Surname	Centre Number	Candidate Number
Other Names		2

GCE A LEVEL – NEW

A400U10-1

S17-A400U10-1

BIOLOGY – A level component 1
Energy for Life

MONDAY, 12 JUNE 2017 – AFTERNOON

2 hours

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**7**	
2.	**10**	
3.	**14**	
4.	**20**	
5.	**12**	
6.	**9**	
7.	**10**	
8.	**9**	
9.	**9**	
Total	**100**	

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ADDITIONAL MATERIALS

In addition to this examination paper, you will need a calculator and a ruler.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen. Do not use correction fluid.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet. If you run out of space, use the continuation pages at the back of the booklet, taking care to number the question(s) correctly.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

The assessment of the quality of extended response (QER) will take place in question **9**.

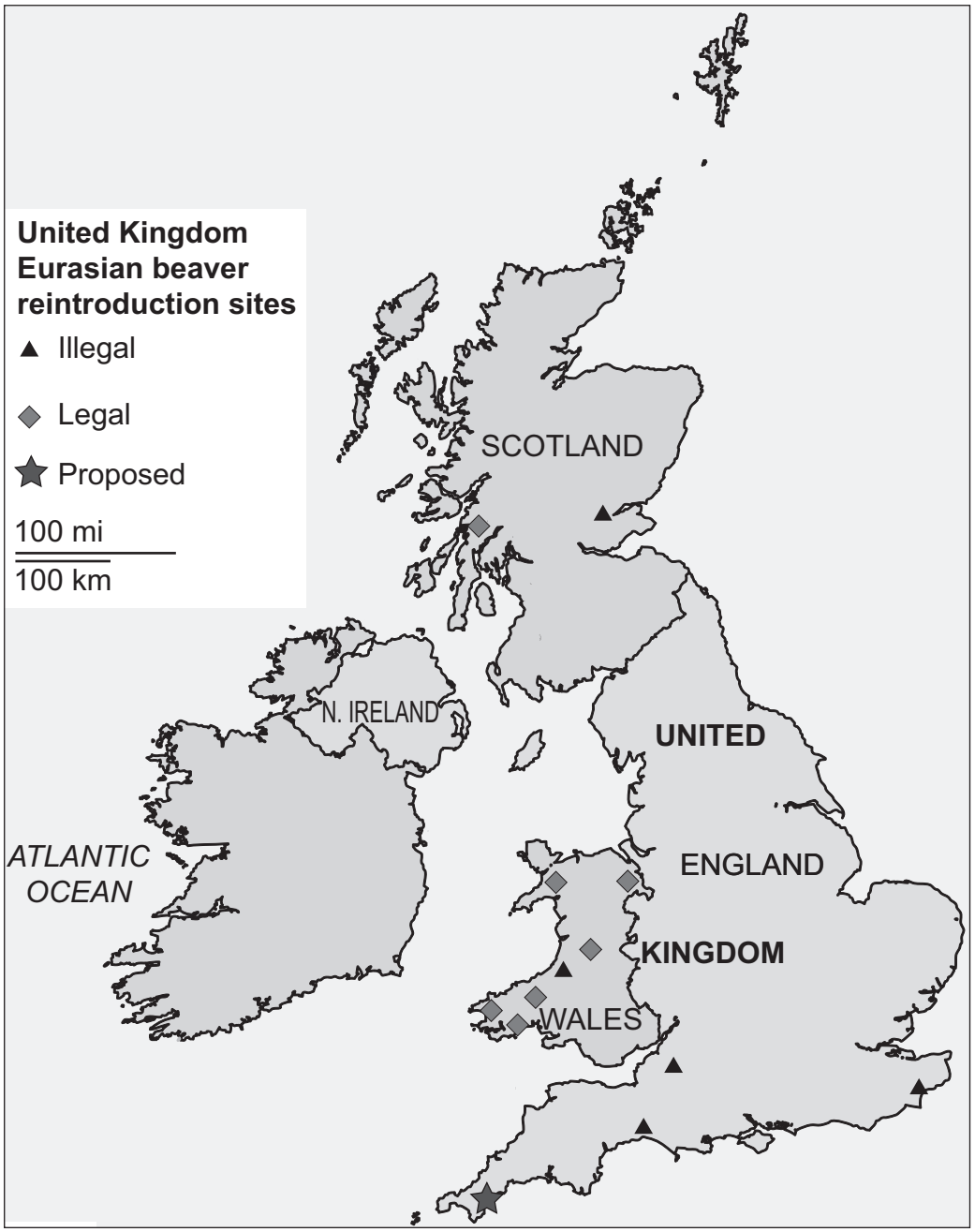
The quality of written communication will affect the awarding of marks.

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Answer **all** *questions.*

1. The Eurasian beaver *(Castor fiber)*, a large, strictly herbivorous mammal, was formerly native to the UK. They played an important part in our landscape by felling trees to build dams. These dams block small streams, slowing their flow and forming small ponds and bogs. Beavers were hunted to extinction in the 16th century. The loss of this species led to the loss of many freshwater habitats.

The map below shows the sites where beavers from Northern Europe have been reintroduced into the wild in the UK together with some proposed sites.



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(a) Beavers used to be an endangered species in Europe. Explain what is meant by an endangered species. [1]

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(b) Give **two** advantages of using re-introduction of beavers from northern Europe as a strategy for conservation in the UK. [2]

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(c) There has been some re-introduction of beavers into the UK, both legal and illegal. Give **two** reasons why people might be concerned about illegal, unregulated re-introduction of beavers. [2]

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(d) Environmental conservation decisions can only be made on the basis of sound scientific principles. Give **two** factors that scientists would have to consider when planning the successful re-introduction of beavers. [2]

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2. Good plant growth requires all nutrients to be available and in sufficient quantity. There are six macronutrients needed in the largest quantities, four of these being nitrogen (N), phosphorus (P), potassium (K) and sulfur (S).

(a) (i) State why nitrogen and phosphorus are needed for plant growth. [2]

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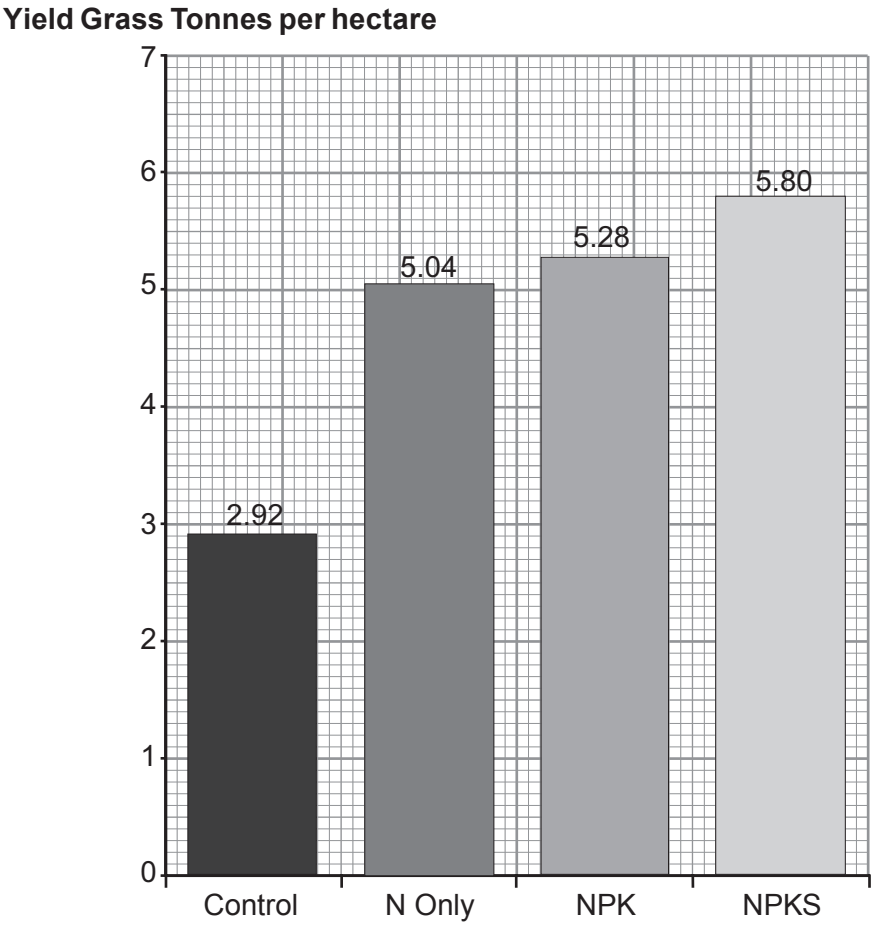
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(ii) Give an example of a biological molecule that contains sulfur. [1]

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Field trials were carried out by a fertiliser company to determine the effect of the four macronutrients on grass growth.

Effect of different fertiliser treatments on grass yield



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(b) (i) Use the graph to describe the effect of adding different fertilisers on grass yield. [2]

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(ii) What control would have been used in these field trials? [1]

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(c) Give experimental details of how you could set up an experiment in the laboratory to determine increase in mass of the grasses over a 4 week period with the three fertilisers shown on the graph. [4]

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3. The planetary boundaries framework was first introduced in 2009. A group of scientists identified nine planetary boundaries within which humanity can develop and thrive for generations to come. Crossing these boundaries could generate irreversible environmental changes.

The table below shows two planetary boundaries and their current values.

Planetary boundary	Variable(s)	Boundary	Current Value
Climate change	Atmospheric CO_2 concentration, ppm	350 ppm CO_2	396.5 ppm CO_2
Change in biosphere integrity	Genetic diversity: Extinction rate	less than 10 extinctions per million species per year	100-1000 extinctions per million species per year

ppm = parts per million

(a) Explain what the term "planetary boundary" means. [2]

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(b) Calculate the percentage by which the current atmospheric carbon dioxide concentration exceeds the boundary, giving your answer to one decimal place.
Show your working in full. [2]

Percentage = ... %

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(c) Explain how deforestation can directly affect the planetary boundary for climate change. [3]

(d) Using your knowledge of natural selection, explain why more species have become extinct recently, compared to pre-industrial times. [3]

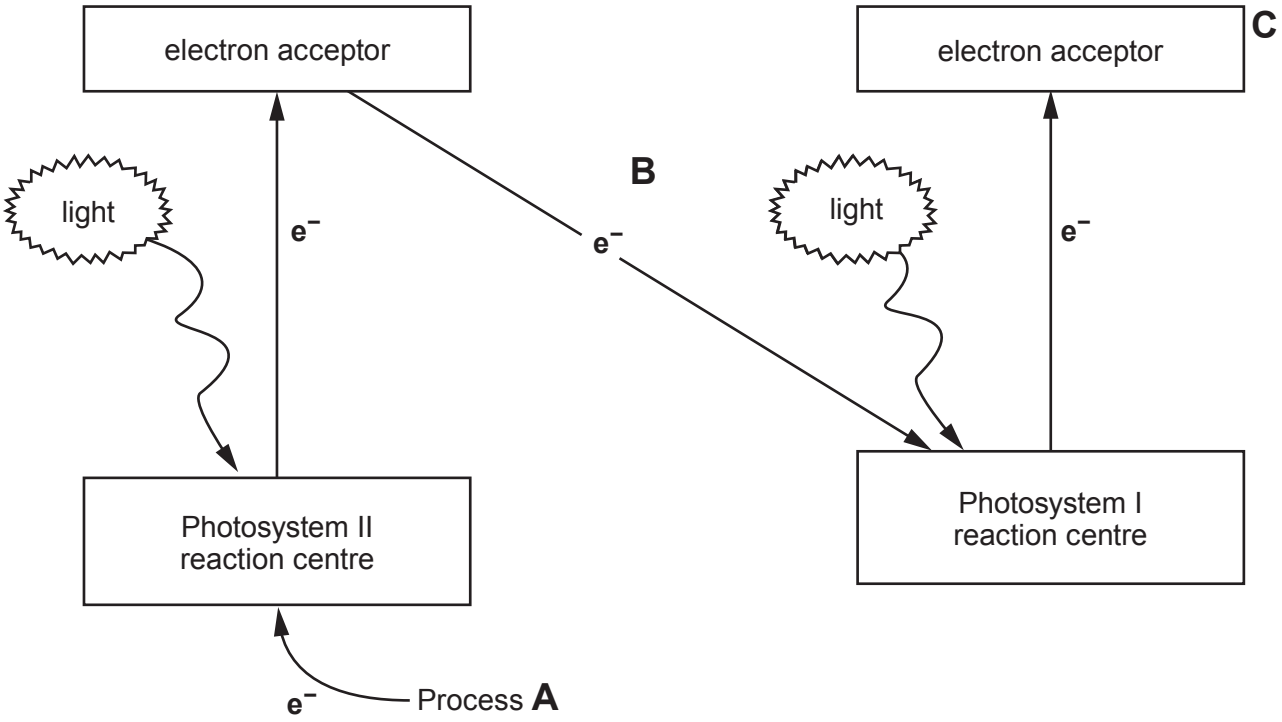
(e) Suggest how biodiversity loss may be delayed using conservation methods. [4]

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4. The light dependent stage of photosynthesis can be represented by a diagram called the Z-scheme, shown below.



(a) (i) **Describe** the process at **A** which replaces the electrons lost from photosystem II and explain how electrons are used at **B** and **C**. [3]

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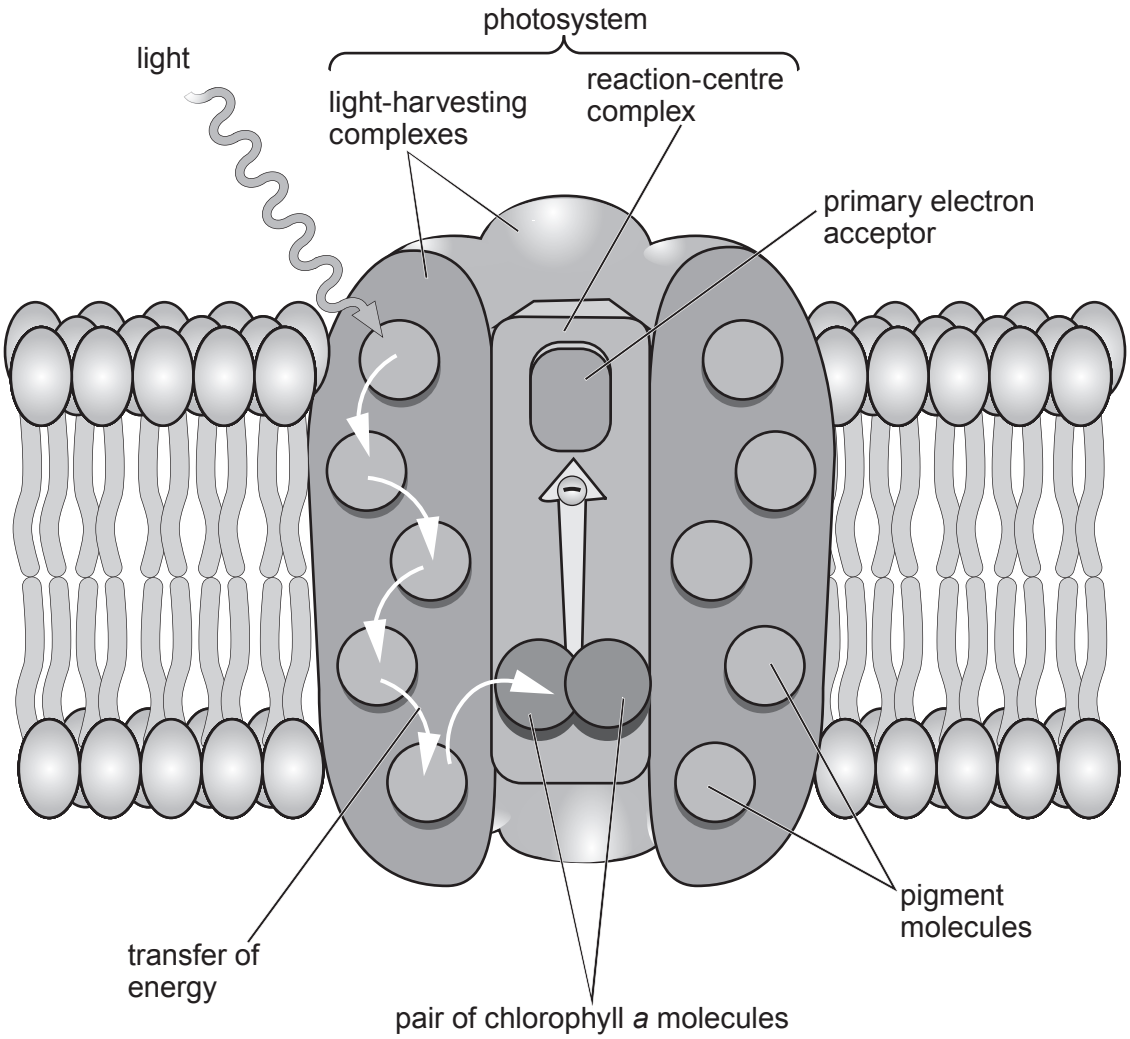
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(ii) **Draw a clear line** labelled **X** on the Z-scheme diagram above, to indicate the movement of electrons in cyclic photophosphorylation. [1]

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(b) The modern representation of a photosystem is shown in the diagram below.



(i) Apart from chlorophyll *a*, name **three** *other* pigments you would expect to be present in a photosystem. [2]

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(ii) State precisely where a photosystem would be found in a plant cell. [1]

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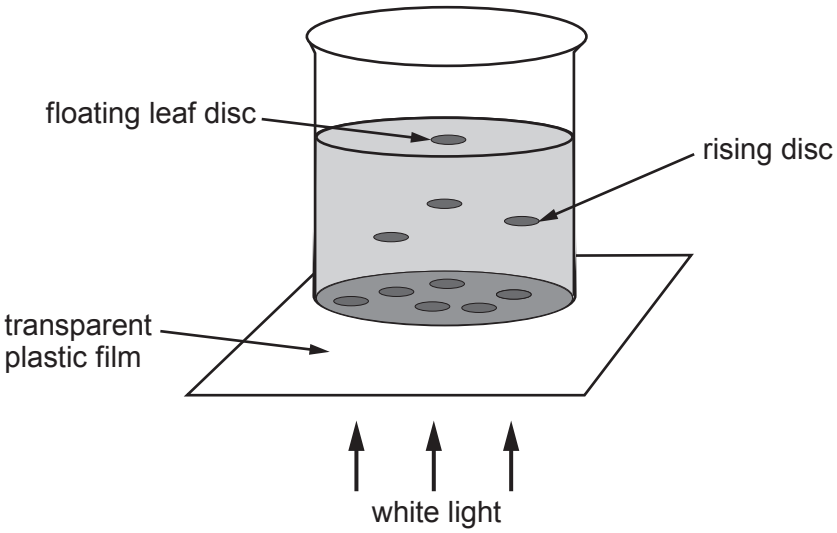
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(c) An experiment was carried out to investigate the effect of leaf colour on the rate of photosynthesis. Leaves placed in water naturally float, but if small discs of leaves are punched out of the leaves and the air in the discs is replaced by hydrogen carbonate solution (a CO_2 source), they will sink.

The time taken for 15 light green leaf discs to float to the top of the solution when illuminated from below can be determined and gives an estimate of the rate of photosynthesis. This was repeated for dark green leaf discs.



The results of such an experiment are shown below.

Order of leaf discs rising	Time taken for each leaf disc to rise / seconds	
	Dark green colour discs	Light green colour discs
1st	102	296
2nd	157	324
3rd	186	358
4th	201	360
5th	240	420
6th	260	422
7th	287	665
8th	317	666
9th	396	805
10th	404	1000
11th	474	1108
12th	535	1173
13th	622	1674
14th	808	1821
15th	898	2388
Mean time	.....	898.7

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(i) Calculate the mean time taken for the 15 dark green discs to float and **insert your answer in the table**. [1]

(ii) Explain what caused the discs to rise in the solution. [2]

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(iii) Explain why the darker green leaf discs rose faster than the lighter green discs. [4]

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(d) (i) Describe how would you use the technique described in *(c)* to investigate the effect of light wavelength on photosynthesis. [4]

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(ii) Predict the results that you would expect from this experiment. [2]

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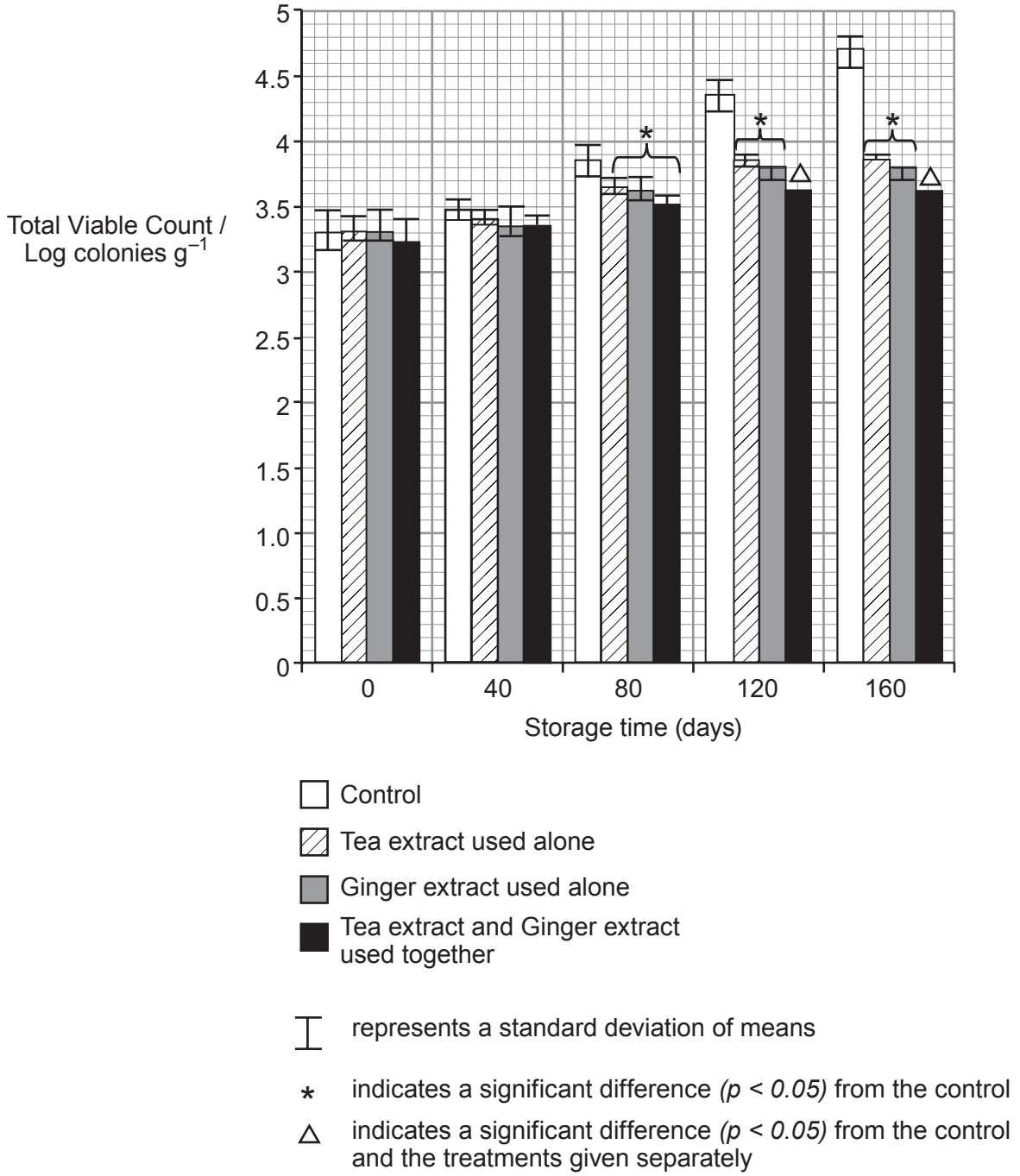
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5. An experiment was carried out to determine the effects of natural preservatives on shrimp paste, a common additive in Chinese food. These were tea extract and ginger extract. They were tested separately and then in combination.

Shrimp paste samples were stored at 25 °C for 160 days and samples were taken at regular intervals. Total viable counts (TVC) were determined on agar plates by counting the number of colonies after incubation at 35 °C for 48 hours. Three replicates were made for each sample.

The mean results were plotted as logarithms of the number of colonies (colonies g^{-1}). The standard deviations for each sample are also shown.



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(a) What is meant by a total viable count? [2]

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(b) Explain why the numbers of colonies were converted to logarithms before they were plotted on the graph. [2]

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(c) Explain the importance of standard deviations and how the researchers have used them in this experiment to conclude that there was no significant difference between the samples after 40 days. [2]

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Question *(d)* and *(e)* continued overleaf

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(d) Using the information provided, what conclusions could you draw from the treatment of shrimp paste with tea extract and ginger extract and what advice would you give as to the best way to preserve shrimp paste? [4]

(e) What further investigations would need to be carried out before you could use tea and ginger extracts to preserve shrimp paste on a commercial basis? [2]

12

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6. DNP is an insecticide which inhibits ATP production in mitochondria. DNP acts as an agent that can transport protons across biological membranes. It greatly decreases the proton gradient across mitochondrial membranes. Instead of producing ATP, the energy of the proton gradient is lost as heat.

(a) Following the establishment of an electrochemical gradient, describe the normal route that the protons would take in order to synthesise ATP. [2]

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(b) Explain how DNP can act as an insecticide. [2]

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In the 1930s DNP in high doses was used as a dieting aid. People lost weight rapidly, they felt fatigued, sweated excessively and had an elevated body temperature. After a number of years, DNP was identified as causing severe side-effects, including deaths. In 1938, DNP was designated as "extremely dangerous and not fit for human consumption" and its use ceased.

More recently DNP has again caused deaths in people taking it to lose weight.

(c) Explain in detail how DNP brings about the symptoms described. [4]

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(d) How might DNP cause the rapid death of a person who is taking it to lose weight? [1]

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7. The native red squirrel has disappeared from large parts of the UK over the past 50 years. This is mainly as a result of the spread of the introduced non-native grey squirrel which is better suited to live in most broad-leaved and mixed woodland areas. However, habitat fragmentation and disease may also have played a part. The larger grey squirrel competes for resources with the red squirrel and carries a disease to which it is immune but which is deadly to the red squirrel.



The populations of both species in an area were surveyed and monitored for 20 years. Hair-tube surveys were carried out as follows:

- small plastic tubes are baited to attract squirrels
- hairs are collected on sticky tapes inside the tubes as the animals enter to get the food
- collected hair is removed from the tubes periodically and used to identify the squirrel species by microscopy
- hairs can be used for DNA testing to identify individuals

(a) What are the main advantages of using hair-tube surveys to determine population numbers of the two species of squirrel? [2]

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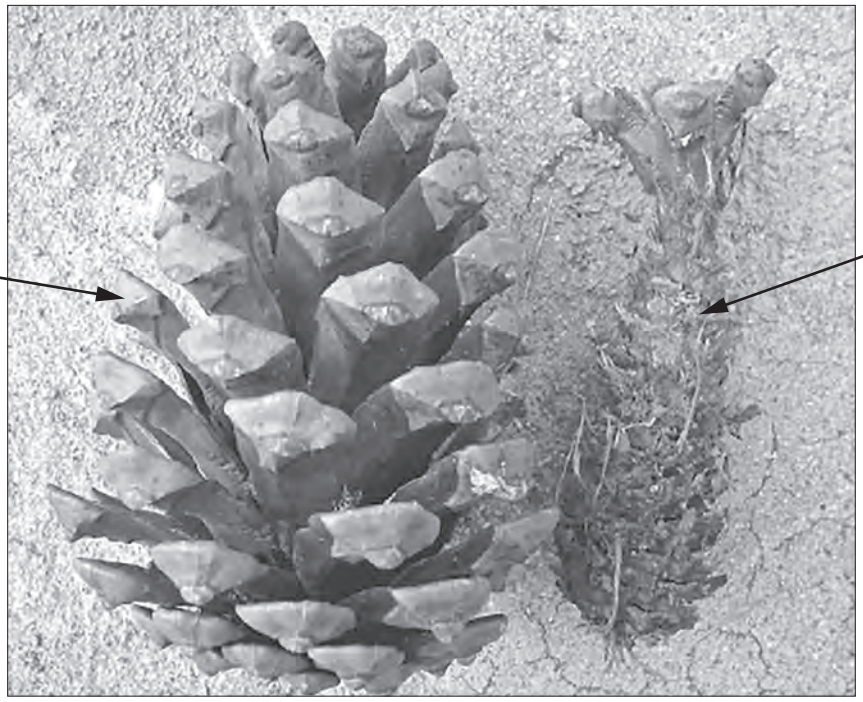
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Another type of survey involves the systematic assessment of the remains of pine cones, called cone cores, the seeds of which are eaten by squirrels. This provides information on squirrel numbers, habitat use and the timing and spatial distribution of seed availability.

The photograph below shows an uneaten pine cone compared with the feeding remains of a Scots pine cone eaten by a red squirrel.



(b) Describe how you would set up a transect so that the distribution of cone cores could be easily assessed. [3]

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(c) Results from such a UK survey are shown below.

Woodland type: Scots pine
Total area sampled = 250 m^2
Cone cores collected over 84 days.
Total number of cone cores collected = 240
Average number of seeds per cone = 25
Average energy value per seed = 0.18 kJ

(i) Calculate the total energy consumed by the squirrels from the cones. [2]

Total energy consumed from the cones = ... kJ

(ii) Using your answer from (i) and the information above, calculate the total energy consumed in the area per hectare per day. (There are 10 000 m^2 in 1 hectare.) [2]

Total energy consumed = ... kJ ha^{-1} day^{-1}

(iii) The average adult red squirrel consumes 550 kJ per day.
Calculate the estimated density of squirrels for the woodland. [1]

Squirrels per hectare = ...

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8. Respiration is a process that takes place in all cells.

(a) (i) Describe the stage of the biochemical pathway in the cytoplasm which produces reduced NAD. [2]

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The energy budget for the complete oxidation of a single glucose molecule is frequently quoted as 38 ATP.

The majority of ATP produced in respiration is from the re-oxidation of the reduced NAD and reduced FAD, by the electron transport chain.

Some of the reduced coenzymes must be transferred from the cytoplasm into the mitochondrial matrix. This is done via two mechanisms in insect flight muscles.

A If levels of reduced NAD in the cytoplasm are high, the reduced NAD is transferred into the matrix through the outer and inner mitochondrial membranes.

B If cytoplasmic levels of reduced NAD are low, then an alternative pathway is used whereby the reduced NAD passes its electrons to FAD in the inner mitochondrial membrane.

(ii) Explain why the ATP yield per glucose molecule will be decreased if mechanism **B** is used. [2]

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(iii) Explain why mechanism **A** would be used in the muscle of flying insects. [2]

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(b) If a human eats a diet low in nutrients, amino acids from muscle tissue can be used as an alternative respiratory substrate. The amino acids, when processed, produce nitrogenous waste.
Describe the production of nitrogenous waste and state where this takes place. [3]

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9. Biochemical reactions in cells often involve cyclic metabolic pathways which occur within compartments inside cells.
Compare the Krebs cycle and Calvin cycle in plant cells with reference to their biochemistry and explain why the cellular compartmentalisation in both cycles is so important. [9 QER]

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