic co
Lipids	3.1.3	**Digestion an**
Structure of eukaryotic cells	3.2.1.1	**Photosy**
Structure of prokaryotic cells and of viruses	3.2.1.2	**Respir**
All cells arise from other cells		Survival an
Transport across cell membran	3.2.3	Recep
Cell recognition and th ystem	3.2.4	Nerve im
S re o volume ratio	3.3.1	Synaptic tra
Gas exchange	3.3.2	**Control of blood glu**

Practice Paper 3B

Question part	Answers	Extra in
1.1	Phloem is living tissue (with companion cells and many mitochondria), while xylem is mostly dead tissue; Phloem needs mitochondria for active loading [illegible], while transpiration in xylem is passive **OR** Xylem has li[illegible] walls, while phloem does not; [illegible] rigidity and strength to prevent xylem [illegible] from collapsing when pressure is low (i.e. dry conditions).	**1 mark** for c **1 mark** for e
1.2	• Waterproofs the gap in the rubber bung. • So that water in the capillary tube is not lost by evaporation through the hole, only taken up by the plant.	
1.3	Must first calculate capillary tube cross-sectional area (csa) csa = πr^2 d = 0.6 cm, so r = 0.3 cm csa = $\pi (0.3)^2 = 0.283$ cm^2 V = πr^2 × bubble movement	**1 mark** for c sectional are **1 mark** for c filled in on t **ALLOW** ± 0.0 (rounding er
1.4		**1 mark** for c with volume as x, AND us appropriate appropriate **1 mark** for c of points (**EC** **1 mark** for c best fit.
1.5	Rate = vol[illegible]e [illegible] 1.20 cm^3 min^{-1}	**ECF** from 1.3 **ACCEPT** from error: ± 0.01 **ACCEPT** 0.02

Time (min)	Bubble movement (cm)	Volume [illegible] ter [illegible] pi[illegible] (cm^3)
0	0	0
3	2.[illegible]	0.57
6	4.2	1.19
9	6.3	1.78
12	8.5	2.40
15	10.5	2.97
18	12.7	3.59

Question part	Answers	Extra info
2.1	**Any THREE from:** • Glucose moves through a carrier protein. • It is transported at the same time as sodium/Na^+ ions. • Sodium ions (actively) transported out of cell to maintain concentration gradient. • Na^+ moves down concentration gradient so glucose moves against concentration gradient.	
2.2	• Stops lymphocytes / white blood cells / macrophages from recognising the implanted cells as 'non-self'. • Prevents an immune response which would destroy the implanted cells.	AW
2.3	(Two) bar chart(s) with error bars / standard deviation bars.	
2.4	People with type 2 diabetes produce insulin, but target cells are less responsive to it.	**ACCEPT** 'People with diabetes produce ... treatments involve ... carbohydrate ... stimulating insulin production.'

Question part	Answers	Extra info
3.1	Substitution (mutation).	
3.2	• siRNA combines with an enzyme, and pairs with a complementary mRNA strand. • mRNA is broken down by the enzyme. • Translation does not occur / occurs less, so less protein is produced / the protein is not produced.	
3.3	• Loses specific shape features (such as cilia / cytoskeletal structure) and become irregular/amorphous. **OR** • Tissue loses its specific shape and becomes amorphous / becomes a mass of cells. • Cell loses control of protein production / expresses proteins that it would not usually express.	

Question part	Answers	Extra info
4.1	Kinesis is non-directional movement to avoid or find a stimulus; taxis is directional movement towards or away from a stimulus.	
4.2	**Any TWO from:** • The 'dry' chamber is bigger than the 'damp' chamber. • The dark cloth means that light levels vary between chambers / cannot determine whether the results are due to light or moisture. • No measurement of number of worms / conditions in control chamber. • Desiccant could be poisonous / a deterrent for earthworms.	**DO NOT ACCEPT** based on conc **ACCEPT** simila relating to res temperature **ACCEPT** 'worm move out of c chamber'.
4.3	$(30-25)^2 + (31-25)^2 + (17-25)^2 + (20-25)^2 + (28-25)^2 + (33-25)^2 + (24-25)^2 + (13-25)^2 + (29-25)^2 = 384$ N = 9 $\frac{384}{9} = 42.67$ $\sqrt{42.67} = 6.53\ (3\ \text{s.f.})$	**1 mark** for cor of differences **1 mark** for cor **ECF** **ACCEPT** 6.5.
4.4	• Earthworms become habituated to stimulus / respond less quickly to stimulus; • Because stimulus is frequent and is not observed to be harmful.	
4.5	**Any THREE from:** • Thermoreceptors and mechanoreceptors in hand detect rapid temperature increase and tissue damage. • Impulse passes through sensory neuron to a relay neuron in the spinal cord. • Impulse passes from relay neuron to motor neuron. • Causes contraction in (flexor) muscles in the arm. • Hand is withdrawn from the hot plate in a jerking motion.	**ACCEPT** correct relevant musc deltoids, trape

Question part	Answers	Extra info
5.1	• A large number of genes act on fur length / fur length is a polygenic trait. • Because the characteristic **shows continuous variation** (with a wide range of measured values), this suggests many genes contribute to phenotype.	
5.2	**Any THREE, in logical order, from:** • Directional selection acts against the phenotypic extreme. • Rising Arctic temperatures could cause animals with fur to overheat / these animals are wasting energy on fur production. • These animals are at a selective disadvantage / will have lower reproductive success. • Over time, the mean fur length is likely to decrease.	**ACCEPT** reverse based on advan shorter fur. **ACCEPT** 'allele f genes causing lo decrease'.

Question part	Answers	Extra info
5.3	**Any TWO from:** • **Crossing over** of homologous chromosomes during prophase I; means chromosomes swap genetic material / new combinations of alleles formed. • **Independent segregation** of homologous chromosomes during metaphase/anap[illegible]. • **Independent segregation** of [illegible] during metaphase/anapha[illegible]	**ACCEPT** 'indepe[illegible] assortment' in p[illegible] 'independent se[illegible] Points must incl[illegible] descriptive state[illegible]
5.4	2000 popula[illegible] op[illegible]tion = 2600 $\left(\frac{[illegible] - 300}{300}\right) \times 100 = 767$ % increase	**ACCEPT** 250–32[illegible] **ACCEPT** 2550–2[illegible] **ECF** **ACCEPT** 2 s.f., e[illegible] **ACCEPT** any valu[illegible] 685–950%, if co[illegible] calculated from [illegible] **DO NOT ACCEP[illegible]** correct range w[illegible] working.
5.5	*Yes:* • Strong positive correlation between Arctic fox activity and lemming population. • Arctic fox activity reaches maximum every three or four years, and lemming have similar pattern[illegible] suggests the two species have related pop[illegible]n cycles. • When lemming pop[illegible]gh, Arctic fox activity increases **AN**[illegible] *reference to data points*. [illegible]etimes Arctic fox activity increases while lemming population remains very low or falls **AND** *reference to data points*. • Foxes may exploit another food source. • Some other factor, such as climate, could cause both populations to rise and fall in size. • Activity doesn't necessarily prove population size.	**1 mark** for each [illegible] to a total of 3 m[illegible] **MAXIMUM 2 m**[illegible] one point of vie[illegible] is considered. (e.g. 1996, 1999) (e.g. 2001, 2006)

Question part	Answers	Extra info
6.1	• If there is not enough vitamin A, some rhodopsin pigments will not be functional. • Signal from rod cells to brain will be reduced/halted, so difficulty seeing / inability to see in dim light / night blindness.	
6.2	• Cysteine can no longer form a disulfide bond/bridge with another part of the molecule / interaction between this amino acid and others around it will change. • Changes tertiary structure / 3D shape of the molecule. • So that rhodopsin no longer binds (to retinal) / the protein no longer 'fits' in its membrane location / the protein can no longer catalyse further reactions.	**ACCEPT** any other explanation which structure to pro
6.3	• Gene/chromosome duplication causes gene to be copied. • Extra versions are not needed for their original role; mutations which lead to new functions (such as colour vision) will be advantageous.	**ACCEPT** answers alternative splic producing differ which are useful
6.4	Compare DNA / mRNA / amino acid sequences; more similar sequences suggest more closely related proteins.	

Essay Mark Scheme

Mark	Impression	Crite
0		No response or nothing relevant.
Level 1 (1–5)	Unfocused	List of biological facts which are desc The theme of the question is not adc Co[illegible] is [illegible]nsistently below A Level A large number of errors and irreleva
Level 2 (6–10)	[illegible] two themes covered but not related to each other	One or two topics which do relate to each other. Content is mostly below A Level com well, but others are not clearly expla terminology is used inconsistently. Some significant errors and several ir
Level 3 (11–15)	Several (three or four) themes covered but not related to each other	Several aspects of the question them linked together effectively. The content is mostly appropriate fo Terminology is generally consistent a explained clearly. Some significant errors, or multiple ir
Level 4 (16–20)	Related topics linked toget[illegible]ve	Answer considers several interrelate and links t[illegible]omewhat effectively The [illegible]ontent and level of detail are ge although one or two topics may be la consistent and correct, and language One major error or irrelevant topic.
Level 5 (21–25)	Extended information – five plus themes – and beyond the specific course content. Shows ability to think abstractly about concepts in biology.	Answer considers several aspects of links them effectively to produce a h Detailed biology that is all A Level co consistently and correctly. Language and focused. No significant errors or irrelevant ma reading.

7.1 Why exchange surfaces are important in cells and organisms

The indicative content includes topics that the student might plausibly discuss during the
and students will receive credit for any topic which links the structure and function of an
advantage for a cell or organism.

Students should discuss at least five examples to gain access to the highest marking leve
as describing, and link paragraphs together.

Topics in bold have **major** relevance, and are more likely to be covered in each student's

Topic cove	Spec. reference	Topic cove
Trans oss cell membranes	3.2.3	Photosynth
Cell recognition and the immune system	3.2.4	Respirati
Surface area to volume ratio	3.3.1	Nutrient cy
Gas exchange	3.3.2	Nerve imp
Digestion and absorption	3.3.3	Synaptic trans
Mass transport in animals	3.3.4.1	Control of blood gluco
Mass transport in plants	3.3.4.2	Control of blood wa

7.2 Energy transfers in organisms and ecosystems

The indicative content includes topics that the student might p ly discuss during the
and students will receive credit for any topic which pla tr fer of energy in a broad

Students should discuss at least five gain access to the highest marking leve
as describing, and link paragr

Topics in bo ma relevance, and are more likely to be covered in each student's

Topic covered	Spec. reference	Topic cov
ATP	3.1.6	**Energy and ec**
Transport across cell membranes	3.2.3	**Nutrient c**
Digestion and absorption	3.3.3	Recept
Mass transport in animals	3.3.4.1	Control of he
Mass transport in plants	3.3.4.2	Nerve imp
DNA and protein synthesis	3.4.2	**Skeletal muscles are contract by nerves an**
Photosynthesis	3.5.1	ontrol of blood gluco
Respiration	3.5.2	Populations in e

Practice Paper 3C

Question part	Answers	Extra info
1.1	Mesophyll ORGAN → ORGAN SYSTEM	**ACCEPT** 'Palisad mesophyll'.
1.2	Volume = (10 × 25 × 35) = 8 750 μm^3 Surface Area = 2 (35 ×25) + 2 (+ 2 (25 ×10) = 2 950 Ratio = $\left(\frac{2\,950}{8750}\right)$ = 0.34 :1	**1 mark** for corre **1 mark** for corre units. **ECF** **1 mark** for corre
1.3	increases, SA:V ratio decreases **AND** so exchange surfaces are needed to increase exchange of gases/nutrients.	
1.4	X = guard cell; Y = stoma	**MUST** have bot mark. **ACCEPT** 'Y = sto
1.5	Ensures all measurements are taken from the same point when calculating R_f values. **OR** Allows precise measurement of solvent front, so R_f values can be calculated.	
1.6	$R_f = \frac{\text{Distance travelled by pigment}}{\text{Distance travelled by solvent}}$ Distance travelled by solvent = 7.5 cm. Distance travelled by pigm = cm. $R_f = \frac{4.1}{7.5}$ = 0.54 ... 0.54, allowing for minor measurement). it is anthocyanin.	**1 mark** for appr equation and m **1 mark** for corre and answer.
1.7	• (Swiss chard can survive in shade.) • Different photosynthetic pigments absorb a range of light wavelengths. • Helps maximise rate of photosynthesis at lower light intensities.	

Question part	Answers	Extra info
2.1	**Any TWO from:** • Low density relative to carbohydrates; reduces work needed by muscles to move body. • Many high-energy carbon–hydrogen bonds; store a large amount of energy. • Insoluble in water; doesn't affect solu[illegible] concentration / water potenti[illegible] • High RQ (respirator[illegible] large amount of energy rele[illegible] molecule when respired.	**1 mark** for each associated justif a maximum of 2 **ACCEPT** 'non-po justification.
2.2	[illegible]: Unsaturated; C: Unsaturated [illegible]rated fatty acids have one or more double bonds between carbon atoms, while saturated fatty acids have no double bonds.	**1 mark** for all th correctly classifi **1 mark** for corre **ACCEPT** AW.
2.3	Protein channels are not needed because fatty acids are soluble in the lipid membrane of the cell.	**ACCEPT** '... fatty polar, so can dif the membrane'
2.4	• Used as a control, to see the background rate of reaction / create a baseline to compare experimental results to. • Provides data on the effect of low bile salt concentrations on lipase activity. ***OR*** • Excludes theory that something other than bile salts is causing the change.	
2.5	There is a greater increase in lipase activity with bile salts when unsaturated fatty acids are present. *(Any correct numerical comparison of change in rate.)* **ALSO TWO from:** • However, there is some increase in lipase activity in the test tubes. • Stomach churns and changes composition of fats/oils before they reach small intestine (which bile salts are released into). • Saturated fats tend to be solid at low temperatures, so less surface area for bile salts / lipase to act on. • Temperature used is 30 °C, while the temperature of the small intestine is warmer (around 37 °C). • Only four lipids studied – small sample size. • Statistical test should be used to test/confirm whether difference is significant.	**ACCEPT** compar of absolute num percentages or greater'.

Question part	Answers	Extra info
3.1	29 − 18 =11 mm	**MUST** have unit
3.2	Mitotic Index = $\left(\frac{\text{Number of dividing cells}}{\text{Total number of cells}}\right) \times 100$ MI = 2.3 (%) $2.3 = \left(\frac{n}{750}\right) \times 100$ Rearranging: $\frac{2.3}{100} \times 750 =$ 17 n = 17 (cells)	**1 mark** for corre and substitution **1 mark** for corre and answer.
3.3	Drug A reduces tumour size by 24 %, while Drug B reduces growth by 38 %; Drug B has a greater effect on the size of the tumour, suggesting it has greater efficacy. • Drug A reduces mitotic index by 87 %, while Drug B reduces MI by 89 %; • Drug B reduces cell division in the tumour more, suggesting it has greater efficacy. • Drug B reduces MI in surrounding tissue by 30 %, while Drug A only reduces MI by 5.4 %; • Suggests Drug B may be less specific / do more harm to surrounding tissue.	**1 mark** for each comparison. **1 mark** for expla comparison. $\left(\frac{22 - 29}{29}\right) \times 10$ $\left(\frac{18 - 29}{29}\right) \times 10$ $\left(\frac{2.8 - 21}{21}\right) \times 1$ $\left(\frac{2.3 - 21}{21}\right) \times 1$ $\left(\frac{3.5 - 3.7}{21}\right) \times$ $\left(\frac{2.6 - 3.7}{3.7}\right) \times 1$
3.4	• Drug A could [illegible] acetylation, meaning DNA is [illegible] less tightly around histones. [illegible] can be transcribed (and translated) more easily, producing proteins which cause apoptosis in cancer cells.	**ACCEPT** AW rela expression of tu suppressor prot

Question part	Answers	Extra info
4.1	• ATP synthase is an **enzyme AND** a protein channel / ion channel / transmembrane protein. • Protons pass through ATP synthase down a proton gradient, producing energy. • Energy is used to phosphorylate ADP (to produ[illegible]P.)	**ACCEPT** referen[illegible] turning a motor [illegible] which causes ph[illegible] of ADP.
4.2	Non-competitive inhibitors.	
4.3	• Release chloroplasts [illegible] leaves without destroying th[illegible] • Light [illegible] reaction requires intact chloroplasts because it uses pigment complexes / electron transfer chain in thylakoid membrane.	**ACCEPT** reverse [illegible] 'grinding leaves [illegible] would destroy ch[illegible]
4.4	**Any FOUR, in logical order, from:** • As DCPIP changes from blue to colourless, red light begins to pass through the cuvette (in the colorimeter). • With no zinc present, DCPIP accepts electrons and becomes colourless, so light transmission is high. • As zinc levels rise, ferredoxin NADP+ reductase is inhibited. • Fewer electrons available (for DCPIP to accept), so less DCPIP changes colour. • (At intervals) above 1200 µMol dm^{-3} zinc hydroxide concentration, ferredoxin $NADP^+$ reductase is fully inhibited.	**ACCEPT** '... light [illegible] reaction is fully [illegible] does not occur'
4.5	Uncertainty = $\left(\frac{\text{Absolute uncertainty}}{\text{Measurement}}\right) \times 100$ $U = \left(\frac{(\pm 0.018)}{0.55}\right) \times 100$ = ± 3.3 %	**1 mark** for subst[illegible] values into equa[illegible] **1 mark** for corre[illegible] 2 s.f.

Question part	Answers	Extra info
5.1	**Any TWO from:** • Action potential in one part of the axon causes depolarisation in the next section (of axon). • Layer of insulating myelin covers much of the axon, so action potential jumps between nodes (of Ranvier), by saltatory conduction). • When action potential reaches the neuromuscular junction, causes neurotransmitter to be released into synapse.	
5.2	Speed = $\frac{\text{distance}}{\text{time}}$ $115\ \text{m s}^{-1} = \frac{0.9}{x}$ Rearranging the equation: $115x = 0.9$ $x = \frac{0.9}{115} = 0.008$ s (or 8 ms)	**ECF**
5.3	• Impulses move more slowly through unmyelinated neurons. • Reaction times are slower when recognising and fleeing a predator.	
5.4	So data points are not crowded in one corner of the graph / so data points can be clearly distinguished / so data on different orders of magnitude can be compared.	**AW**
5.5	*For:* • There is a strong positive correlation/relationship between weight and neuron number. • Therefore, weight can be used to roughly estimate neuron number. *Against:* • However, there are significant outliers / the relationship is not directly proportional. • *Any valid use of data; for example:* Octopus has higher mass than domestic cat (8 kg > 4 kg) but fewer neurons (500 million < 750 million). • Can estimate within an order of magnitude but not a precise number. • Seven species studied – small sample size.	**1 mark** for each to a total of 3 m **MAXIMUM** of 2 one side of the presented.

Essay Mark Scheme

Mark	Impression	Crite
0		No response or nothing relevant.
Level 1 (1–5)	Unfocused	List of biological facts which are desc The theme of the question is not add Co ter is consistently below A Level A large number of errors and irreleva
Level 2 (6–10)	One or two themes covered but not related to each other	One or two topics which do relate to each other. Content is mostly below A Level com well, but others are not clearly expla terminology is used inconsistently. Some significant errors and several ir
Level 3 (11–15)	Several (three or four) themes covered but not related to each other	Several aspects of the question them linked together effectively. The content is mostly appropriate fo Terminology is generally consistent a explained clearly. Some significant errors, or multiple ir
Level 4 (16–20)	Related topics linked t	Answer conside s several interrelate and lin h somewhat effectively he content and level of detail are ge although one or two topics may be la consistent and correct, and language One major error or irrelevant topic.
Level 5 (21–25)	Extended information – five plus themes – and beyond the specific course content. Shows ability to think abstractly about concepts in biology.	Answer considers several aspects of links them effectively to produce a h Detailed biology that is all A Level co consistently and correctly. Language and focused. No significant errors or irrelevant ma reading.

6.1 How organisms are adapted to their external environment

The indicative content includes topics that the student might plausibly discuss during the
and students will receive credit for any topic which places a transfer of energy in a broad

Students should discuss at least five examples to gain access to the highest marking leve
as describing, and link paragraphs together.

Topics in bold have **major** relevance, and are more likely to be covered in each student's

Topic covered	Spec. reference	Topic cove
Wat	3.1.7	Biodiversity within
St of ukaryotic cells	3.2.1.1	Respirat
Structu prokaryotic cells and of viruses	3.2.1.2	Nutrient c
Gas exchange	3.3.2	Survival and r
Mass transport in animals	3.3.3	Recepto
Mass transport in plants	3.3.4	**Evolution may lead**
Genetic diversity and adaptation	3.4.4	**Populations in e**
Species and taxonomy	3.4.5	

6.2 Why cell specialisation is essential for complex organisms

The indicative content includes topics that the student might plausibly discuss during the
and students will receive credit for any topic which places a transfer of energy in a broad

Students should discuss at least five examples to gain access to th ighest marking leve
as describing, and link paragraphs together.

Topics in bold have **major** relevance, and are more likely to be covered in each student's

Core ideas:

- Specialisation increases efficiency.
- Specialisation allows division of labour.
- Specialisation allows metabolic demands to be met.
- Specialisation allows bulk transport.
- Specialisation allows production of new physical structures.
- Cells need to produce different products.
- Some cells need to be mobile.
- Cells may need to communicate long distance, and with specific other cells.
- Some cells are adapted for exchange.
- Some cells join together to carry out functions they cannot carry out alone.

Topic covered	Spec. reference	Topic cov
Carbohydrates	3.1.2	Nutrient c
Structure of eukaryotic cells	3.2.1.1	**Recepto**
Transport across cell membranes	3.	Control of he
Cell recognition and the immu sys	3.2.4	**Nerve imp**
Gas	3.3.2	**Skeletal muscles are contract by nerves an**
M nsport in animals	3.3.4.1	Control of blood gluco
Mass transport in plants	3.3.4.2	Most of a cell's DNA
Genetic diversity can arise as a result of mutation or during meiosis	3.4.3	Regulation of transcript

Practice Paper 3D

Question part	Answers	Extra info
1.1	(Hydrolysis reaction), using **water/H_2O** to break the (1,2-)**glycosidic bond** between molecules. Fructose **AND** (α-)glucose	**MUST** name bo… for mark.
1.2	**Any TWO from:** • **Insoluble**, so does n… di… …water potential (ψ) / so starch mol… …move away from storage areas. • **Bran…** …enzymes can act on several parts of the …ecule and catalyse it quickly (when energy is …eeded). • Relatively compact, so a lot of energy can be stored.	**ACCEPT** 'osmoti… place of water p… **ACCEPT** 'branch… easily hydrolyse… (for transport/re…
1.3	• Increase surface area, so HCl reacts with sucrose more easily. • Allow free movement of saccharides, so they come into contact with Benedict's reagent more easily.	
1.4	Ensures a constant temperature throughout the boiling tube.	**ACCEPT** answer… increased precis… temperature.
1.5	• After five minutes, place (a sample of) each mixture (into a cuvette) in a **colorimeter** with a red/blue filter. • Measure transmission of light through each sample, and compare data to a **calibration curve** (based on known quantities of sucrose).	**ACCEPT** 'measu… of light, and cor…

Question part	Answers	Extra info
2.1	When the biceps contracts, the triceps relaxes (to lift the weight) **AND** bone shape/length doesn't change.	**ACCEPT** reverse on same princip
2.2	**Any THREE, in logical order, from:** • Action potential causes calcium channels to open i presynaptic neuron. • This causes vesicles containing acetyl ho to fuse with the membrane, so ac yl e is released into the junction. • Acetylch e ar with receptors on the sts membrane / sarcolemma. • ses the sarcoplasmic reticulum to release calcium/$Ca2^+$ ions (changing the relative electrical potential across the membrane).	**ACCEPT** 'This ca exocytosis, so...'
2.3	**Any TWO from:** • Many muscle cells fused together into multinucleate fibres. • Many cells surrounded by the same sarcolemma / external membrane. • Contains sarcoplasmic reticulum, which is rich in calcium/$Ca2^+$ ions. • Organised into many smaller structures called myofibrils. • Myofibrils contain actin and myosin proteins which are organised in a specific pattern. • Cytoplasm contains many mitochondria. • Fibres packed together in highly vascularis bundles.	**ACCEPT** 'Many c motor neuron b fine-tuning of c
2.4	Differences between rate is contraction will not be statistically sig t in the two groups. treated with Substance X and with the placebo not show significantly different muscle contraction speeds/rates.	AW

Question part	Answers	Extra info
3.1	High rainfall levels; high light intensity / many hours of sunlight; high temperature.	**ACCEPT** 'high co nutrients in soil'
3.2	• Biomass must be measured dry; killing and drying producers (plants) is much easier than consumers / does not raise ethical issues. • Consumers generally move; harder to get representative sample by a[illegible]	
3.3	32 % = 0.32 [illegible] 760 kJ - 5 760 = 12 240 kJ (in 100 m^2 in one day) $\frac{12\,240}{100}$ = 122 kJ day^{-1}	**ACCEPT** '122.4 k
3.4	Species richness has significantly declined in Forest F, with 99 % confidence / $p<0.01$, but not in Forest G. **AND TWO from:** • Data shows richness rather than abundance – species in F could be more evenly distributed / one species could dominate in G. • Data only shows plant biodiversity; does not consider animal species. • Other factors besides National Park status (e.g. remoteness) could contribute to difference. • Natural Park may preserve species richness, h[illegible] evidence that it increases it, as $p>0.1$	**1 mark** for recog significance of di between t-test v **1 mark** for each limitation, up to 2 marks. **ACCEPT** any othe limitation of data

Question part	Answers	Extra info
4.1	**Any TWO from:** • Thick layer of elastic tissue – allows recoil / reduces risk of rupture. • Thick layer of smooth muscle – increases ability to withstand pressure. • Lumen shape is (relatively) flexible – can change shape in response to different volumes of blood. • Large lumen for an artery – allows large quantities of blood to pass through. • Lumen smaller compared to equivalent vein – maintains high blood pressure.	
4.2	Average heart rate = $\frac{(104 + 121+111+98+103+116+115+107)}{8} = 109$ (3 s.f.) Cardiac output=heart rate ×stroke volume $12.2 = 109 \times$ s.v. $\frac{12.2}{109}$ = s.v. s.v. = 0.11 dm^3 min^{-1}	**ACCEPT** answers 110, allowing for inaccuracies in g **ECF**
4.3	Reduces the effects of random fluctuations from minute to minute. **OR** Reduces the effects of **random** errors in recording **OR** Easier to perceive and discount anomalies which are due to errors.	
4.4	• Parasympathetic nervous system actively reduces heart rate from a resting individual (to around 80 bpm). • This is an ongoing process; otherwise, heart rate would gradually rise towards 100 bpm when at rest.	**ACCEPT** explanat PNS reduces he

Question part	Answers	Extra info
5.1	*Advantage:* Can view the cell's ultrastructure more clearly/can see the cell's organelles internal structures in high resolution. *Disadvantage:* Need to kill the cell in order to visualise i[t] ca[n]/ visualise living processes wit[h] in th[e] /sample preparation is comp[lex] and [ca]n introduce artefacts + errors.	**1 mark** for any v[alid] of TEM. **1 mark** for any v[alid] disadvantage of [TEM] **DO NOT ACCEPT** [answers] 'requires special [training]'
5.2	120 mm = 120 000 µm $\frac{120\,000}{8.15}$ = 14 724× = 14 700× (3 s.f.)	**ACCEPT** 14 724×
5.3	*Eukaryote:* Nuclear membrane is present, DNA is linear rather than circular. **OR** *Prokaryote:* DNA is not attached to histone proteins, Membrane-bound organelles are generally absent. **OR** *Neither:* organism belongs to a new group. (Compare and contrast two features listed above)	**1 mark** for each [valid] point, up to a tot[al] **DO NOT ACCEPT** [answers] plasma membran[e] justification.
5.4	Means the name used in literature [is] consistent, so research on the organis[m] unambiguous / easy to find.	
5.5	• *P. myojin[ensis]* [amino] acid sequence differs from [*E.*] *coli* in [some] positions, and (eukaryotic) humans in [more] positions. • [This] suggests that the newly discovered organism is more similar to bacteria. • However, only one partial protein – other proteins may be more similar to those in eukaryotes. **OR** *E. coli* / *H. sapiens* may not be representative of their domains for this gene.	**ACCEPT** reverse [argument] on number of sim[ilarities] **ACCEPT** answer [that] convergent evolu[tion]
5.6	**Any TWO from:** • *Ribosomal RNA* – found in all organisms and highly conserved, so easy to compare 'like for like'/ sequences differ between eukaryotes and bacteria due to different ribosome structures. • *Highly-conserved genes* – have fundament[al] purposes which link to an organism's [basic] [nature] of living and classification. • *Introns/exons* – Eukaryotes have introns in their DNA, while Bact[eria] [do] not. • *Structure of cell wall* – peptidoglycan/murein in [bacteria]; varied in eukaryotes. • *Ribosomes* – 70S in bacteria; 80S in eukaryotes.	**ACCEPT** any other [feature] which focuses on [the] differences betwe[en] and eukaryotes. **ACCEPT** 'overall [similarity] genome – mutat[ions] accumulate over [time] genome more sim[ilar] closely related sp[ecies]

Question part	Answers	Extra info
6.1	$p^2 + 2pq + q^2 = 1$ $p^2 + 2pq = 0.84$, so $q^2 = 1 - 0.84 = 0.16$ $q = \sqrt{0.16} = 0.4$ $p + q = 1$, so p = 0.6 $2pq = 2(0.4 \times 0.6) = 0.48$	**ACCEPT** correct a working for 3 mar **ECF**
6.2	**Any TWO fro** • ly … es / other alleles are very rare. • ulation is reproductively isolated. • opulation is large (so no genetic drift). • Mating within the population is random. • Neither allele offers a significant survival advantage. • The mutation rate is zero/negligible.	
6.3	**Any THREE from:** • Initial decline in moth population due to predation. • Mutation gives birds new food source, so spreads (gradually) throughout bird population. • Moths with bright patterning are more visible to predators, and, therefore, more likely to be eaten. • These moths, on average, are less likely to survive and have offspring / have fewer offspring. • Frequency of *R* allele decreases / frequency of *r* allele increases.	**ACCEPT** reverse a on moths with du patterns surviving
6.4	• Data suggests directional selecti … ha … used decrease in wingspan • However, can … clude that predation is the caus … more evidence); some other factor … ld … responsible.	**ACCEPT** use of da wingspan reduced 34.6 mm to 31 m

Essay Mark Scheme

Mark	Impression	Crite
0		No response or nothing relevant.
Level 1 (1–5)	Unfocused	List of biological facts which are desc The theme of the question is not add Co ter is consistently below A Level A large number of errors and irreleva
Level 2 (6–10)	One or two themes covered but not related to each other	One or two topics which do relate to each other. Content is mostly below A Level com well, but others are not clearly explai terminology is used inconsistently. Some significant errors and several ir
Level 3 (11–15)	Several (three or four) themes covered but not related to each other	Several aspects of the question them linked together effectively. The content is mostly appropriate fo Terminology is generally consistent a explained clearly. Some significant errors, or multiple ir
Level 4 (16–20)	Related topics linked t	Answer conside s several interrelated and lin h somewhat effectively he content and level of detail are ge although one or two topics may be la consistent and correct, and language One major error or irrelevant topic.
Level 5 (21–25)	Extended information – five plus themes – and beyond the specific course content. Shows ability to think abstractly about concepts in biology.	Answer considers several aspects of links them effectively to produce a h Detailed biology that is all A Level co consistently and correctly. Language and focused. No significant errors or irrelevant ma reading.

7.1 Technology in modern genetics

The indicative content includes topics that the student might plausibly discuss during the
and students will receive credit for any topic which discusses technology's impact on the
indirect (e.g. Fast Plant®), but the connection between the technology and the field of ge

Students should discuss at least five examples to gain access to the highest marking leve
as describing, and link paragraphs together.

Topics in bold have **major** relevance, and are more likely to be covered in each student's

Topic cov	Spec. reference	Topic cov
M or studying cells	3.2.1.3	Alteration of the sequen can alter the structu
All cells arise from other cells	3.2.2	Most of a cell's DNA i
Genetic diversity can arise as a result of mutation or during meiosis	3.4.3	Regulation of transcripti
Species and taxonomy	3.4.5	**Using genome**
Investigating diversity	3.4.7	**Recombinant DNA**
Inheritance	3.7.1	**Differences in DNA betw the same species can identification and diag condition**
Evolution may lead to speciation	3.7.3	**Genetic finger**

7.2 The role of ions in plants and animals

The indicative content includes topics that the student might plausibly discuss during the
and students will receive credit for any topic which connects ions to a particular process

Students should discuss at least [illegible] examples, including examples from both the animal
access to the highest mark levels (4/5). They should explain as well as describing, and

Topics in bold have **major** relevance, and are more likely to be covered in each student's

Topic covered	Spec. reference	Topic cov
Many proteins are enzymes	3.1.4.2	Respirat
ATP	3.1.6	**Nutrient cy**
Inorganic ions	3.1.8	Recepto
Digestion and absorption	3.3.3	**Nerve imp**
Mass transport in animals	3.3.4.1	Synaptic tran
Mass transport in plants	3.3.4.2	**Skeletal muscles are ntract by nerves and**
Photosynthesis	3.3.5	Control of blood w