Surname	Centre Number	Candidate Number
Other Names		2

GCE A LEVEL

A400U20-1

S19-A400U20-1

BIOLOGY – A level component 2
Continuity of Life

THURSDAY, 13 JUNE 2019 – MORNING

2 hours

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**9**	
2.	**10**	
3.	**12**	
4.	**13**	
5.	**16**	
6.	**14**	
7.	**17**	
8.	**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 additional 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 **8**.

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

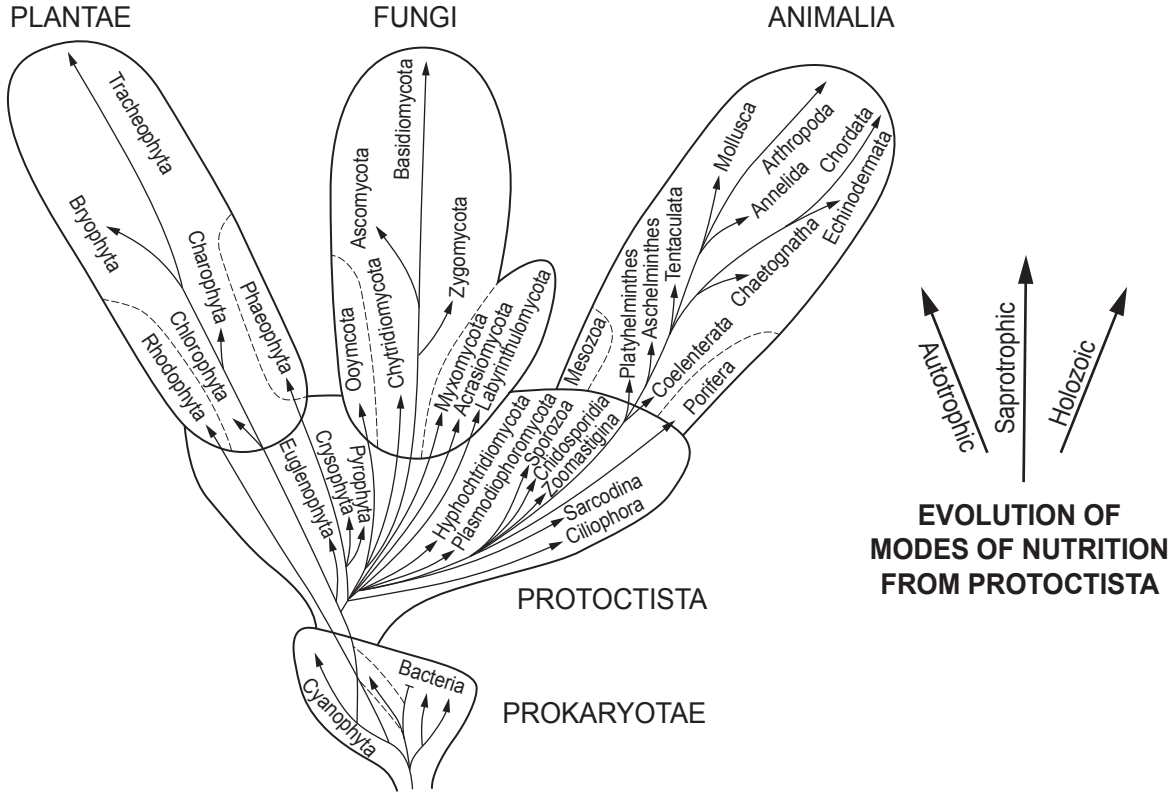
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Answer **all** *questions.*

1. Classifying organisms is important because it allows scientists to better understand evolutionary relationships. In 1969, RH Whittaker proposed a five Kingdom system including evolutionary relationships based on modes of nutrition.

Figure 1.1



(a) (i) Explain how the three arrows indicating mode of nutrition on Figure 1.1 illustrate the evolution of the three higher Kingdoms from the Protoctista. [3]

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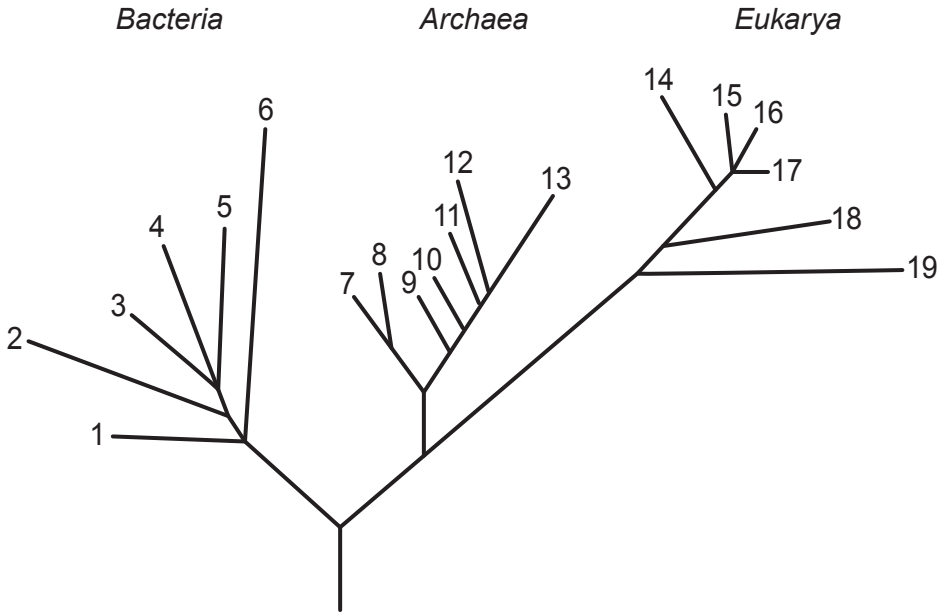
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(ii) Identify which of the Kingdoms is described in the following extract taken from the 1969 paper.
"Primarily multinucleate organisms with eukaryotic nuclei dispersed in a walled and often septate mycelial syncytium, plastids and photosynthetic pigments lacking."
[1]

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In 1990, Carl Woese justified replacing the five Kingdom system because, *"Molecular comparisons show that life on this planet divides into three primary groupings, commonly known as the bacteria, the archaea, and the eukarya."* He illustrated his suggestion with a phylogenetic tree. Figure 1.2 is adapted from it.

Figure 1.2



(b) (i) State the term that is used for the three primary groups in this system. [1]

.....

(ii) Name a biochemical technique that can be used to investigate evolutionary relationships between organisms. [1]

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(iii) **Write a letter X** on the phylogenetic tree in Figure 1.2 to show the **most recent** common ancestor of the Eukarya. [1]

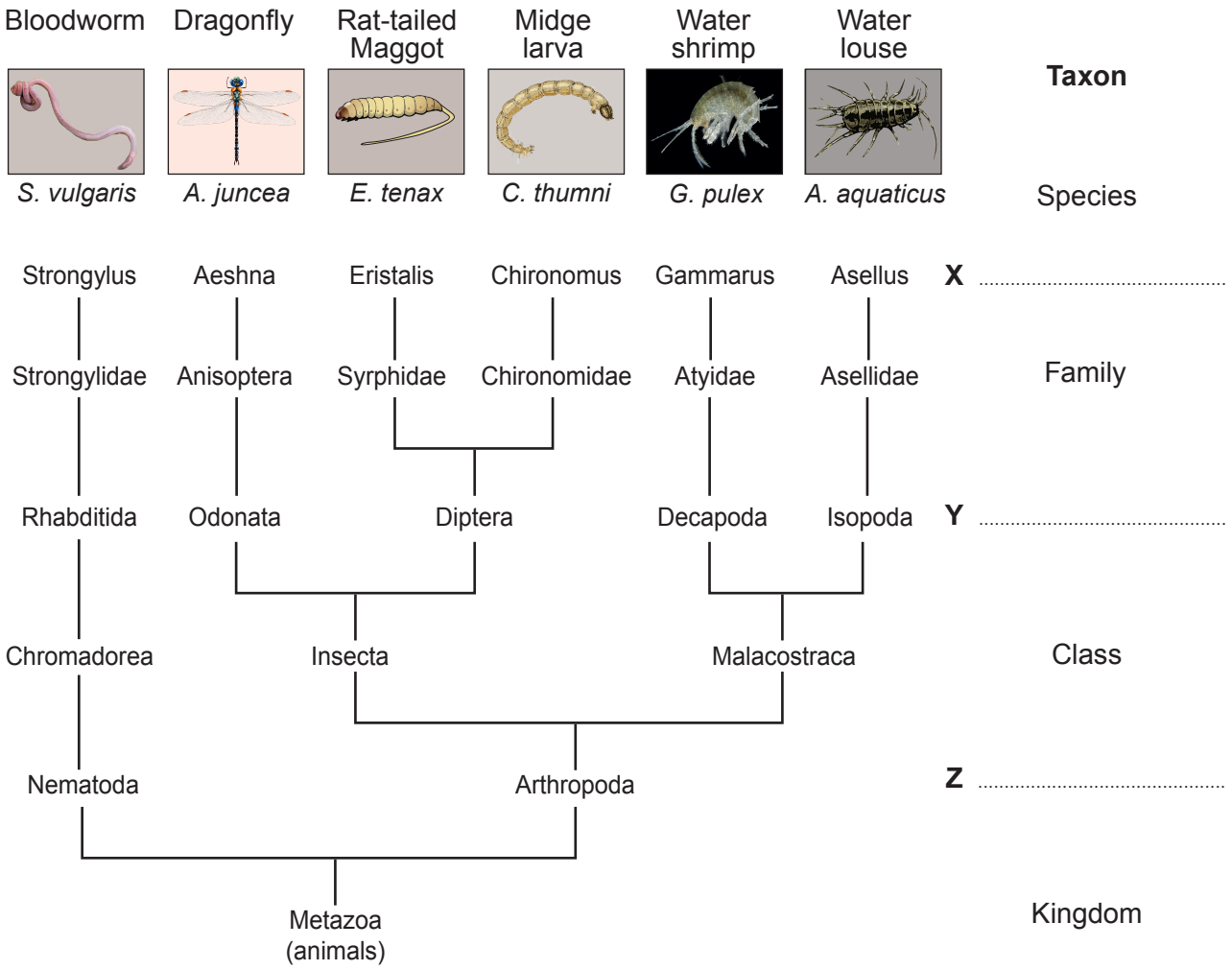
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(c) The phylogenetic tree in Figure 1.3 shows the evolutionary relationships between some organisms that were caught during a survey of a stream.

Figure 1.3



(i) **Complete Figure 1.3** by writing in the names of the missing taxa **X**, **Y**, **Z**. [1]

(ii) Using information from the phylogenetic tree in Figure 1.3, place dragonfly, midge larva, bloodworm and water louse in order of how closely related they are to the rat-tailed maggot, from most related to least related. [1]

Rat-tailed maggot

Most closely related .....

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Least closely related .....

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2. A recently developed technique in genetic engineering is called CRISPR. In this technique guide RNA is made which attaches to complementary sequences on DNA.

Nucleic acid molecules are constructed from sub-units called nucleotides.

(a) Describe **three** ways in which a DNA molecule differs from an RNA molecule. [2]

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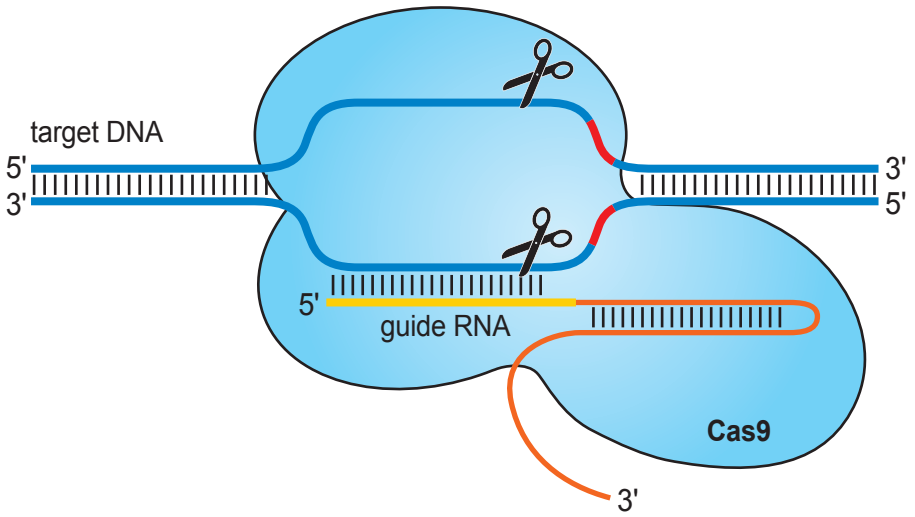
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The CRISPR technique can be used to remove a target gene.
In this technique:

- Guide RNA is made.
- The guide RNA and Cas9 endonuclease combine to form a CRISPR / Cas9 complex.
- The complex is then inserted into a cell.
- The guide RNA attaches to the target gene as shown in Figure 2.1.

Figure 2.1



(b) Cas9 enzyme is a restriction endonuclease. State what is meant by a restriction endonuclease. [2]

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Genetic engineers have discovered that by synthesising guide RNA with particular nucleotide sequences they can target any gene in any organism, if they know its nucleotide sequence. Using this technique it is possible to remove a target gene.

(c) Scientists have identified a gene that is essential for fertility in mosquitoes of the genus *Anopheles*.

Suggest how the CRISPR technique could be used to modify mosquito eggs to produce sterile adult mosquitoes. [3]

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(d) Explain how releasing these sterilised mosquitoes into the wild might benefit humankind and suggest an ethical reason for not doing so. [3]

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3. In order to investigate the effects of mowing on biodiversity, a group of students carried out surveys on two different sites on their school fields.

- A playing field that was mown regularly throughout the growing season.
- A meadow set aside for conservation that was mown once a year.

The students used quadrats to estimate the numbers of plants of the species found on the two sites.

The results were analysed using the Simpson's Diversity Index.

(a) Explain the steps the students should have taken to ensure their sampling methods produced representative totals. [3]

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(b) The meadow had a Simpson's Diversity Index of 0.58. The results for the playing field are shown below.
Calculate the Simpson's Diversity Index for this site. [3]

Species	n	(n–1)	n(n–1)
ryegrass	401		
daisy	11		
buttercup	2		
dandelion	2		
yarrow	4		
plantain	3		
clover	11		
(N)	434	$\sum$n(n–1) =	
$N(N–1)$ =			

$D = 1 - \frac{\sum n(n-1)}{N(N-1)}$, where N = number of organisms present and n = the number in each species.

D = ...

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(c) State a conclusion about the effect of mowing on the biodiversity of grassland. [2]

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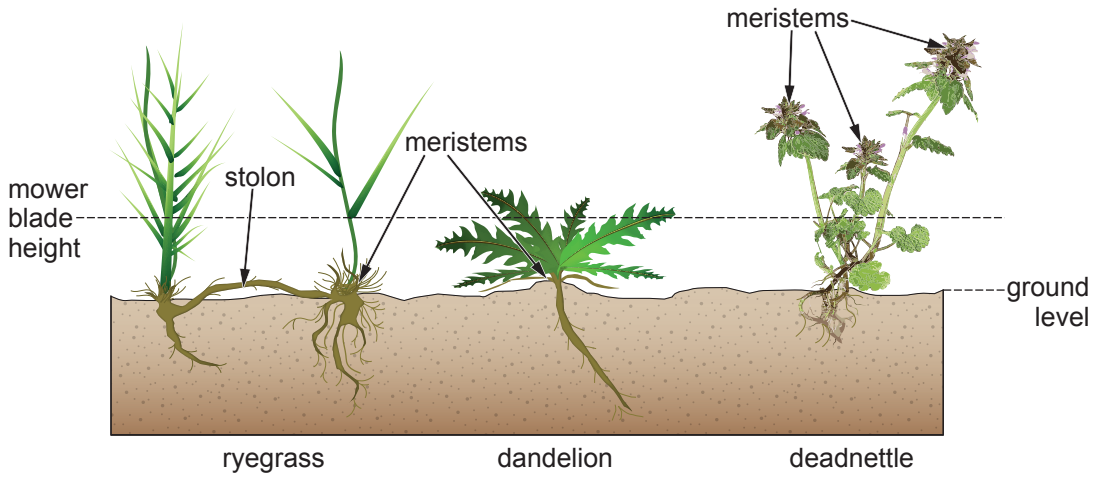
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Figure 3.1 shows the morphology of common meadow species: ryegrass, dandelion and deadnettle. It also shows the height the mower blade passes over the ground.

Figure 3.1



(d) Using information from Figure 3.1 give an explanation that could account for your conclusion in part *(c)*. [4]

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4. A species of bird called the Monarch flycatcher *(Monarcha castaneiventris)* is found on the Solomon Islands. There are a number of sub-species of this bird which have distinctive plumage colourings and live on different islands.

(a) Explain why they are classified as sub-species and not as separate species. [1]

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One sub-species is polymorphic. The undersides of the three forms of the sub-species found on the islands are shown in Figure 4.1.

Figure 4.1



chestnut chestnut-black black

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(b) In breeding experiments:

- chestnut crossed with black always produced chestnut-black offspring,
- chestnut-black crossed with other chestnut-black produced offspring of all three phenotypes.

Using appropriate symbols, complete the key to identify the alleles involved.
Use these symbols to complete the genetic diagram below to show a cross between two chestnut-black parents and predict the phenotype ratio of the offspring. [4]

Key: Allele for Chestnut colour ..... Allele for Black colour .....

Parental phenotypes:	chestnut-black	x	chestnut-black
Parental genotypes:	.....	x	.....
Gametes:	.....	x	.....

F_1 Genotypes ....

F_1 Phenotypes ....

Phenotype ratio .....

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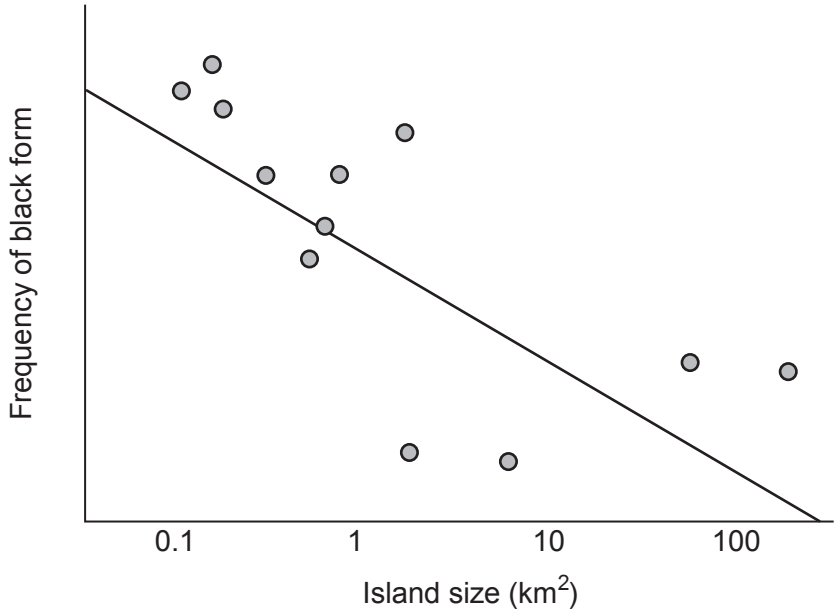
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A group of scientists studied the frequency of the black forms on the Russell Islands within the Solomon group.

Their results are shown in Figure 4.2. The island size is shown as a log scale.

Figure 4.2



Monarch flycatchers are known to be territorial and behaviour studies have shown increased aggression in black forms.

(c) State the trend shown on the graph and use the information about the birds' behaviour to suggest a possible mechanism to account for the trend. [3]

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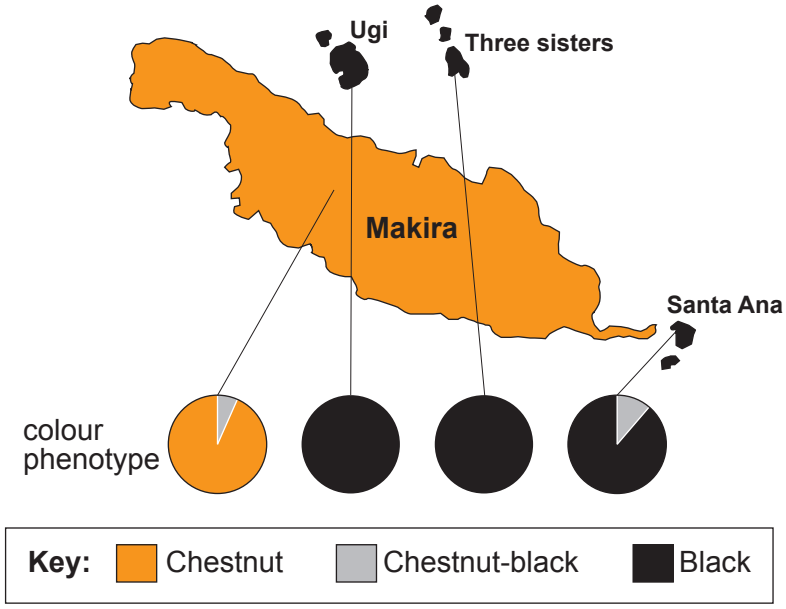
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(d) Figure 4.3 shows the distribution of the phenotypes on the southern-most islands of the Solomon group.

Figure 4.3



(i) Explain how the evidence from the phenotype distribution in Figure 4.3 supports your answer from part *(c)*. [1]

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(ii) Explain the presence of chestnut-black forms on Santa Ana. [2]

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(e) Since the 1950s, nuclear weapons tests have taken place in the South Pacific. Suggest how this might have accounted for the emergence of the black phenotype on the Solomon Islands. [2]

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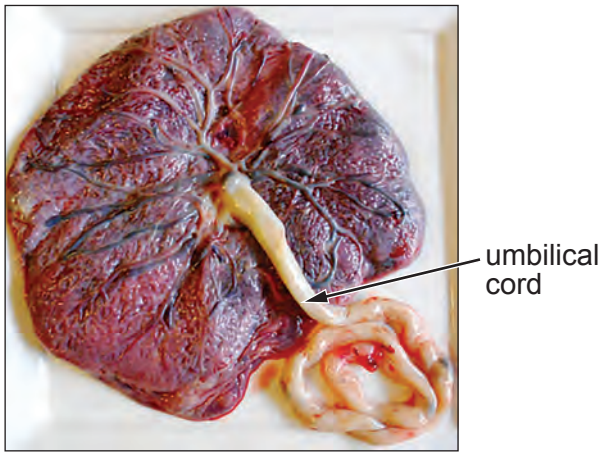
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5. Figure 5.1 shows a placenta at full term and a transverse section through the umbilical cord.

Figure 5.1



Placenta



T.S. umbilical cord

(a) Name structures **A** and **B** in Figure 5.1 and give details of the features that allowed you to identify each one. [4]

Structure	Name	Features
A		
B		

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Figure 5.2 shows the maternal and fetal blood supplies to the placenta.

Figure 5.2



(b) Using appropriate labels from Figure 5.2 describe how the maternal blood flows through the placenta. [2]

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(c) Using Figure 5.2 compare the arrangement of blood vessels in the fetal circulation within the placenta with the arrangement of blood vessels in the maternal circulation within the placenta. Explain how this increases the efficiency of exchange. [2]

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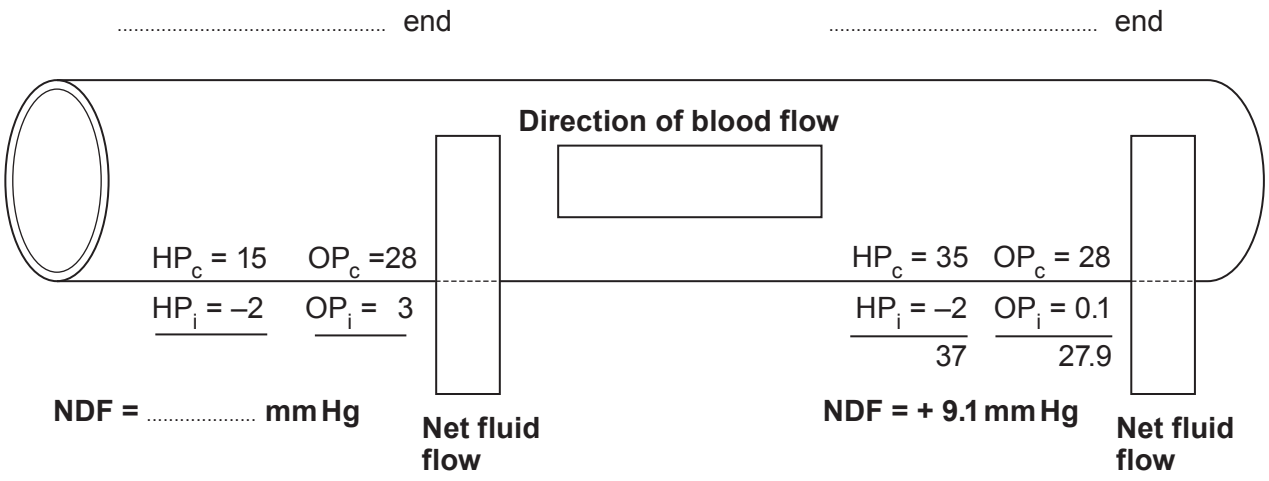
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Tissue fluid is the name given to fluid that passes across capillary membranes and leaves the blood at the arterial ends of capillaries. Some of the fluid returns to the blood at the venous ends of capillaries, the rest is drained away by lymph vessels. Figure 5.3 shows the forces affecting the movement of fluid **across** capillary membranes at both ends of a capillary. The forces are hydrostatic pressure (HP) and osmotic pressure (OP), all values are in mmHg.

Figure 5.3



The Net Driving Force (NDF) can be calculated from the formula:

$$NDF = (HP_c - HP_i) - (OP_c - OP_i)$$

- HP_c is the capillary hydrostatic pressure
- HP_i is the interstitial hydrostatic pressure
- OP_c is the capillary osmotic pressure
- OP_i is the interstitial osmotic pressure

(d) (i) The NDF for the right-hand end of the capillary has been calculated using this formula. Use the formula to calculate the missing NDF and **enter your value on Figure 5.3**. [2]
Space for working.

(ii) By convention, **outward** force is defined as **positive**, and **inward** force is defined as **negative**. Use the given value of NDF and the result of your calculation, to conclude whether the net fluid movement would be outward or inward at each end of the capillary. **Draw arrows in the two rectangles labelled 'net fluid flow'** to show your conclusions. [1]

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(iii) Use all the information provided and calculated to identify

I. the arterial and venous ends of the capillary. **Write your answers on the dotted lines above Figure 5.3.** [1]

II. which direction blood is moving inside the capillary. **Draw an arrow in the rectangle labelled 'direction of blood flow'.** [1]

(e) Predict what might happen to a patient's leg if lymph vessels were damaged during a hip replacement operation. [1]

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Following birth, babies must adapt to exchanging gases using lungs. Premature babies often have lungs which are not completely developed and they must be treated with surfactants.

(f) Explain the purpose of treating premature babies with surfactants. [2]

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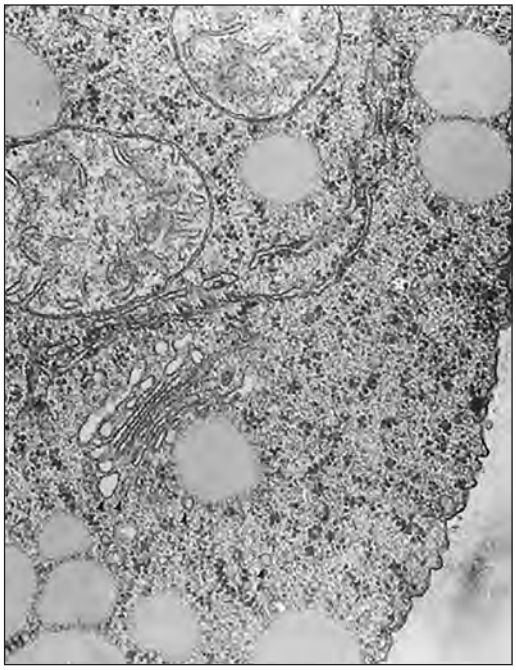
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6. The brewing industry relies on biological processes that take place in two organisms, barley and yeast. Figure 6.1 is an electron micrograph showing part of a cell from the aleurone layer of a germinating barley grain.

Figure 6.1



(a) **Complete the table below** by naming the organelles that carry out the following functions. **Label each of the organelles on the photomicrograph** using the letters **A** and **B**. [2]

Organelles	Name	Function
A	.....	synthesises proteins
B	.....	packages proteins

In the brewing process the sugars produced by the germinating grains are extracted and are used to provide yeast with their respiratory substrate.

(b) Give the word equation for anaerobic respiration in yeast. Explain why it is less efficient than aerobic respiration for the yeast but essential to the brewing industry. [3]

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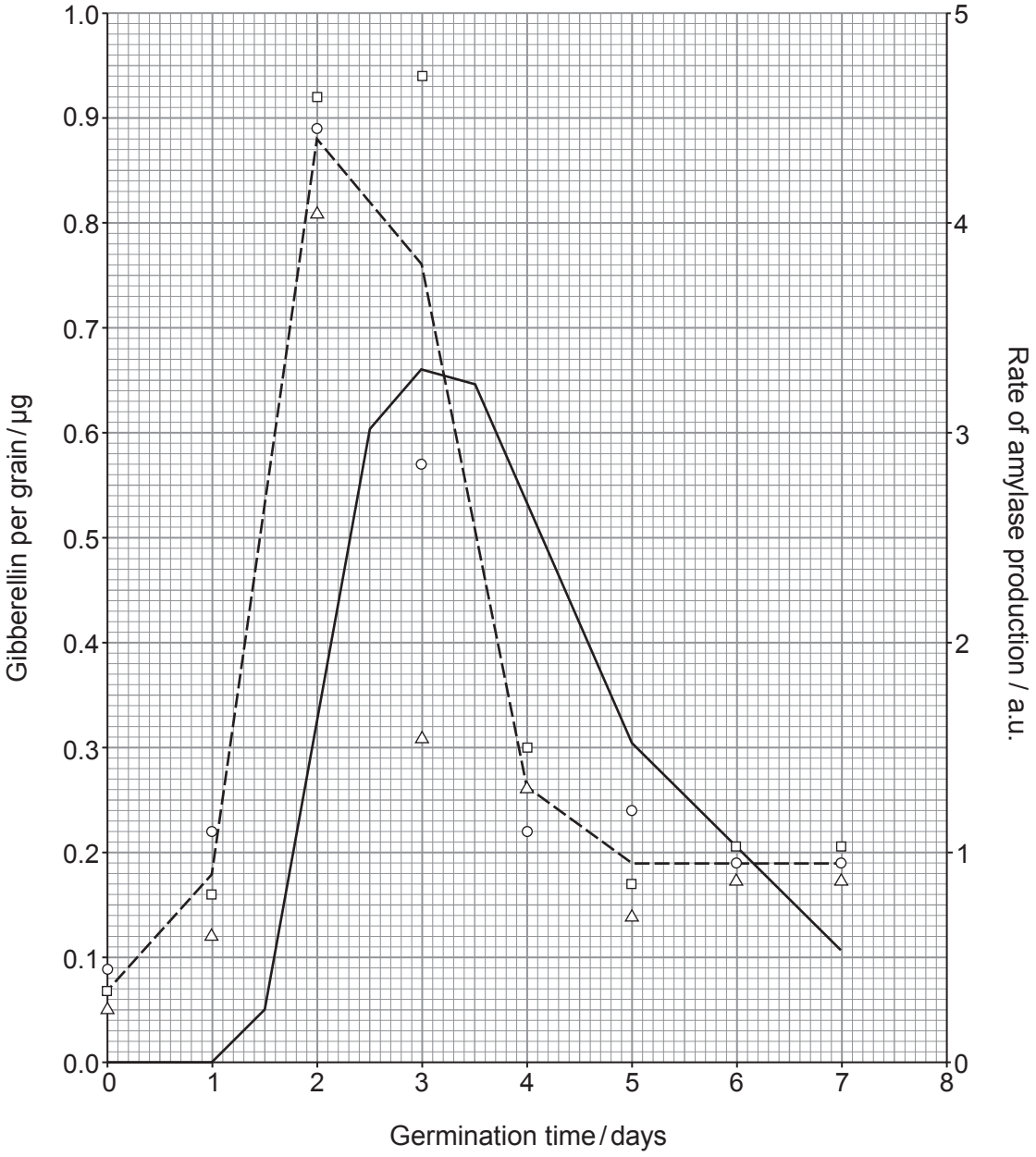
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Gibberellin is a hormone which induces the production of amylase. The production and effects of gibberellin on barley germination were studied by three separate teams of scientists. Each team repeated the experiment ten times. Figure 6.2 shows the results of the investigation.
The mean gibberellin production for each team is indicated with a different symbol; team 1. □ team 2. ○ team 3. △ .
The dashed line indicates the mean gibberellin production for all repeats for all teams.
The solid line indicates the mean rate of amylase production in the barley grains for all repeats for all teams.

Figure 6.2



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(c) Reliability has two aspects, repeatability, which describes the variation in the data from one team and reproducibility, which describes the variation in the data between different teams.

(i) State how reproducibility is represented on Figure 6.2 and comment on the reproducibility of the data obtained. [3]

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(ii) Name a mathematical value that each team could have calculated to indicate the variability of its results and the aspect of reliability of the experiments that would be assessed by this value. Describe how this aspect could have been improved. [3]

I. mathematical value .....

II. aspect of reliability .....

III. Improvement .....

.....

(iii) Identify a statistical test that could have been used to test if the mean results from teams 1 and 3 were significantly different. [1]

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(iv) The solid line on Figure 6.2 shows the rate of production of amylase in the barley grains. Explain what evidence from the graph supports the hypothesis that the production of gibberellin induces the production of amylase. [2]

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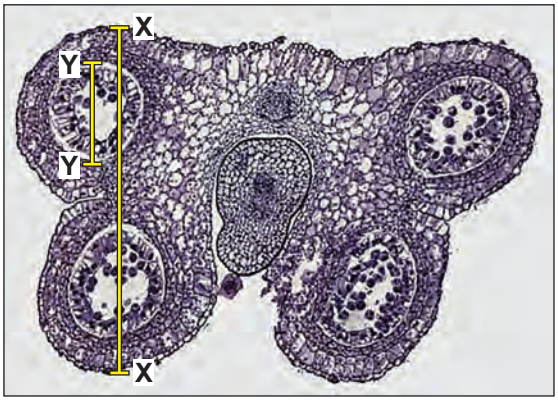
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7. A student examined the TS Anther shown in the photomicrograph in Figure 7.1 through a microscope and measured the dimensions indicated by lines **X-X** and **Y-Y** using a calibrated eyepiece graticule.

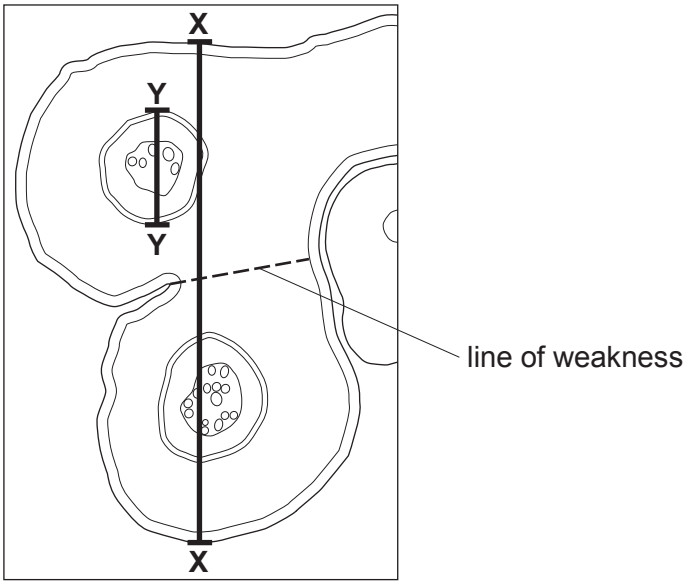
Figure 7.1

X-X measured 1080 µm; **Y-Y** measured 360 µm.



The low power plan drawing of a **representative portion** of the specimen is shown in Figure 7.2.

Figure 7.2

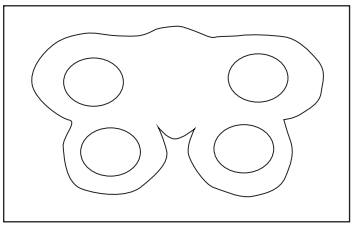


(a) (i) One structure is shown in the micrograph in Figure 7.1 but missing from the low power plan in Figure 7.2.
Draw this structure on the low power plan. Label it with its name and its function. [3]

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(ii) **In the rectangle provided** below, which contains a sketch of the whole section, indicate which part is shown in the tissue plan in Figure 7.2. [1]



(b) Use the measurement lines on Figure 7.2 and the measurements given for the photomicrograph in Figure 7.1 to deduce whether the low power plan in Figure 7.2 is in proportion. Show all workings. [4]

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(c) (i) Describe the part played by **mitosis** and **meiosis** in the formation of the male gametes in flowering plants, explaining the biological significance of each type of cell division. [5]

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(ii) State the function of the tapetum. [1]

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Figure 7.3 shows an anther undergoing dehiscence.

Figure 7.3



(d) Use the photomicrograph in Figure 7.3 and the low power plan in Figure 7.2 to suggest the significance of a line of weakness in the position shown on the drawing. [3]

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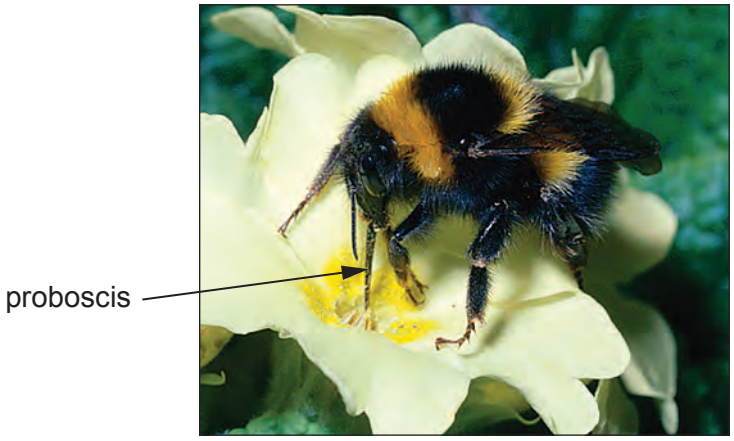
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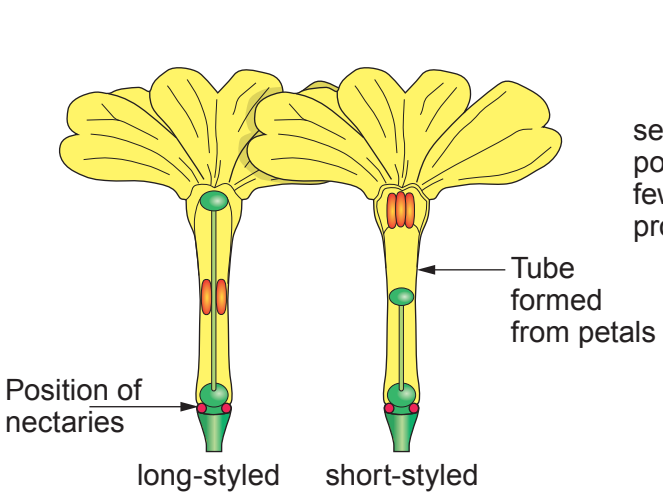
8. Figure 8.1 shows a bumble bee collecting nectar from a flower of *Primula vulgaris*.

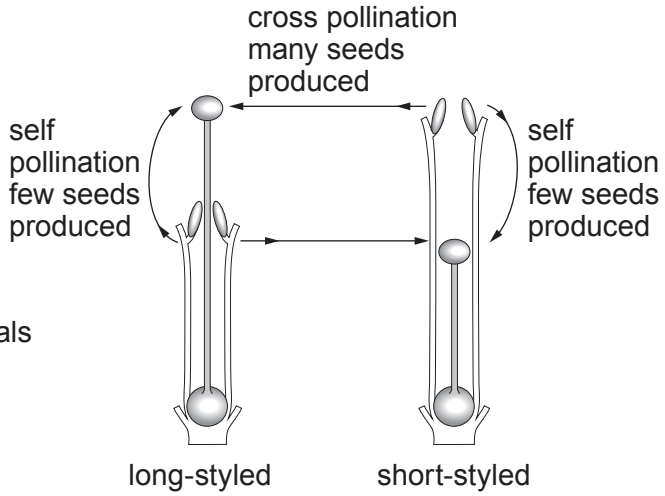
Figure 8.1



There are two different forms of these flowers. Each plant only has one of the two forms.

Figure 8.2





Apart from the length of the style, there are other differences between the two types:

- the stigma is rougher in the long-styled flowers;
- the pollen-grains are smaller in the long-styled flowers;
- the pollen-grains of the long-styled flowers are more triangular.

Experiments have been carried out where some flowers have been protected from insects (to force self-pollination) and others were allowed to cross pollinate. The number of viable seeds produced was counted as a measure of fertility. The structure of the flowers and the results are shown above.

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Describe the structural differences visible between the drawings of the long-styled and short-styled flowers in Figure 8.2. Explain how the anatomy of these flowers promotes cross-pollination. Use the observations about the stigma and pollen to explain why self-pollination produces fewer seeds than cross-pollination. [9 QER]

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