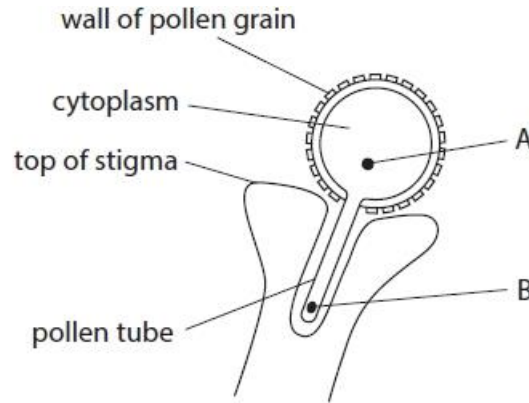


Questions

Q1.

(i) The diagram shows a pollen grain that has begun to germinate after landing on the surface of the stigma of a flower.



Identify the structures labelled A and B.

(2)

A

B

(ii) Describe the process of double fertilisation in flowering plants.

(3)

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(Total for question = 5 marks)

Q2.

The photograph shows a germinating pollen grain as seen through a light microscope.



(Source: © CAROLINA BIOLOGICAL SUPPLY COMPANY/SCIENCE PHOTO LIBRARY)

The actual length of this pollen tube is 136 μm .

Calculate the magnification of this photograph.

(2)

Answer

(Total for question = 2 marks)

Q3.

Devise an investigation to determine the effect of pH on the rate of growth of pollen tubes.

(5)

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(Total for question = 5 marks)

Q4.

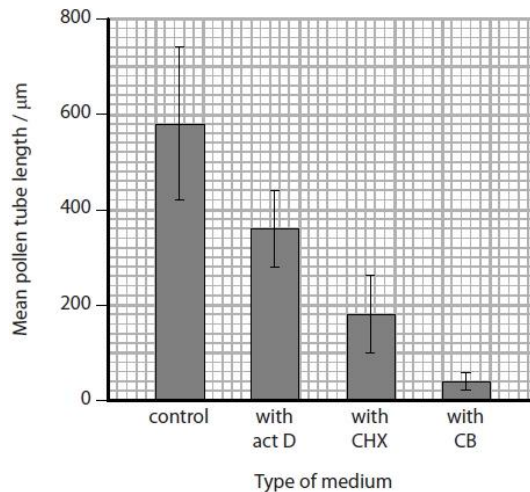
A student investigated the effect of three inhibitors on the growth of pollen tubes.

Pollen grains were incubated in a control medium.

In addition, some pollen grains were also incubated in three media, each containing one inhibitor.

The inhibitors used were actinomycin D (act D), cycloheximide (CHX) and cytochalasin B (CB).

The results of this investigation are shown in the graph.



The student made the following conclusions from these results:

Conclusion 1: all three inhibitors affected pollen tube growth

Conclusion 2: pollen grown in CB grew the slowest

Conclusion 3: the control result was the least repeatable

Conclusion 4: more pollen grains germinated in the control group

Analyse the results of this investigation to comment on each of these conclusions.

(4)

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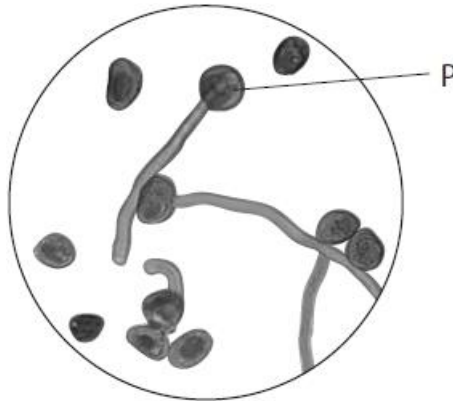
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(Total for question = 4 marks)

Q5.

A student used a light microscope to determine the mean percentage germination of pollen grains.

The photograph shows one high power field of view observed by the student.



The actual diameter of pollen grain P is $30\ \mu\text{m}$.

Calculate the magnification of pollen grain P.

(2)

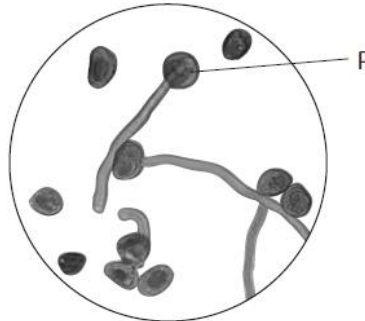
Answer

(Total for question = 2 marks)

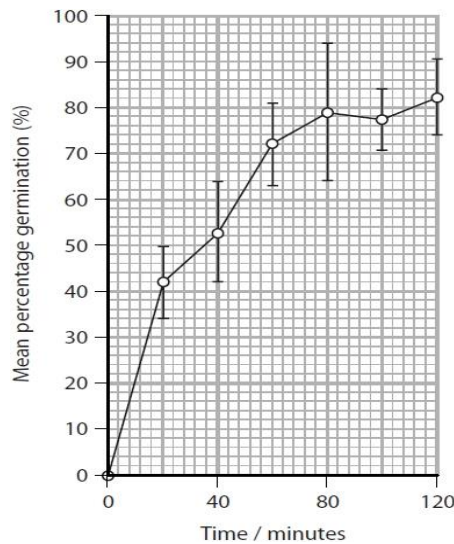
Q6.

A student used a light microscope to determine the mean percentage germination of pollen grains.

The photograph shows one high power field of view observed by the student.



The graph shows the results of the investigation.



(i) Explain why the student plotted standard deviation bars on the graph.

(2)

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(ii) Determine the time when the photograph was taken.

(2)

Answer minutes

(Total for question = 4 marks)

Q7.

In flowering plants, pollen grains grow pollen tubes that are involved in fertilisation, producing a zygote and endosperm.

A scientist investigated the effects of chemical A and chemical B on pollen tube growth. Chemical A prevents transcription.

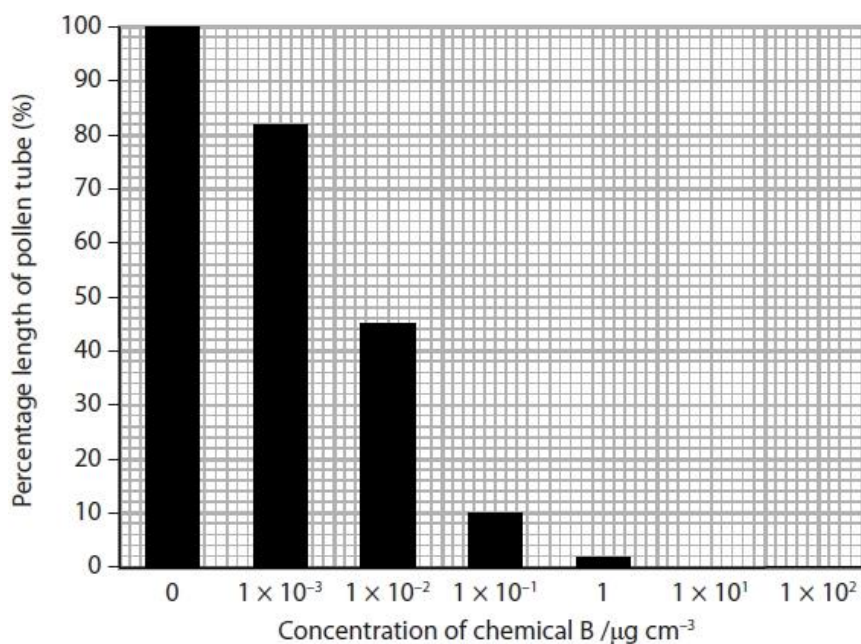
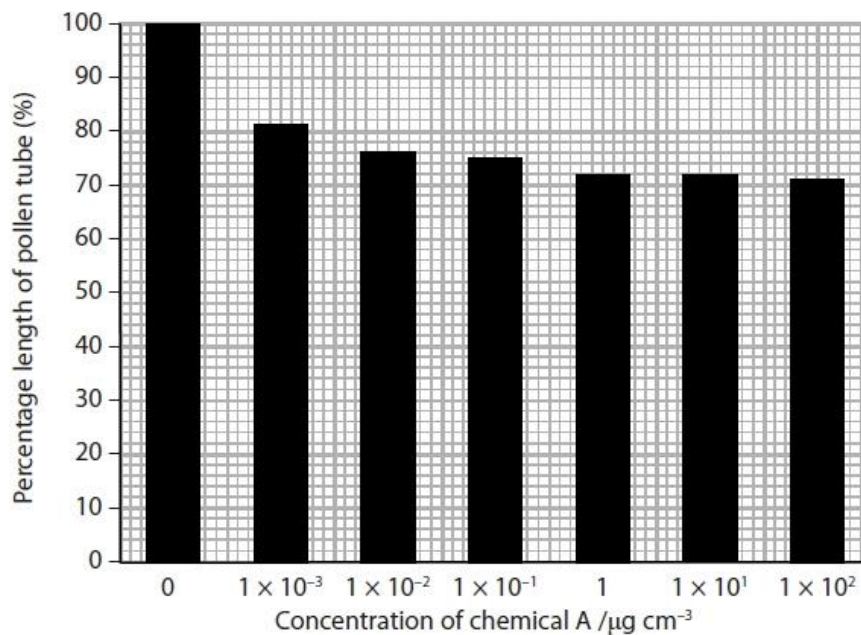
Chemical B prevents translation.

Pollen grains were treated with different concentrations of these two chemicals.

The lengths of the pollen tubes they produced were compared with a control group of pollen grains.

The lengths of the pollen tubes were measured and expressed as a percentage of the control group.

The results are shown in the graphs.



- (i) The mean length of the pollen tubes in the control group was 7.5 mm.
Calculate the mean length of the pollen tubes after adding $0.010 \mu\text{g cm}^{-3}$ of chemical A. (2)

Answer

- (ii) Analyse the data to comment on the effects of chemical A and chemical B on the roles of transcription and translation in pollen tube growth. (4)

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(Total for question = 6 marks)

Q8.

In flowering plants, pollen grains grow pollen tubes that are involved in fertilisation, producing a zygote and endosperm.

(i) Which row of the table shows the correct description for these nuclei?

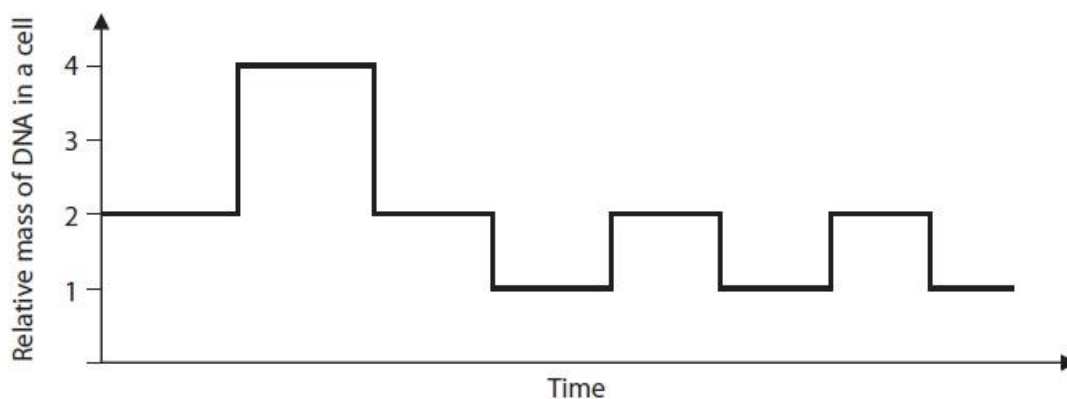
(1)

	Zygote nucleus	Endosperm nucleus	Pollen tube nucleus
<input type="checkbox"/> A	diploid	diploid	haploid
<input type="checkbox"/> B	diploid	triploid	haploid
<input type="checkbox"/> C	diploid	triploid	diploid
<input type="checkbox"/> D	haploid	triploid	diploid

(ii) The production of plant cell gametes involves both mitosis and meiosis.

The graph shows the DNA content of a cell during the production of a pollen grain.

(1)



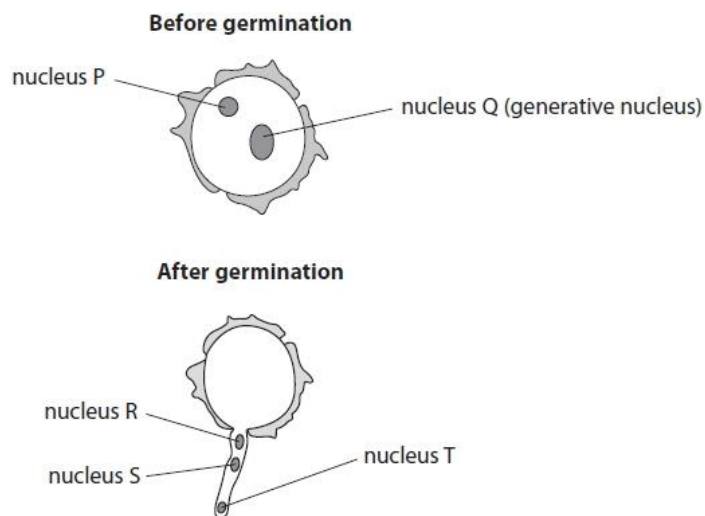
The order of nuclear divisions shown in the graph is

- A meiosis, mitosis, mitosis
- B meiosis, mitosis, meiosis
- C mitosis, meiosis, meiosis
- D mitosis, mitosis, meiosis

(Total for question = 2 marks)

Q9.

The diagram shows a pollen grain, before and after germination.



(a) In which part of the plant are pollen grains made?

- A anther
 B embryo sac
 C filament
 D stigma

(1)

(b) One species of grass has a diploid number of 14 chromosomes.

Which row of the table is correct for this species of grass?

(1)

Chromosome number		
	Nucleus P	Nucleus Q
<input type="checkbox"/> A	14	14
<input type="checkbox"/> B	14	7
<input type="checkbox"/> C	7	14
<input type="checkbox"/> D	7	7

(c) Which of the following is a correct statement?

- A nucleus P divides by meiosis to form nuclei R and S
 B nucleus P divides by mitosis to form nuclei R and S
 C nucleus Q divides by meiosis to form nuclei R and S
 D nucleus Q divides by mitosis to form nuclei R and S

(1)

(d) The following three statements were made by a student:

- nucleus R and S will fertilise the endosperm nucleus
- the genetic material in nucleus R or S could become part of the zygote
- nucleus T will fertilise the female gamete

The number of correct statements is

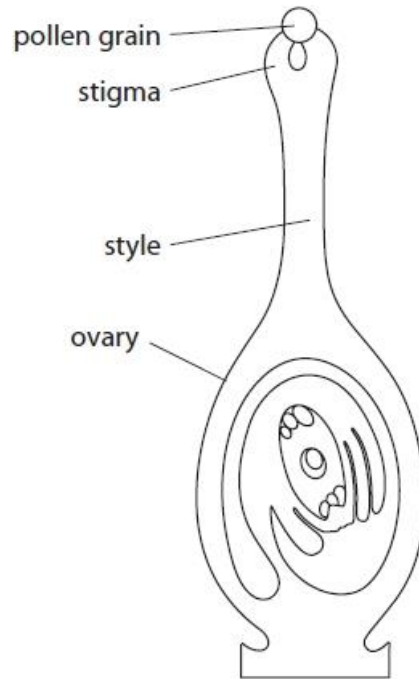
(1)

- A none
- B one
- C two
- D three

(Total for question = 4 marks)

Q10.

The diagram illustrates part of a flowering plant when pollination has just taken place.



The styles of some plants secrete RNAase enzymes when pollen from the same flower germinates on the stigma.

Explain how these RNAase enzymes affect the growth of the pollen tube.

(3)

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(Total for question = 3 marks)

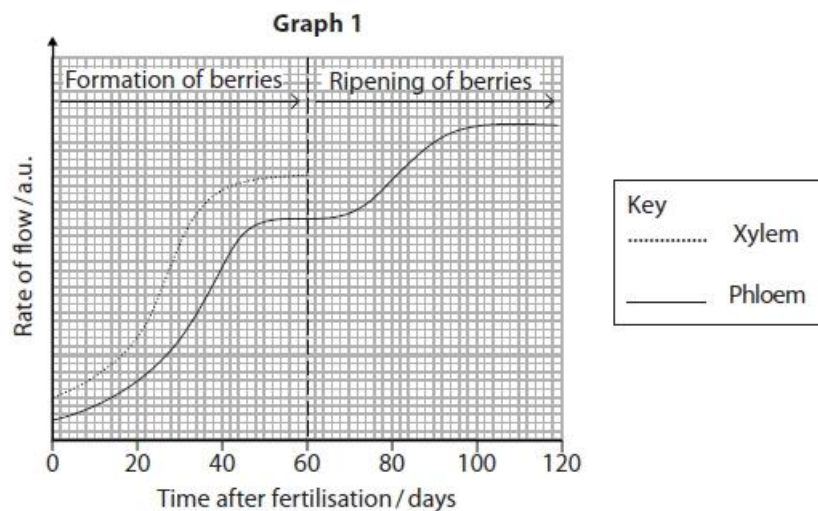
Q11.

Xylem and phloem are involved in transport in plants.

* Double fertilisation in some plants leads to the development of fruits, such as berries.

In an investigation, the rate of flow in xylem during the formation of berries was measured. The rate of flow in the phloem during the formation and ripening of the berries was also measured.

The results are shown in graph 1.

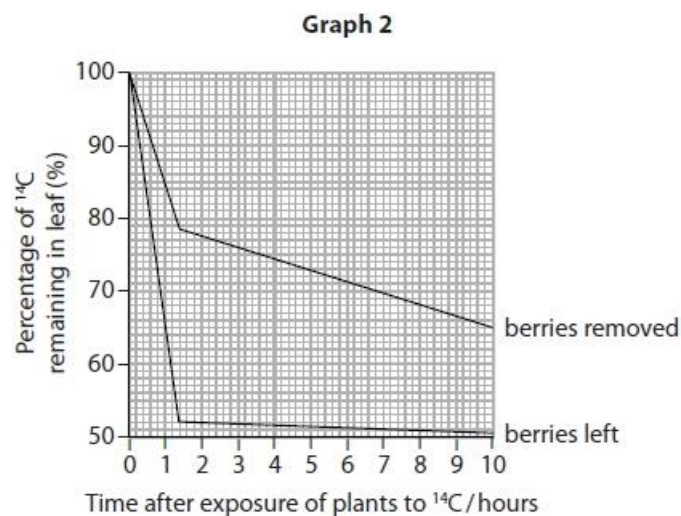


In a second investigation, two plants with berries were exposed to radioactive carbon dioxide (^{14}C).

After exposure to ^{14}C , the berries were removed from one plant and left on the second plant.

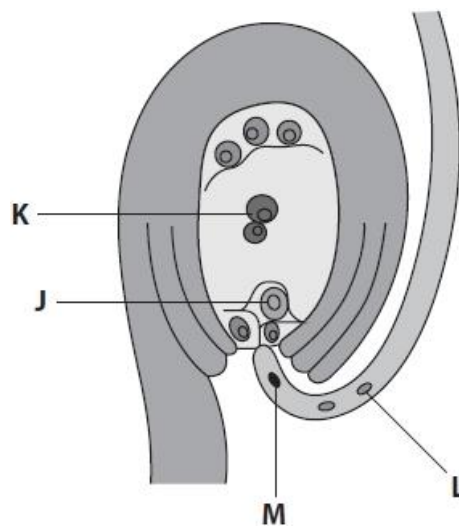
The percentage of ^{14}C remaining in the leaves of each plant was determined during the next 10 hours.

The results are shown in graph 2.



Q12.

The diagram shows a pollen tube entering the embryo sac of a flowering plant.



Complete the table to give the name of each labelled structure and the number of sets of chromosomes that each structure contains.

(4)

Structure	Name of structure	Number of sets of chromosomes
J		
K		
L		
M		

(Total for question = 4 marks)

Q13.

Explain the role of double fertilisation in flowering plants.

(4)

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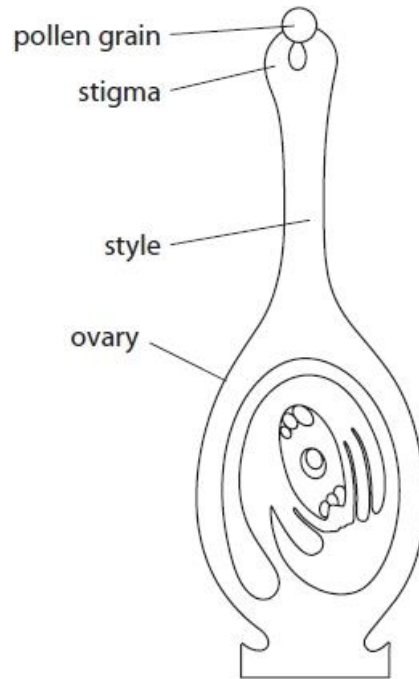
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(Total for question = 4 marks)

Q14.

The diagram illustrates part of a flowering plant when pollination has just taken place.



Describe the role of enzymes in the growth of the pollen tube.

(3)

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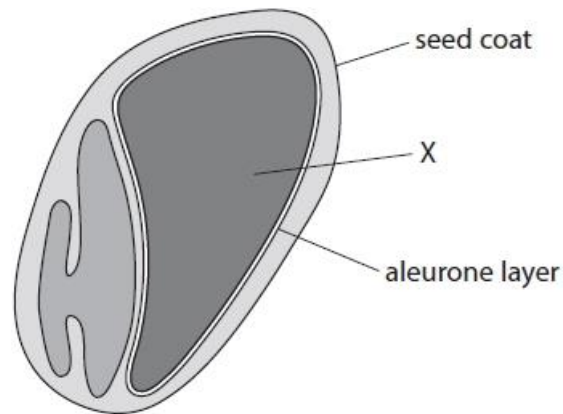
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(Total for question = 3 marks)

Q15.

Gibberellin stimulates cells in the aleurone layer of cereal grains, such as barley, to produce the enzyme amylase.

The diagram shows the location of the aleurone layer in a barley grain.



The part labelled X contains triploid cells.

Name the part labelled X.

(1)

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(Total for question = 1 mark)

Mark Scheme

Q1.

Question Number	Answer	Additional Guidance	Mark
(i)	A: generative nucleus (1) B: (pollen) tube nucleus (1)	If 2 suggestions provided, 0 marks	Grad (2)
Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation including three of the following <ul style="list-style-type: none"> • {one male nucleus / one male gamete} fuses with the two polar nuclei • to form a {triploid / 3n} nucleus (1) • {one male nucleus / one male gamete} fuses with the {egg cell / female gamete / ovum} • to form the {diploid / 2n} zygote (1) 	Do not allow polar bodies Do not allow fertilises Accept triploid endosperm nucleus Accept fertilises Do not accept embryo	Exp (3)

Q2.

Question Number	Answer	Additional Guidance	Mark
	<ul style="list-style-type: none"> • length of pollen tube measured from photo (1) • magnification calculated (1) 	Length = 33 (mm) Accept 31 – 34 (mm) / 3.1 – 3.4 (cm) Magnification = $\frac{\text{photo size}}{\text{actual size}} = \frac{33\,000}{136}$ = 243 / 242.7 / 242.65x Accept values in the range 227.9 to 250.0 x Units lose mp2 Correct answer with no working gains 2 marks	Grad (2)

Q3.

Question Number	Answer	Additional Guidance	Mark
	<p>A description which includes five of the following:</p> <ul style="list-style-type: none"> • at least 5 different pH values tested (1) • sucrose solution added (1) • suitable time before pollen tube measured (1) • method of measurement of pollen tube with a microscope described (1) • calculation of rate of growth (1) • method of control of one relevant variable (1) • a repeat at each pH and calculate {mean / standard deviation} (1) 	<p>eg intervals eg every 10 minutes or single measurement. If single measurement must be minimum of 30 mins and max of 24 hours</p> <p>eg use of stage micrometer and {graticule / scale bar} / calibrated graticule</p> <p>Length divided by time</p> <p>eg. (temperature) - use of waterbath sucrose concentration - described / named (humidity) - environmental chamber / lid on petri dish / coverslip on cavity slide (species) of flower - collect from same flower / plant (ripeness of pollen) - collect from same anther mineral salt concentration - stock solution / named</p>	Exp (5)

Q4.

Question Number	Acceptable Answers	Additional Guidance	Mark
	<p>A response that makes reference to the following:</p> <ul style="list-style-type: none"> conclusion one is justified as the height of the columns for the three inhibitors are lower than the control column (1) conclusion two has no information given about time (1) conclusion three {(could be) justified as the range bar is the longest / is not justified as the range bar is shorter in proportion to the mean} (1) conclusion four is not justified as there is no information given about {numbers of pollen grains used / numbers of pollen grains that germinated} (1) 	<p>Allow the use of the term 'valid'</p> <p>Allow error bar, confidence limits or standard deviations for range bar</p> <p>Allow conclusion one not justified because there is an overlap between act D and control range bar</p>	(4)

Q5.

Question Number	Answer	Additional Guidance	Mark
	<ul style="list-style-type: none"> conversion of 6 mm / 0.6 cm into μm (1) division by 30 (1) 	<p><u>Example of calculation</u></p> <p>6 mm = 6000 μm</p> <p>6000 \div 30 = 200</p> <p>Correct answer gains full marks, with no working shown</p> <p>ACCEPT one mark in working \div 30</p>	(2)

Q6.

Question Number	Answer	Additional Guidance	Mark
(i)	<p>An explanation that makes reference to the following:</p> <ul style="list-style-type: none"> shows variation from the mean / shows range of results from mean / spread of data around the mean / shows reproducibility / shows repeatability (1) therefore gives an indication of significant difference / overlap gives indication of significant difference (1) 	ACCEPT average	(2)

Question Number	Answer	Additional Guidance	Mark
(ii)	<ul style="list-style-type: none"> divide number germinating by total number (1) use graph to determine time (1) 	<p><u>Example of calculation</u></p> $4 \div 11 = 36.36 / 36 / 36.4$ <p>36.36 is 16 to 18 minutes</p> <p>ACCEPT one mark for 12 to 14 if $3 \div 11$ seen in working</p>	(2)

Q7.

Question Number	Answer	Additional Guidance	Mark
(i)	<ul style="list-style-type: none"> reading from graph at 1×10^{-2} reading multiplied by 7.5 and divided by 100 	<p><u>Example of calculation:</u> 76 %</p> <p>$76 \div 100 \times 7.5 \text{ mm} = \underline{5.7 \text{ mm}}$</p> <p>Accept 5700 μm</p> <p>TE for wrong reading from graph A Correct answer gains full marks</p> <p>5.7 with no units = maximum 1 mark</p>	(2)

Question Number	Answer	Additional Guidance	Mark
(ii)	<p>An answer that makes reference to four of the following:</p> <ul style="list-style-type: none"> {chemical A / stopping transcription} has {less effect / smaller reduction} on pollen tube growth (1) growth levels off when chemical A increases and growth {falls steeply / drops to zero} when chemical B increases (1) mRNA is already present (1) (pollen tube) growth requires production of new proteins / enzymes (1) 	<p>Accept converse for chemical B / stopping translation</p> <p>Accept correct mathematical comparison e.g. overall chemical A causes a 29% drop and chemical B causes a 100 % drop</p> <p>Accept transcription occurred before chemical A added</p> <p>Accept pollen tube cannot grow without synthesis of new proteins</p>	(4)

Q8.

Question Number	Answer	Additional Guidance	Mark
(i)	<p>The only correct answer is B (diploid , triploid, haploid)</p> <p>A is not correct because the endosperm nucleus is not diploid but triploid</p> <p>C is not correct because the pollen tube nucleus is not diploid but haploid</p> <p>D is not correct because the zygote nucleus is not haploid but diploid and the pollen tube nucleus is not diploid but haploid</p>		(1)

Question Number	Answer	Additional Guidance	Mark
(ii)	<p>The only correct answer is A (meiosis, mitosis, mitosis)</p> <p>B is not correct because the third division is not meiosis but mitosis as the DNA mass remains the same</p> <p>C is not correct because the first division is not mitosis as the DNA mass halves and the second and third divisions are both mitosis as the DNA mass remains the same and does not halve</p> <p>D is not correct because the first nuclear division halves the DNA mass and the third nuclear division does not halve the DNA mass so is not meiosis</p>		(1)

Q9.

Question Number	Answer	Additional Guidance	Mark
(a)	A (anther)		(1)

Question Number	Answer	Additional Guidance	Mark
(b)	D (7,7)		(1)

Question Number	Answer	Additional Guidance	Mark
(c)	D (nucleus Q divides by mitosis to form nuclei R and S)		(1)

Question Number	Answer	Additional Guidance	Mark
(d)	B (one)		(1)

Q10.

Question Number	Answer	Additional Guidance	Mark
	<p>An explanation that includes:</p> <ul style="list-style-type: none">• enzymes (hydrolyse / digest) the (m)RNA (1)• this prevents (translation / protein synthesis / enzyme synthesis) (1)• which prevents (digestion of style / pollen tube growth / pollen tube reaching ovule / prevents self-pollination) (1)		(3)

Q11.

Question Number	Indicative content
*	<p>Answers will be credited according to candidates' deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <p>Indicative content:</p> <ul style="list-style-type: none">• male gamete fertilise female gamete to produce embryo• one male gamete fuses with {both polar nuclei / (diploid) endosperm nucleus} to form a triploid endosperm nucleus• endosperm is a store of {starch / protein / oils}• ovules will become the seeds inside the berries • xylem transports the water needed for berry formation shown in graph 1• xylem transports the water needed for hydrolysis of food stores• xylem transports mineral ions for berry formation • phloem transports the sucrose needed for berry formation and ripening in graph 2• more sucrose is transported from the leaves when berries are present in graph 2• ^{14}C incorporated into glucose during photosynthesis• glucose converted into sucrose for transport in the phloem

Level 0	Marks	No awardable content
Level 1	1-2	<p>An explanation may be attempted but with limited interpretation or analysis of the scientific information with a focus on mainly just one piece of scientific information.</p> <p>The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context.</p> <p>2 or 3 comments made which may include description of graphs and / or explanations</p>
Level 2	3-4	<p>An explanation will be given with occasional evidence of analysis, interpretation and/or evaluation of both pieces of scientific information.</p> <p>The explanation shows some linkages and lines of scientific reasoning with some structure.</p> <p>4 of 5 comments that include explanations with reference to at least two components</p>
Level 3	5-6	<p>An explanation is made which is supported throughout by sustained application of relevant evidence of analysis, interpretation and/or evaluation of both pieces of scientific information.</p> <p>The explanation shows a well-developed and sustained line of scientific reasoning which is clear and logically structured.</p> <p>6 or 7 comments that include explanations with reference to all three components</p>

Q12.

Question Number	Answer			Additional Guidance	Mark
	Structure	Name of structure	Number of sets of chromosomes	<p>NB Any two correct cells = 1 mark</p> <p>ACCEPT ovum / ova</p> <p>ACCEPT pleural</p> <p>ACCEPT male / sperm nucleus pleurals</p> <p>DO NOT ACCEPT generative nucleus</p>	(4)
	J	egg cell / female gamete	one / haploid / n (1)		
	K	polar nucleus / nucleus that forms the endosperm nucleus	one / haploid / n (1)		
	L	male gamete	one / haploid / n (1)		
	M	(pollen) tube nucleus	one / haploid / n (1)		

Q13.

Question Number	Answer	Additional Guidance	Mark
	<p>An explanation that includes four of the following:</p> <ul style="list-style-type: none"> • one (male nucleus) fuses with two polar nuclei (1) • which produces a triploid (endosperm) nucleus (1) • which therefore, provides nutrients (for germination) (1) • one (male nucleus) fuses with the female gamete nucleus (1) • which produces the diploid zygote (1) 	Allow pollen/egg/ova/fertilises	(4)

Q14.

Question Number	Answer	Additional Guidance	Mark
	<p>A description that includes:</p> <ul style="list-style-type: none"> • enzymes (hydrolyse / digest) the tissue (of the style) (1) • provides (nutrients / energy /ATP) for pollen tube growth (1) • clears path for pollen tube growth / allows pollen tube to enter ovule (1) 	<p>Allow enzymes (regulate the production of growth hormones / extend the cytoskeleton / are involved in aerobic respiration / produce new cell membranes)</p> <p>Allow provides cell structures needed for growth</p>	(3)

Q15.

Question Number	Answer	Additional guidance	Mark
	endosperm		(1)