PEARSON EDEXCEL IAL BIOLOGY · YBI11

BIOLOGY



MARK SCHEME

UNIT 2: CELL STRUCTURE, REPRODUCTION AND DEVELOPMENT

SCORE	PERCENTAGE
/497	%

STEMUP

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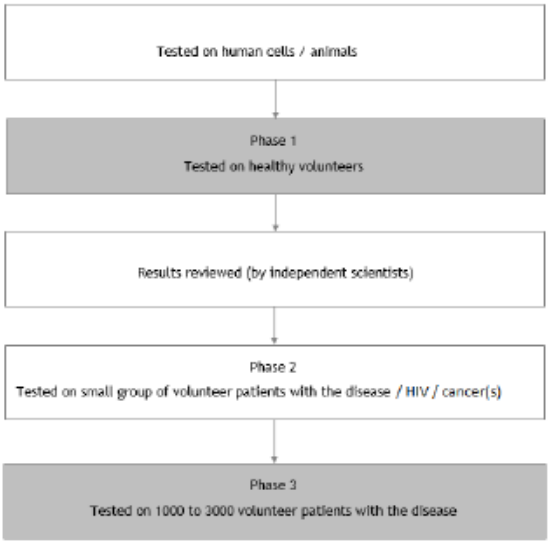
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Mark Scheme

Q1.

Question Number	Answer	Additional guidance	Mark
(a)	An answer that makes reference to the following: • named nitrogen containing compound synthesised (1) • credit role of this compound in the plant (1)	 e.g. amino acids / proteins / nucleic acids / ATP / NADP e.g. {Proteins/ (peptide) hormones} are needed for {growth / repair} / DNA is needed for protein synthesis Ignore amino acids needed to form proteins Ignore nucleotides needed to form DNA/RNA	**(2)**

Question Number	Answer	Additional guidance	Mark
(b)	A description that makes reference to two of the following: • modification of protein (into enzyme) (1) • **enzyme**(s) packaged into (secretory) vesicles (1) • **enzyme**(s) leave cell by exocytosis (1)	 Accept vesicles fuse with cell (surface) membrane and release enzyme(s) outside cell	**(2)**

Question Number	Answer	Additional guidance	Mark
(c)		Accept identification of side effects Ignore identification of appropriate dosage Accept tested on 100-500 volunteer patients with {disease / HIV/ cancer} Ignore patients unqualified	(3)

Q2.

Question Number	Answer	Additional guidance	Mark
(a)	An explanation that includes four of the following points: • cortical granules are released (from the egg cell) (1) • cortical granules fuse with the {zona pellucida / egg cell membrane} (1) • cortical granules release {chemicals / enzymes / proteins} tocause the hardening of zona pellucida (1) • prevents more than one sperm (cell) entering the egg cell (1) • egg cell and sperm nuclei are haploid and they fuse (during fertilisation) (1)	ACCEPT prevents polyspermy	**(4)**

Question Number	Answer
* **(b)**	Answers will be credited according to candidate's 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 indicated as relevant. Additional content included in the response must be scientific and relevant. <u>length of middle region</u> • increased length of mid region size increases swimming speed (I) • due to more mitochondria supplying more {energy/ ATP} to move the flagella (I) • increased chance of that male's sperm {reaching the egg cell(s) first / fertilising the egg cell(s)} / reproductive successfor that male} (R) • selection pressure / males with alleles for longer mid sections will have an advantage over other males (R) • more offspring will {have the same father/ inherit same alleles} (G) • leading to possible reduction in genetic diversity (G) • many males and many egg cells could lead to an increased genetic diversity of offspring (G) <u>spermatophore</u> • spermatophore contains sperm cells for fertilisation of egg (I) • nutrients will be used by female to produce {egg cells with more nutrients / more egg cells} (R) • {chemicals / pheromones} reduce chances of other males mating with the female (R) • increased chance of that male's sperm {reaching the egg cells(s) first / fertilising the egg cell(s)} / reproductivesuccess for that male} (R) • more offspring will {have the same father/ inherit same alleles} (G) • leading to possible reduction in genetic diversity (G) <u>storage of sperm</u> • {fertilised eggs / offspring} can be produced in absence of a mate (I) • increased reproductive success for {that female / males that mated} (R) • increased chance that offspring will {have different father/ inherit different alleles} (G) • leading to possible increase in genetic diversity (G) • not mating with (new) males every year could reduce genetic diversity (G) **(6)**

			Additional guidance
Level 0	0	No awardable content	
Level 1	1-2	Limited number of the most important or relevant scientific factors from the data/information provided are synthesised. No judgement is made.	1 mark – either R or G for one mating strategy 2 marks – either R+G for one mating strategy OR either R or G for two mating strategies OR 1 mark - basic information (I) given 2 marks - basic information (I) given + 1 or 2 x {R orG}
Level 2	3-4	Some of the most important or relevant scientific factorsfrom the data/information provided are synthesised. A limited accurate judgement is made.	3 marks – 3 x (R or G) considered 4 marks = 4 x (R or G) considered
Level 3	5-6	Most of the important or relevant scientific factors from the data/information provided are synthesised. A detailed and accurate judgement is made.	5 marks = either reproductive success for all strategies considered plus genetic diversity of two strategies considered OR genetic diversity for all strategies considered plus reproductive success of two strategies considered 6 marks genetic diversity and reproductive successconsidered for all strategies

Q3.

Question Number	Answer	Additional guidance	Mark
(a)	An answer that includes at least one similarity and one difference: similarities: • both contain membrane bound organelles (1) • both contain a {cell membrane / cell wall} (1) max 2 differences: • plant cell wall is composed of cellulose whereas a fungal cellwall is composed of chitin (1) • fungal cells contain glycogen granules whereas plant cells contain {starch grains / amyloplasts} (1) • plant cells contain {chloroplasts / plasmodesmata /tonoplast} whereas fungal cells do not (1)	ACCEPT named organelle(s) e.g. nucleus,mitochondria, 80S ribosomes etc ACCEPT both contain DNA associated with histones (1) ACCEPT fungal cells contain lysosomes whereas plant cells do not / plant vacuole may be larger than fungal vacuole	**(3)**

Question Number	Answer	Additional guidance	Mark
(b)(i)	An explanation that makes reference to four of the following points: • reduction in growth (1) and any three from: • due to reduced {cell division / mitosis} (1) • reduced gene expression will cause reduction in {enzyme/ protein} production (1) • reduced phospholipids which are needed for (growth of) {cell /organelle} membranes (in daughter cells) (1) • reduced transport of sucrose (around the plant) in the phloem /reduced sucrose available for other plant cells (1)	ACCEPT reduced DNA synthesis resultsin fewer cells in S phase / not enough DNA produced for mitosis to occur ACCEPT named enzyme e.g. DNA polymerase ACCEPT correct examples of sucrose useby plant e.g. reduced {respiration / ATP production}	**(4)**

Question Number	Answer
* **(b)(ii)**	Answers will be credited according to candidate's 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 indicated as relevant. Additional content included in the response must be scientific and relevant. <u>Description of data</u> • infection with fungus results in increased {tannin/ flavonoid} production • increasing the concentration of tannin reduces the leaf damage from herbivores • negative correlation / linear decrease • increasing the concentration of flavonoids increases the diameter of inhibition zone • doubling the concentration of flavonoids increases the diameter of inhibition zone by 28.6% <u>Plant</u> • explanation of how tannins reduce leaf damage e.g. herbivores don't like the taste / toxic / poisonous therefore less likely to eat the plant (A) • more leaves for photosynthesis and therefore increased growth (A) • explanation of what the diameter of inhibition zone shows = link to bactericidal/ bacteriostatic effect of flavonoids (A) • reduced plant infections (A) • link to why reduced herbivory and reduced plant infection benefits the infected plant e.g. fewer resources goes into growing new leaves and more can go into sexual reproduction (A) • disadvantage for plant – increased fungal growth (D) • more resources required {to produce tannins / for gene expression} instead of being used for {growth / sexualreproduction} (D) <u>Fungus</u> • link to why reduced herbivory benefits the fungus e.g. reduced competition for plant resources from herbivores, more plant resources available to fungus (A) • link to why reduced plant infection benefits the fungus e.g. reduced competition for plant resources from {bacteria / other fungi} (A) • reduced resources for fungus from plant as more used to synthesise tannins / flavonoids (D)

	• the fungus might only be able to {influence / live in / complete life cycle in} darnel plants (D) **(6)**		
			Additional guidance
Level 0	0	No awardable content	
Level 1	1-2	Demonstrates isolated elements of biological knowledgeand understanding to the given context with generalised comments made. Vague statements related to consequences are made withlimited linkage to a range of scientific ideas, processes, techniques and procedures. The discussion will contain basic information with some attempt made to link knowledge and understanding to thegiven context.	Information from one section
Level 2	3-4	Demonstrates adequate knowledge and understanding byselecting and applying some relevant biological facts/concepts. Consequences are discussed which are occasionally supported through linkage to a range of scientific ideas, processes, techniques and procedures. The discussion shows some linkages and lines of scientificreasoning with some structure.	level one content plus consideration of advantage(s)and / or disadvantage(s) 5 marks = L1+ one from {FA / FD / PA / PD} 6 marks = L1+ two from {FA / FD / PA / PD} FA = fungal advantage FD = fungal disadvantage PA = plant advantage PD = plant disadvantage
Level 3	5-6	Demonstrates comprehensive knowledge and understanding by selecting and applying relevant knowledgeof biological facts/concepts. Consequences are discussed which are supported throughout by sustained linkage to a range of scientificideas, processes, techniques and procedures. The discussion shows a well-developed and sustained line of scientific reasoning which is clear and logically structured.	Information from three sections applied to the givencontext showing a good understanding of the advantages and disadvantages to the infected plant and to the fungus 7 marks = L2 + three from {FA / FD / PA / PD} 6 marks – all four of {FA / FD / PA / PD} discussed

Question Number	Answer	Additional guidance	Mark
(b)(iii)	A description that includes reference to the following points: • (flavonoid drug) tested on small numbers of patients with {*P. aeruginosa* / lung infection} (1) • use of double-blind trial (1)	ACCEPT tested on {100 to 500} of patientswith {*P. aeruginosa* / lung infection} ACCEPT placebo / established drugtreatment	**(2)**

Q4.

Question Number	Answer	Mark
(a)(i)	The only correct answer is C two *A is not correct because there is one maternal and one paternal chromosome with three gene loci* *B is not correct because there is one maternal and one paternal chromosome with three gene loci* *D is not correct because there is one maternal and one paternal chromosome with three gene loci*	**(1)**

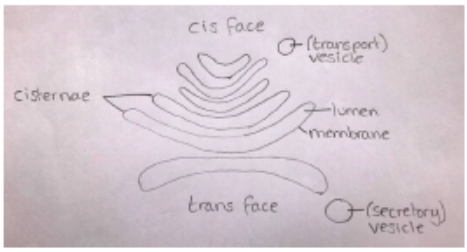
Question Number	Answer	Additional guidance	Mark
(a)(ii)	A description that makes reference to the following points: • uncoiling (of chromosome) (1) • used in protein synthesis / DNA replication (in S phase) (1)	Accept correct reference to histones / toform chromatin Accept transcription	**(2)**

Question Number	Answer	Additional guidance	Mark
(b)(i)	• prophase I		**(1)**

Question Number	Answer Additional guidance	Mark
(b)(ii)	The only correct answer is C three *A is not correct because ABe could not be formed by one chiasmata* *B is not correct because ABe could not be formed by one chiasmata* *D is not correct because ABe could not be formed by one chiasmata*	**(1)**

Question Number	Answer	Additional guidance	Mark
(b)(iii)	An explanation that makes reference to two of the following points: • alleles b and e are closer together (1) • therefore {crossing over / chiasma} is less likely to occur between these alleles (1)	Accept converse for A and E Accept converse for A and E	**(2)**

Q5.

Question Number	Answer	Additional guidance	Mark
(a)(i)	An answer that includes the following points: • at least two curved cisternae drawn (without ribosomes or interconnections) (1) • vesicle drawn (1) • cisternae labelled (1) • second correct label (1)	Example of diagram 	**(4)**

Question Number	Answer	Mark
(a)(ii)	The only correct answer is C two *A is not correct because the Golgi apparatus is involved in the formation of extracellular enzymes and modification ofproteins* *B is not correct because the Golgi apparatus is involved in the formation of extracellular enzymes and modification ofproteins* *D is not correct because the Golgi apparatus does not form peptide bonds*	**(1)**

Question Number	Answer	Mark
(a)(iii)	The only correct answer is D ribosomes *A is not correct because the ribosomes would become radioactive first* *B is not correct because the ribosomes would become radioactive first* *D is not correct because the ribosomes would become radioactive first*	**(1)**

Question Number	Answer	Additional guidance	Mark
(b)(i)	• 120(%) / 54.5(%) / 54(%) / 55(%)	Example of calculation $\frac{0.5 - 1.1}{0.5} \times 100$	**(1)**

Question Number	Answer	Mark
(b)(ii)	The only correct answer is B interphase *A is not correct because the Golgi apparatus would increase in size in interphase* *C is not correct because the Golgi apparatus would increase in size in interphase* *D is not correct because the Golgi apparatus would increase in size in interphase*	**(1)**

Question Number	Answer	Additional guidance	Mark
(b)(iii)	An answer that makes reference to four of the following points: • mitosis / two cells formed from one cell (1) • therefore {number / size} of Golgi (in each cell) has to increase(in interphase / G1) (1) • to provide enough cell {contents / organelles} for two (daughter) cells (after mitosis has occurred) (1) • because increased {protein synthesis / protein modification /gene expression} will occur (in interphase) (1) • because named protein(s) are required (by the cell) (1)	Accept relationship between {number/size}of Golgi and level of protein synthesis e.g. enzymes, hormones, structural proteins	**(4)**

Q6.

Question Number	Answer	Additional guidance	Mark
(a)(i)	A calculation in which: • conversion of actual length of scale into nm (1) • actual length divided by the given length (answer given to 2significant figures and in standard form) (1)	<u>Example of calculation:</u> 30mm = 30 000 000 nm 30 000 000 ÷1200 = ×2.5 x 10^4 accept +/- 1mm for length of bar	**(2)**

Question Number	Answer	Additional guidance	Mark
(a)(ii)	An explanation that makes reference to two of the following points: • electron microscope (1) • due to high magnification (1)	ecf from 2(a)(i) applies Accept high resolution Accept converse for light microscope Accept 3D image if qualified as scanningelectron microscope	**(2)**

Question Number	Answer	Additional guidance	Mark
(b)(i)	An answer that makes reference to the following points: • presence of {(peptidoglycan) cell wall / circular chromosome(s) /DNA associated with histones / 70S ribosomes / RNA polymerase} (1) • absence of {nucleus / membrane bound organelles} (1)	Accept ether bonds	**(2)**

Question Number	Answer	Additional guidance	Mark
(b)(ii)	An explanation that makes reference to three of the following points: • (analysis of) molecular evidence (1) • to identify similarities and differences in biological molecules /comparison of biological molecules (1) • (analysis of) phenotype (1) • to identify similarities and differences between the two microorganisms (phenotype) (1)	e.g. DNA, mRNA, proteins, enzymes e.g. cell structure / anatomical features,grow in different {habitats/ conditions} e.g. named similarities and differences incell structure	**(3)**

Q7.

Question Number	Answer	Additional guidance	Mark
(a)	A calculation in which: • calculation of volume of liposome (1) • expressed in standard form (1)	<u>Example of calculation:</u> 220893 2×10^5 / 2.2×10^5 / 2.21×10^5 (nm^3) answer given to 3 sig fig ecf applied for mp2 for correct volume calculation using 75 as radius	**(2)**

Question Number	Answer	Additional guidance	Mark
(b)	An explanation that makes reference to the following points: Similarities • both are single-stranded (1) • both contain the bases A,U,C,G / both contain a base, phosphate group and ribose (sugar) / both contain phosphodiester bonds (1) • an exon on pre-mRNA contains same base sequence as the matching exon on active mRNA (1) Differences • pre-mRNA contains both introns and exons whereas active RNA only contains exons (1) • active mRNA may have {fewer / different order of} exons (than pre-mRNA) (1)	ACCEPT linear ACCEPT both do not contain thymine ACCEPT both contain RNA nucleotides / both contain uracil ACCEPT both contain exons ACCEPT pre-mRNA contains introns whereas active RNA does not ACCEPT pre-mRNA is {longer / has more bases} than active mRNA ACCEPT pre-mRNA has recognition site for splicesome whereas active RNA does not ACCEPT active mRNA has a different base sequence to pre-mRNA	**(4)**

Q8.

Question Number	Answer	Additional guidance	Mark
(a)(i)	The only correct answer is C Eukarya *A is incorrect because plants are found in the domain Eukarya* *B is incorrect because plants are found in the domain Eukarya* *D is incorrect because plants are found in the domain Eukarya*		**(1)**

Question Number	Answer	Additional guidance	Mark
(a)(ii)	A description that makes reference to the following: • (evidence from) molecular phylogeny (1) • identification of {similarities / differences} in {DNA / RNA / proteins / enzymes / ribosomes / membrane components / cell wall components} (1)	Accept comparing {DNA / RNA / proteins / enzymes / ribosomes / membrane components / cell wall components} Ignore {looking at / analysing} the {DNA / RNA / proteins / enzymes / ribosomes / membrane components / cell wall components / genetic makeup}	**(2)**

Question Number	Answer	Additional guidance	Mark
(b)	An explanation that includes three of the following points: • (tube) grows (through style) to {ovary / ovule / egg cell} / transports the {male nuclei / generative nucleus / male gametes} to {ovary / ovule / egg cell} (1) • (and secretes) digestive enzymes used to aid growth of tube (to ovule) (1) • (therefore) male nuclei can fuse with {egg cell (nucleus) / polar nuclei} (1)	Ignore micropyle Accept forms pathway to reach {ovary / ovule / egg cell} Accept enzymes digest through the style Accept fertilisation occurs to form {zygote / endosperm} Accept double fertilisation occurs / zygote and endosperm formed	**(3)**

Question Number	Answer	Additional guidance	Mark
(c)(i)	An answer that makes reference to the following: • as the Verapamil concentration increases the length of the pollen tube decreases (1) • credit a correct manipulated mathematical statement (1)	Accept negative correlation	**(2)**

Question Number	Answer	Additional guidance	Mark
(c)(ii)	An answer that makes reference to the following: • lower concentration of calcium ions (in the cells) (1) • fewer {pectin / calcium pectate} molecules formed (1) • therefore increased flexibility of {microfibrils / cellulose} (due to fewer {pectin / calcium pectate} molecules) (1)	Accept no calcium ions present (in the cells) Accept calcium (ions) needed to produce {pectin / calcium pectate} Accept {calcium pectate / pectin} (are needed to) hold {microfibrils / cellulose} together (in a matrix) Accept {microfibrils / cellulose} are not held together by {calcium pectate / pectin} Accept calcium pectate helps middle lamella to hold adjacent cell walls together	(3)

Q9.

Question Number	Answer	Additional guidance	Mark
(a)	• anatomical • behavioural		(2)

Question Number	Answer	Additional guidance	Mark
(b)(i)	electron (microscope)		(1)

Question Number	Answer	Additional guidance	Mark
(b)(ii)	A description that includes the following points: • aerobic respiration (1) • produce ATP (1) • for cell metabolism / named cell process (1)	Accept {Krebs / citric acid} cycle / oxidative phosphorylation accept cell {reactions / processes} / named process e.g. mitosis, protein synthesis, muscle contraction, active transport etc accept contains ribosomes for protein synthesis	(3)

Question Number	Answer	Additional guidance	Mark
(c)	An answer showing: • at least two tubules with ribosomes on surface (1) • {cisternae / membrane} labelled (1) • ribosomes labelled (1)	Accept tubules ignore cell membrane	**(3)**

Q10.

Question Number	Answer	Additional guidance	Mark
(a)(i)	The only correct answer is D animal, plant and prokaryotic cells *A is not correct because all three cell types contain a cell membrane* *B is not correct because all three cell types contain a cell membrane* *C is not correct because all three cell types contain a cell membrane*		**(1)**

Question Number	Answer	Additional guidance	Mark
(a)(ii)	The only correct answer is C plant and prokaryotic cells only *A is not correct because prokaryotic cells contain a cell wall* *B is not correct because animal cells do not contain a cell wall* *D is not correct because animal cells do not contain a cell wall*		**(1)**

Question Number	Answer	Additional guidance	Mark
(b)(i)	A calculation in which: • cell diameter measured and converted into micrometres (1) • diameter divided by 25 with no units (1) OR • 25 converted to mm • diameter divided by 0.025 with no units	<u>Example of calculation:</u> 42mm=42000 µm 42000 ÷ 25 = x1680 ecf for ±1mm and incorrect conversions Correct answer with no units and with no working scores full marks	**(2)**

Question Number	Answer	Additional guidance	Mark
(b)(ii)	An answer that includes one of the following points: • (site of) photosynthesis / converts light energy to {chemical energy / ATP} (1)	ACCEPT formation of correct named product of photosynthesis e.g. glucose ignore makes food	**(1)**

Question Number	Answer	Additional guidance	Mark
(b)(iii)	An answer that includes the following point: • this organism has a nucleus / prokaryotic cells do not contain a nucleus (1)	DO NOT ACCEPT cell membrane / cytoplasm ignore contains membrane bound organelles	**(1)**

Question Number	Answer	Additional guidance	Mark
(c)(i)	• plasmodesma / plasmodesmata (1)		**(1)**

Question Number	Answer	Additional guidance	Mark
(c)(ii)	An explanation that includes the following points: • communication between / connects (connected) cells (1) • therefore signalling substances pass through {symplast / cytoplasm} / cytoplasmic streaming / transport of suitable named molecules e.g. minerals, water, glucose, amino acids, proteins, RNA (1)	allow ECF for pits, cell wall and middle lamella only pits • communication between / connects (connected) cells • therefore transport of suitable named molecules cell wall • (sieve like network made of) cellulose fibres support the cell • therefore helps retain rigid structure / prevent cell lysis middle lamella • joins (adjacent) cell (walls) together • therefore increases {strength / stability} of {plant / cell (wall)}	**(2)**

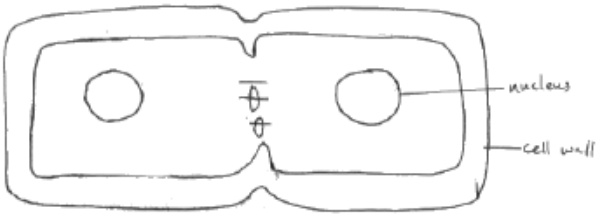
Q11.

Question Number	Answer	Mark
(a)(i)	The only correct answer is B K *A is not correct because the DNA content is not doubling* *C is not correct because the DNA content is not doubling* *D is not correct because the DNA content is not doubling*	**(1)**

Question Number	Answer	Mark
(ii)	The only correct answer is B L *A is not correct because the chromosomes are not condensing* *C is not correct because condensation of chromosomes would have completed before metaphase begins* *D is not correct because the chromosomes are not condensing*	**(1)**

Question Number	Answer	Additional guidance	Mark
(b)(i)	• prophase		**(1)**

Question Number	Answer	Additional guidance	Mark
(b)(ii)	An explanation that makes reference to two of the following points: • the {attachment/binding} of centromeres (to the spindle fibres) (1) • to allow the separation of the {(daughter) chromatids / chromosomes} (1) • so that each daughter cell gets identical genetic material (1)	ignore sister ACCEPT contract to move {chromatids /chromosomes} to opposite {poles/ends of cell} ACCEPT same number of chromosomes	**(2)**

Question Number	Answer	Additional guidance	Mark
(b)(iii)	An answer that makes reference to the following points: • cell wall and nuclear envelopes {present / reforming} (1) • cell plate visible (1)	Example of diagram  cell wall either labelled or cell has two outer lines ACCEPT phragmoplast	**(2)**

Question Number	Answer	Additional guidance	Mark
(c)	A description that makes reference to the following: • count number of cells in mitosis and the total number of cells (1) • divide the number of cells in mitosis by the total number of cells in the photograph (then multiply the answer by 100) (1)	ACCEPT named stages of mitosis ACCEPT correct equation	**(2)**

Q12.

Question Number	Answer	Additional guidance	Mark
(a)	An explanation that includes four of the following points: • water for {hydrolysis reactions / form cytoplasm / solvent / hydration} (1) • (some bacteria require) oxygen for (aerobic) respiration (1) • (suitable/optimum) temperature for {enzyme-controlled / metabolic} reactions to occur (at suitable rate) (1) • (suitable/optimum) pH for {enzyme-controlled / metabolic} reactions to occur (at suitable rate) (1) • named organic molecule and an explanation of why that organic molecule is needed (1)	ACCEPT (some anaerobic bacteria require) no oxygen for anaerobic respiration ACCEPT (suitable) temperature so enzymes do not denature ACCEPT (suitable) pH so enzymes do not denature e.g. glucose for respiration / lipids to provide fatty acid chains for new cell membrane / proteins to provide amino acids for {protein synthesis / growth}	**(4)**

Question Number	Answer	Additional guidance	Mark
(b)(i)	A calculation showing the following steps: • calculation of difference in mean area of ulcer (1) • calculation of percentage decrease (1)	<u>Example of calculation</u> (802.71-95.71) =707 $\frac{(802.71-95.71)}{802.71} \times 100$ = 88 / 88.077 / 88.08 / 88.1 (%) Correct answer with no working shown scores full marks	**(2)**

Question Number	Answer	
(b)(ii)	Answers will be credited according to candidate's 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 indicated as relevant. Additional content included in the response must be scientific and relevant. <u>Description of data in table</u> • mass of mucus • ulcer area <u>Conclusions and Explanations</u> • omeprazole was most effective treatment /none of the extracts were as effective as omeprazole at reducing ulcer area / all treatments resulted in {reduction of ulcer area / increased mass of mucus} • correlation between mucus mass and ulcer area (apart from omeprazole) • bacteria damage stomach lining causing ulcers • suggestion that {omeprazole / extract} increases mucus production • high mucus content prevents bacteria {reaching / damaging} stomach lining • explanation of how mucus production links to ulcer area • high mucus content prevents acid contents damaging stomach lining <u>Sustained</u> • link to biological process resulting in increased mucus production • {omeprazole / extract} causes the {stomach lining / goblet cells} increases mucus production • suggestion that {omeprazole / extract} reduces acidity of stomach making it less suitable for *H. pylori* • antimicrobial properties of {omeprazole / extract} reducing {number / reproduction} of bacteria • therefore {slow population growth / reduced population of bacteria} results in {reduced damage to stomach lining / smaller ulcer area} **(6)**	

			Additional guidance
Level 0	0	No awardable content	
Level 1	1-2	An explanation may be attempted but with limited interpretation or analysis of the scientific information and with a focus on mainly just one piece of scientific information. The explanation will contain basic information, with some attempt made to link knowledge and understanding to the given context.	Either Description of: mass of mucus data and/or ulcer area data OR description of one and/or conclusion / explanation of one data set
Level 2	3-4	An explanation will be given, with occasional evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows some linkages and lines of scientific reasoning, with some structure.	description of both data plus: explanation of mass of mucus / ulcer area and/or simple conclusion of most effective treatment
Level 3	5-6	An explanation is made that is supported throughout by sustained application of relevant evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows a well-developed and sustained line of scientific reasoning, which is clear and logically structured.	all level 2 plus: a detailed explanation using sustained application. The detail of sustained application determines the mark in this level.

Q13.

Question Number	Answer	Additional guidance	Mark
(a)(i)	An answer that includes the following point: • group of (similar) cells (working together to) perform a (specific) function (1)	ACCEPT cells with similar {structure / function / origin}	**(1)**

Question Number	Answer	Additional guidance	Mark
(a)(ii)	An answer that includes the following points: • patient P has a mitotic index of 20 (1) • patient R has a mitotic index of 45 (1) • correct order of cancer stage identified (1)	e.g. P has an earlier stage of cancer (than R), R has a more advanced stage of cancer ACCEPT ecf from calculated MI for P and R	**(3)**

Question Number	Answer	Additional guidance	Mark
(b)	An answer that includes at least one similarity and one difference: similarity: • the survival probability decreases over time (for all three stages) (1) differences: • stage I has the highest survival probability for all years whereas stage IV has the lowest probability for all years (1) • stage IV has the {fastest/steeper} decrease (in survival probability) / stage I has the slowest decrease (in survival probability) (1)	ACCEPT correct order of survival probability for a point on the graph	**(3)**

Question Number	Answer	Additional guidance	Mark
(c)	A description that includes the following points: • correct description of a placebo being given to one group (and the other group receiving (anticancer) drug) (1) • neither the patient nor the doctor knows whether the patient is receiving (the drug or) the placebo (1)	ACCEPT description of a placebo e.g. has no active ingredient / already known drug / sugar pill / dummy drug ACCEPT scientist / researcher for doctor	**(2)**

Q14.

Question number	Answer	Mark
(a)	• {restricted / native} to a particular area	(1)

Question number	Answer	Additional guidance	Mark
(b)(i)	• subtraction (1) • percentage (1) Example of calculation: 5 500 – 3 000 / 2 500 (2 500 ÷ 5 500) × 100 = 45.45	Accept 45.5 and 45	(2)

Question number	Answer	Mark
(b)(ii)	An explanation that includes three of the following points: • because of habitat destruction there is no food (1) • because of habitat destruction there is no shelter (1) • fragmentation of habitat makes it harder to find a mate (1) • therefore, there is a decrease in genetic diversity (1)	(3)

Question number	Answer	Mark
(c)(i)	A description that includes the following points: • sperm observed under a microscope to assess {motility / ability to swim in a straight line} (1) • use of {stains / microscope} to observe the integrity of the acrosome (1) • comparisons need to be made to freshly collected sperm so that effects can be calculated (1)	(3)

Question number	Answer	Mark
(c)(ii)	An explanation that includes any four of the following points: • because sperm can be frozen from different males to increase genetic diversity (1) • because frozen sperm will always be available if numbers of Baird's tapir decrease too far (1) • can freeze sperm so that they are available when females come in to season (1) • freezing could reduce the number of successful fertilisations because of poor viability (1) • more sperm would need to be used as viability is low, reducing stocks (1)	(4)

Q15.

Question Number	Answer	Additional guidance	Mark
(a)(i)	The only correct answer is C plant cells and prokaryotic cells *A is incorrect because prokaryotic cells also have a cell wall* *B is incorrect because animal cells do not have a cell wall* *D is incorrect because animal cells do not have a cell wall*		**(1)**

Question Number	Answer	Additional guidance	Mark
(a)(ii)	**Drawing** (2): • {double (nuclear) membrane / nuclear envelope} obvious • nuclear pores shown and (1 or more) nucleoli present **Labels** (max 2): • (nuclear) envelope / <u>double</u> membrane / {<u>inner</u> / <u>outer</u>} (nuclear) membrane • (nuclear) pore • nucleolus • correct reference to chromatin / nucleoplasm	if one incorrect label, max of 1 label mark if two incorrect labels then no label marks can be awarded Ignore DNA	**(4)**

Question Number	Answer	Additional guidance	Mark
(b)(i)	An explanation that includes the following points: • the two {layers (of the membrane) /membranes} are very close together / there is a very small distance between the {two layers / membranes} (1) • therefore, the **resolution** of a light microscope is not high enough (1)	Accept the bilayer structure is very close together Ignore the bilayer is too {small / thin}	**(2)**

Question Number	Answer	Additional guidance	Mark
(b)(ii)	A calculation showing the following steps: • length of XY measured correctly +/- 1mm (1) • calculation of actual size (1) • correct answer given in µm (1)	Mark the answer on answer line first <u>Example of calculation</u> 26 mm / 2.6 cm 26 ÷ 200= 0.13 (mm) = 130 (µm) Correct answer scores full marks	**(3)**

Question Number	Answer	Additional guidance	Mark
(b)(iii)	A description that makes reference to the following: • form spindle {fibres / poles} in {prophase / mitosis / meiosis / cell division} (1) • to separate {chromosomes/ chromatids} (1)	Ignore DNA / genetic material	**(2)**

Q16.

Question Number	Answer	Additional guidance	Mark
(a)	An answer that makes reference to the following point: • group of organs that work together to perform {one / one or more / specific} functions		**(1)**

Question Number	Answer	Additional guidance	Mark
(b)(i)	An answer that makes reference to the following point: • group of (similar) cells working together to perform a (specific) function		**(1)**

Question Number	Answer					Mark
(b)(ii)	**Structure**	**Propels male gamete towards female gamete**	**Modified by the action of cortical granules**	**Produce ATP by respiration**	**Contain linear DNA**	**(4)**
	flagellum	☒ A				
	mitochondria			☒ C		
	nucleus				☒ D	
	zona pellucida		☒ B			

Q17.

Question Number	Answer	Mark
(a)	The only correct answer is C Y *A is not correct because W does not contain mitochondria* *B is not correct because X does not contain mitochondria* *D is not correct because Z does not contain mitochondria*	**(1)**

Question Number	Answer	Additional guidance	Mark
(b)(i)	A description that makes reference to the following points: • named organelle involved in protein production (1) • role of organelle described in the production of the enzyme (1)	mitochondria / nucleus / ribosomes / {rough endoplasmic reticulum / rER} / Golgi (apparatus/body) e.g. mitochondria – produce ATP for protein synthesis (of enzyme) nucleus – site of transcription of enzyme gene / location of gene for enzyme ribosomes -site of protein synthesis / where polypeptide is formed rER -site of protein synthesis / where polypeptide is formed / formation of 3° structure / packaging protein into (transport) vesicle Golgi apparatus – modification of {protein / enzyme} / packaging {protein / enzyme} into (secretory) vesicle	**(2)**

Question Number	Answer	Additional guidance	Mark
(b)(ii)	• 800		**(1)**

Question Number	Answer	Additional guidance	Mark
(b)(iii)	An explanation that makes reference to four of the following points: • doubling the acrosin activity of the sperm cell increases the percentage of egg cells fertilised by 68% / non-linear increase • (because) higher acrosin activity means the sperm cells can digest through all of the {outer layer / zona pellucida} (of more egg cells) (1) • (allowing) sperm (cells) to {bind to (egg cell) membrane / enter egg (cell)} (1) • (so that) sperm nucleus can fuse with egg (cell) nucleus / fusion (of nuclei) can occur (1) • (low acrosin activity) could result in death of sperm cells before fertilisation could occur (1)	ACCEPT greater increase (in percentage of egg cells fertilised) between 2.5 and 3(a.u.) ACCEPT 100% fertilisation at 5(a.u.) compared to 32% at 2.5(a.u.) ACCEPT digesting the outer layer {faster /more efficiently} / more digestion occurs Accept converse ACCEPT sperm can reach egg (cell) nucleus ACCEPT sperm can fuse with egg (cell) ACCEPT converse	**(4)**

Question Number	Answer	Additional guidance	Mark
(c)(i)	• image size divided by magnification	ACCEPT 4.5±1 ÷200 ignore unmanipulated equation	**(1)**

Question Number	Answer	Additional guidance	Mark
(c)(ii)	An answer that makes reference to three of the following points: • (when a sperm entered egg cell) cortical granules have fused to cell surface membrane / cortical {reaction/enzymes} resulted in hardening of zona pellucida (1) • as zona pellucida (of some egg cells) are damaged there are areas where it is not {present / hardened} (1) • resulting in polyspermy / {an extra / two} sperm have entered (the egg cell) (1)	ACCEPT some zona pellucida is not hardened reject 3 sperm have entered egg cell	**(3)**

Q18.

Question Number	Answer	Additional guidance	Mark
(a)	An explanation that includes two of the following points: • haploid so that when it is fertilised {a zygote is formed / itbecomes diploid} (1) • contains lipid droplets as a source of energy (1) • {cortical granules / enzymes} to {harden zonapellucida / prevent polyspermy} (1)	ACCEPT large cell to store more {lipid/energy} ACCEPT releases chemicals to attractsperm ACCEPT sperm bind to glycoproteinson egg cell (surface)	**(2)**

Question Number	Answer	Additional guidance	Mark
(b)(i)	An answer that includes the following points: Similarities • lining up of {chromosomes/ chromatids} on equator (ofcell) (1) • centromere bonds to spindle fibres (in metaphase) (1) Differences (max 2): • two metaphase stages in meioisis whereasmitosis has one (1) • {independent/random } assortment occurs (inmetaphase I) in meiosis whereas it does not occur in mitosis (1) • meiosis involves homologous pairs of chromosomes (in metaphase I) and sister chromatids (in metaphase II) whereas mitosisinvolves sister chromatids (1)	Full marks can only be awarded ifthere is a similarity in the answer ACCEPT centre of cell / metaphaseplate ACCEPT {chromosomes/chromatids}bond to spindle fibres ACCEPT independent assortment onlyoccurs in metaphase I in meiosis ACCEPT meiosis involves pairs of chromosomes whereas mitosis involves pairs of {sister chromatids/single chromosomes} ACCEPT meiosis involves pairs of chromosomes whereas mitosis does not	**(3)**

Question Number	Answer	Additional guidance	Mark
(b)(ii)	An explanation that includes four of the following points: • morula cells are totipotent whereas blastocyst cells are pluripotent (1) • (specialisation / differentiation occurs because) gene(s) switched off (in blastocyst cells) (1) • due to {epigenetic modification / DNA methylation /histone modification} (1) • transcription of (active) genes to produce (active) mRNA / (active) mRNA translated at the ribosomes (1) • the protein(s) produced {determine / change} cell {structure / function} (1)	ACCEPT cells become pluripotent ACCEPT differential gene expressionoccurs ACCEPT transcription and translationof (active)gene to produce protein	**(4)**

Question Number	Answer	Additional guidance	Mark
(c)(i)	• correct D2 values (1) • correct calculation of $\sum D^2$ (1)	<table><tr><th>Age (weeks)</th><th>Rank</th><th>Mass of egg (g)</th><th>Rank</th><th>D</th><th>D^2</th></tr><tr><td>36</td><td>1</td><td>2.27</td><td>8</td><td>-7</td><td>49</td></tr><tr><td>39</td><td>2</td><td>1.91</td><td>1</td><td>1</td><td>1</td></tr><tr><td>42</td><td>3</td><td>2.18</td><td>5.5</td><td>-2.5</td><td>6.25</td></tr><tr><td>45</td><td>4</td><td>2.28</td><td>9</td><td>-5</td><td>25</td></tr><tr><td>48</td><td>5</td><td>2.12</td><td>4</td><td>1</td><td>1</td></tr><tr><td>51</td><td>6</td><td>2.19</td><td>7</td><td>-1</td><td>1</td></tr><tr><td>54</td><td>7</td><td>2.18</td><td>5.5</td><td>1.5</td><td>2.25</td></tr><tr><td>57</td><td>8</td><td>2.09</td><td>3</td><td>5</td><td>25</td></tr><tr><td>60</td><td>9</td><td>2.03</td><td>2</td><td>7</td><td>49</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td>159.5</td></tr></table> $\sum D^2 = 159.5$ Correct answer with no working shown scores full marks 1 mark awarded for correct Σ using incorrect D^2 values calculated in table	**(2)**

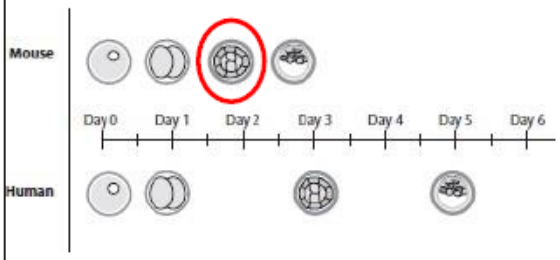
Question Number	Answer	Additional guidance	Mark
(c)(ii)	• correct values substituted into formula (1) • correct r_s value (1)	Example of calculation: 957 ÷ 720 = -0.329 / -0.33 / -0.3 Allow ECF from answer calculated in(c)(i) Correct answer with no workingshown scores full marks	**(2)**

Question Number	Answer	Additional guidance	Mark
(c)(iii)	An explanation that includes the following points: • (the null hypothesis) should be accepted (1) • (because) 0.38 is lower than 0.683 (1)	mark points independently	**(2)**

Q19.

Question Number	Answer	Additional guidance	Mark
(a)	A calculation showing the following steps: • correct difference (1) • correct percentage difference to 2 significant figures (1)	Mark the answer on answer line first <u>Example of calculation:</u> 170 - 105 = 65 (65 ÷ 105) × 100 = 62% Correct answer (62) with no workinggains full marks Accept 38% for both marks	**(2)**

Question Number	Answer	Additional guidance	Mark
(b)(i)	The only correct answer is B 2.85 x 10^{-3} (mm^3) *A is not correct because that is the volume in cm^3* *C is not correct because that is not the volume in mm^3* *D is not correct because that is the volume in μm^3*		**(1)**

Question Number	Answer	Additional guidance	Mark
(b)(ii)		accept circle without morula labelaccept morula label without circle	**(1)**

Question Number	Answer	Additional guidance	Mark
(b)(iii)	A description that includes the following points: • fusion of cortical granules with cell (surface) membrane andrelease of enzymes (1) • hardening of zona pellucida (to prevent polyspermy) (1) • fusion of two haploid nuclei (to form diploid nucleus) (1)	Accept joining of two haploid nuclei	**(3)**

Question Number	Answer	Additional guidance	Mark
(c)	An answer that includes the following points: • it is a short distance between (mitochondria and lipid (1) • quicker diffusion of {lipid / fatty acid / glycerol} (into mitochondria) (1) • lipids used in {respiration / ATP production} (1)	accept they are close together Accept (lipid droplets) converted toglucose ignore energy storage	**(3)**

Q20.

Question Number	Answer	Additional guidance	Mark
(a)(i)	An answer that makes reference to the following: • (step A) mitosis (1) • (step B) meiosis (1)	accept meiosis **I** do not accept meiosis **I** ignore II	**(2)**

Question Number	Answer	Mark
(a)(ii)	The only correct answer is A W B is not correct because the acrosome contains digestive enzymes C is not correct because the acrosome contains digestive enzymes D is not correct because the acrosome contains digestive enzymes	**(1)**

Question Number	Answer	Additional guidance	Mark
(b)	An explanation that includes the following points: • (because) differential gene expression occurs (1) • (due to) epigenetic modification / DNA methylation / histone modification (1) • {transcription of / (active) mRNA made from} active genes (1) • (therefore) translation occurs to form a {polypeptide / protein} (1) • (proteins cause) {structural/functional} change to cells to change them into (specialised) sperm cell (1)	Accept some genes become {switched on / expressed / switched off} Accept description of a {structural/functional} change into a sperm cell	**(5)**

Question Number	Answer	Additional guidance	Mark
(c)(i)	An answer that includes the following points: • outer layer of cells with internal cell mass (1) • cavity in centre of the diagram (1)	Example of diagram: 	**(2)**

Question Number	Answer	Mark
(c)(ii)	The only correct answer is D cells that can give rise to almost any type of cell in the body, excluding totipotent cells A is not correct because pluripotent do not give rise to all cells in the body B is not correct because pluripotent do not give rise to all cells in the body C is not correct because pluripotent do not give rise to totipotent cells	**(1)**

Question Number	Answer	Additional guidance	Mark
(d)	An answer that includes the following points: • (stem cells) can {differentiate / specialise} into different {cells / tissues / organs} (1) • great {potential/ importance/ medical implications} of the research in developing medical therapies (1) • salamander embryos do not have a fully developed nervous system (1) • no need to use human embryos (1)	accept named example of a medical therapy use of stem cells in humans e.g. {repair / transplant} {cells / tissues / organs} in humans accept will save human lives / used to treat certain diseases e.g. cancer / heart disease accept salamander embryos do not feel pain / salamanders are not an endangered species / salamanders produce a large number of embryos	**(2)**

Q21.

Question Number	Answer	Additional guidance	Mark
(a)(i)	• correct magnification calculated	ACCEPT range between x14 000 - x18 000 ACCEPT correct magnification in standard form	**(1)**

Question Number	Answer	Additional guidance	Mark
(a)(ii)	An answer that makes reference to the following point: • too small (0.5 µm) to be viewed (under a light microscope) / magnification (of x14 000-16 000) can't be achieved by a light microscope / resolution would be too low} (1)	ecf applies ignore references to 3D image	**(1)**

Question Number	Answer	Additional guidance	Mark
(b)	An explanation that makes reference to two of the following points: • plant based packaging is (more) sustainable / biodegradable / carbon neutral (than traditional oil-based packaging) (1) • (the antimicrobial property of the oregano oil) will {reduce the numbers of (*L. monocytogenes*) bacteria / prevent bacterial growth (on the food) / prevent microbial growth} (1) • (resulting in) fewer people getting {listeriosis / (microbial) disease} (1)	ACCEPT plant-based packaging is {renewable / available for future generations} ACCEPT kill bacteria ignore reduce microbes entering packaging ACCEPT so food will not go off as quick / extends shelf life	**(2)**

Question Number	Answer	Mark
(c)(i)	The only correct answer is C *A is not correct because L. monocytogenes is least affected by the chemicals* *B is not correct because L. monocytogenes is least affected by the chemicals* *D is not correct because L. monocytogenes is least affected by the chemicals*	**(1)**

Question Number	Answer	Additional guidance	Mark
(c)(ii)	• 6.14 / 6.1 / 6	<u>Example of calculation:</u> 11.1+0.63=11.73 6.0-0.41=5.59 11.73-5.59=6.14	**(1)**

Question Number	Answer	Additional guidance	Mark
(d)	A description that makes reference to the following points: • to test for side-effects (1) • to determine {safe / minimum / effective/ suitable} {dosage / concentration} (1) • to determine if it is more effective than {existing treatments / placebo} (1)	 ignore to check for safety do not accept testing for side effects in context of {in-vitro/animal} ACCEPT to {determine optimum dosage / adjust dose} ACCEPT compare effectiveness with {existing treatments / placebo} ignore to see if it's effective	**(3)**

Q22.

Question Number	Answer	Additional guidance	Mark
(a)(i)	The only correct answer is B one A is not correct because starch only contains α-glucose and is stored in amyloplast C is not correct because starch only contains α-glucose and is stored in amyloplast D is not correct because starch only contains α-glucose and is stored in amyloplast		**(1)**

Question Number	Answer	Additional guidance	Mark
(a)(ii)	The only correct answer is C two *A is not correct because they are all correct apart from contains α-glucose and β-glucose* *B is not correct because they are all correct apart from contains α-glucose and β-glucose* *D is not correct because they are all correct apart from contains α-glucose and β-glucose*		**(1)**

Question Number	Answer	Additional guidance	Mark
(b)(i)	• (bacterial) chromosome and • (70S) ribosomes	Both structures required for the mark Accept nucleoid / (circular) DNA / plasmid / (m)RNA ignore size of ribosome	**(1)**

Question Number	Answer	Additional guidance	Mark
(b)(ii)	An explanation that includes three of the following points: • oxygen for (aerobic) respiration (1) • glucose for respiration / amino acids for protein synthesis (1) • optimum temperature for (faster) {enzyme / metabolic} reaction (1) • optimum pH for (faster) {enzyme / metabolic} reaction (1)	accept lack of oxygen for survival ofobligate anaerobes accept water for {hydrolysis reactions /solvent} accept suitable stated temperature for {faster/optimum} enzyme rate of reaction accept suitable stated pH for {faster/optimum} enzyme rate of reaction	**(3)**

Q23.

Question Number	Answer
* (a)	Answers will be credited according to candidate's deployment of knowledge and understanding of the materialin 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 materialindicated as relevant. Additional content included in the response must be scientific and relevant. • hermaphrodites can self-fertilise / reproduce without the need to find a mate • fertilising own egg cells using their own sperm cells • produce fewer nematode offspring • all offspring likely to be hermaphrodites • as all gametes will contain a sex chromosome • hermaphrodites can reproduce with a {mate / male nematode} / need to find a male to mate with • males have only one chromosome • if hermaphrodite mates with a male then (700) more egg cells are fertilised • half of the offspring will be {hermaphrodites / male} • if sperm cells without a sex chromosome fertilise an egg cell then the offspring will be male • if sperm cells with a sex chromosome fertilise an egg cell then the offspring will be hermaphrodites • half of the male sperm cells will not contain a sex chromosome • consideration of advantages of {reproducing without the need to find a mate/ all offspring beinghermaphrodites} on chance of survival (of nematodes) • consideration of disadvantages of fewer offspring on chance of survival (of nematodes) • consideration of disadvantages of needing to find a mate reproducing on chance of survival ofnematodes • consideration of advantages of more offspring on {increased reproductive success /chance of survival/increased future sexual reproduction} of nematode {population/species/offspring}

	• self-fertilisation leads to limited genetic variation (in offspring) / {decrease/no change} in gene pool • {sexual reproduction / mating with male nematode} results in increased genetic variation of offspring • consideration of disadvantages of limited genetic variation on chance of survival (of nematodes) • consideration of advantages of increased genetic variation on chance of survival (of nematodes) • consideration of benefits of more offspring with increased genetic variation

			Additional guidance
Level 0	0	No awardable content	
Level 1	1-2	An explanation may be attempted but with limited interpretation or analysis of the scientific informationand with a focus on mainly just one piece of scientificinformation. The explanation will contain basic information, withsome attempt made to link knowledge and understanding to the given context.	consideration of both types of reproductivebehaviour from given information only or more detailed consideration of one type ofreproductive behaviour
Level 2	3-4	An explanation will be given, with occasional evidenceof analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows some linkages and lines ofscientific reasoning, with some structure.	all level 1 info plus consideration of two of -explanation of adv/disadv of asexual onsurvival of nematodes (not GD) -explanation of adv/disadv of sexual onsurvival of nematodes (not GD) -effect of reproductive behaviour on geneticdiversity of offspring -explanation of impact of genetic diversity onsurvival of nematodes
Level 3	5-6	An explanation is made that is supported throughoutby sustained application of relevant evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows a well-developed and sustainedline of scientific reasoning, which is clear and logically structured.	all level 2 info plus consideration of all of -explanation of adv/disadv of asexual onsurvival of nematodes (not GD) -explanation of adv/disadv of sexual onsurvival of nematodes (not GD) -effect of reproductive behaviour on geneticdiversity of offspring -explanation of impact of genetic diversity onsurvival of nematodes

Question Number	Answer	Additional guidance	Mark
(b)	An answer that includes the following points: • histone modification can be passed onto zygotes (1) • if enzyme M is present, histone modification is passed on to {all chromosomes / embryo} (after cell division in experiment 1) (1) • cells divide by mitosis (1) • if enzyme M is absent (in the egg cell cytoplasm) thenthe histone modification decreases until no longer detected (1) • (histone modification decreases because) replicatedDNA can't be modified without enzyme (M) (1) • description of histone modification (1)	ACCEPT fertilised egg cells (in both experiments) have histone modification ACCEPT enzyme M causes histone modification ACCEPT histone modification is passedon to {all chromosomes/embryo} in experiment 1 ACCEPT cell division involves replication of DNA ACCEPT histone modification is not passed on to all chromosomes in experiment 2 ACCEPT enzyme M can't be produced (if absent in egg cell) ignore genes being switched {on/off}	**(5)**

Q24.

Question Number	Answer	Additional guidance	Mark
(a)(i)	A - Metaphase I The only correct answer is A *B is not correct because independent assortment does not occur in metaphase II* *C is not correct because independent assortment does not occur in telophase I* *D is not correct because independent assortment does not occur in telophase II*		**(1)**

Question Number	Answer	Additional guidance	Mark
(a)(ii)	C - Prophase I The only correct answer is C *A is not correct because crossing over does not occur in metaphase I* *B is not correct because crossing over does not occur in metaphase II* *D is not correct because crossing over does not occur in prophase II*		**(1)**

Question Number	Answer	Additional guidance	Mark
(b)	An explanation that includes three of the following points: • (due to) linkage (1) • A and B are on same chromosome (1) • {genes/ alleles / AB / ab / 48%} are not separated due to crossing over / {AB / ab} are inherited together (1) • {Ab / aB / 2%} formed by crossing over (1)	ACCEPT 25% due to A and B on separate chromosomes ACCEPT the closer together two loci are the smaller the chance of separation (by recombination) / ORA ACCEPT {Ab / aB} are recombinants	**(3)**

Question Number	Answer	Additional guidance	Mark
(c)	A description that includes the following points: • reference to post transcriptional changes / (pre-)RNA splicing (1) • {introns / P, R, T, V and X} removed by enzymes (1) • rearrangement of {exons / Q, S, U and W} / removal of some exons (1) • credit two different permutations of exon order given (1) • (therefore) a different {primary sequence / sequence of amino acids / polypeptide} (1)	ACCEPT spliceosomes ACCEPT not all exons used ACCEPT different sequence of amino acids can result in differences in {folding / bonding} giving a different protein (3D) shape	**(5)**

Question Number	Answer	Additional guidance	Mark
(d)	An answer that includes the following points: • (activity of) gene T decreases (during development) and gene U increases (1) • (because) gene T is switched off (1) • {product of gene T not needed / (gene T) protein not produced} once blastocyst stage reached (1) • product of gene U is needed at higher levels after the {8-cell / morula} stage (1)	ACCEPT pieced together ACCEPT description ACCEPT product of gene T not needed after 8-cell stage reached ACCEPT gene U is involved in specialisation of the cells / correct description of role of gene U protein	**(3)**

Q25.

Question Number	Answer	Additional guidance	Mark
(a)	A description which includes the following points: • synthesis of organelles (1) • increase in cell size / growth of cell (1) • {synthesis / replication} of DNA (1)	ignore references to G1, S and G2 accept {replication / increasing number} of organelles accept synthesis of {proteins / enzymes} required for the next part of the cell cycle accept increase in cytoplasm ignore growth of organelles accept {DNA / genetic material} is doubled	**(3)**

Question Number	Answer	Additional guidance	Mark
(b)	An answer that includes four of the following points: • {methyl groups / CH_3} are added to {DNA / the gene/ cytosine} (1) • (resulting in RB) gene being {switched off / silenced} (1) • (methylation) prevents the binding of {RNA polymerase / transcription factors} (1) • (therefore) translation (of mRNA) does not occur (1) • (therefore the) {RB / tumour suppressor} protein isn't produced (1) • and {the cell cycle / mitosis} continues (forming a tumour) / {reduced / no} inhibition of tumour growth (1)	ignore methylation of the gene accept gene is not {expressed / active} accept {no / reduced} transcription of (RB) gene / mRNA is not produced (from RB gene) accept fewer {RB / tumour suppressor} proteins are produced accept higher rate of cell division occurs	**(4)**

Question Number	Answer	Additional guidance	Mark
(c)	An explanation that includes the following points: • (sister) chromatids cannot be separated / centromere cannot be split (1) • during anaphase (1)	accept chromosomes won't {be separated / move to poles of cell / move away from equator} accept cell remains in metaphase	**(2)**

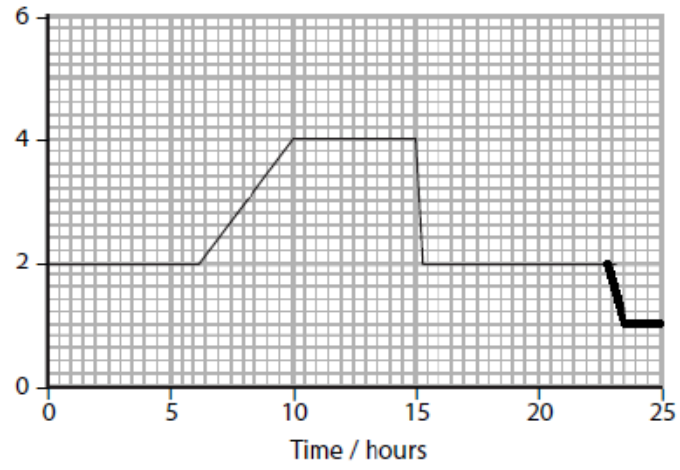
Question Number	Answer
* (d)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material indicated as relevant. Additional content included in the response must be scientific and relevant. • increasing concentration of Paclitaxel {increases the duration of mitosis / slows mitosis} • quantitative comparison using information from table • increasing concentration of Paclitaxel increases the mitotic index • quantitative comparison using information from table • Paclitaxel causes the lowest increase in mass of tumour / lowest mass of tumour with paclitaxel • Paclitaxel was more effective than {placebo / drug X} • quantitative comparison using information from graph • error bars for paclitaxel do not overlap with {drug X / placebo} so there is a significant difference / error bars for drug X and placebo overlap so {the data may not be completely reliable / have similar effectiveness} / correct comment about size of error bars linked to repeatability of data • recognition that there is a significant difference between {placebo/drug X} and paclitaxel data • relevant comment about study design e.g. sample size, no information about age/sex etc of volunteers, no given duration in human lung study, only 21 days in mouse study • paclitaxel stopped division of cancerous cells / {fewer / decreased rate of} cancer cells being produced with paclitaxel • linkage between {increased mitotic index/ slower rate of mitosis / fewer cancer cells produced by mitosis} and smaller mass of tumour • explanation of how mitotic index is calculated (number of cells in mitosis ÷ total number of cells) • linkage between the increased duration of mitosis and the increased mitotic index e.g. more cells in prophase, metaphase, anaphase, telophase than in interphase • linkage between prevention of shortening of spindle fibres and increased duration of mitosis/mitotic index • resulting in, fewer cells in {anaphase/telophase/cytokinesis} than {prophase/metaphase} **(6)**

			Additional guidance
Level 0	0	No awardable content	
Level 1	1-2	Limited scientific judgement made with a few strengths/weaknesses identified. A conclusion may be attempted, demonstrating isolated elements of biological knowledge and understanding but with limited evidence to support the judgement being made.	Basic evaluation of either the effectiveness of Paclitaxel on lung tumours in humans or the effectiveness of Paclitaxel on breast tumours in mice
Level 2	3-4	A scientific judgement is made through the application of relevant evidence, with strengths and weaknesses identified. A conclusion is made, demonstrating linkages to elements of biological knowledge and understanding, with occasional evidence to support the judgement being made.	Basic evaluation of the effectiveness of Paclitaxel on lung tumours in humans and the effectiveness of Paclitaxel on breast tumours in mice OR detailed evaluation of either the effectiveness of Paclitaxel on lung tumours in humans or the effectiveness of Paclitaxel on breast tumours in mice
Level 3	5-6	A scientific judgement is made which is supported throughout by sustained application of relevant evidence from the analysis and interpretation of the scientific information. A conclusion is made, demonstrating sustained linkages to biological knowledge and understanding with evidence to support the judgement being made.	Detailed evaluation of the effectiveness of Paclitaxel on lung tumours in humans and the effectiveness of Paclitaxel on breast tumours in mice

Q26.

Question Number	Answer	Additional guidance	Mark
(a)	C - C D B E A The only correct answer is C *A is not correct because the correct order is C D B E A* *B is not correct because the correct order is C D B E A* *D is not correct because the correct order is C D B E A*		**(1)**

Question Number	Answer	Additional guidance	Mark
(b)(i)	An explanation that includes four of the following points: • DNA content remains constant during {G1 / G2/ mitosis} (1) • the DNA content doubles (1) • due to {DNA / chromosome} replication / S phase / replication (1) • the cell divides / cytokinesis (after 15 hours) (1) • (therefore) it will produce (two) diploid (daughter) cells (1)	ACCEPT DNA content stays at 2 during G1 / DNA content stays at 4 during {G2 / mitosis} ACCEPT DNA content increases {to 4 / by 2} ignore interphase ignore telophase ACCEPT (therefore) it will produce (two) genetically identical (daughter) cells	**(4)**

Question Number	Answer	Additional guidance	Mark
(b)(ii)	An answer that includes the following points: • similar shape graph as mitosis (1) • with a further division line to reduce DNA content to {haploid / 1 a.u.} (1)	Example of graph  	**(2)**

Q27.

Question Number	Answer	Additional guidance	Mark
(a)	correct calculation of magnification	(40 ÷ 4.4 = 9.091) (x) 9.1 reject units	**(1)**

Question Number	Answer	Additional guidance	Mark
(b)	The only correct answer is B 0.20% *A is not correct because* 0.20% *of infected people died* *C is not correct because that is the percentage of infected people whosurvived* *D is not correct because* 0.20% *of infected people died*		**(1)**

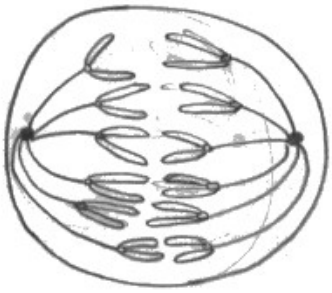
Question Number	Answer	Additional guidance	Mark
(c)(i)	produce ribosomal subunits	Accept produce ribosomes ignore contains genetic material	**(1)**

Question Number	Answer	Additional guidance	Mark
(c)(ii)	A description that includes three from the following points: • plant cell would have {starch (grain) / amyloplast} (instead ofglycogen granule) (1) • plant cell would have cell wall made from cellulose (not chitin)(1) • plant cell would contain {plasmodesmata / one nucleus} (whereas this cell does not) (1) • the plant cell vacuole would be larger (1)	ignore chloroplast accept plant cells do not have glycogengranules accept plant cell would have lignin accept plant cells do not have chitin cellwall ignore pores	**(3)**

Question Number	Answer
(d)	Answers will be credited according to candidate's 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 indicated as relevant. Additional content included in the response must be scientific and relevant. • description of the table data e.g. comparison of numbers of mosquitoes {killed / survived} • consideration of GM fungus being most effective treatment • consideration that most mosquitoes were resistant to the insecticide used / some were not resistant to insecticide and were killed / inheritance of resistance • consideration that resistance arose due to mutation / natural selection / genetic variation in population • as gene is only {switched on / expressed} when the fungus has infected an *Anopheles* mosquito • the toxin is only produced when the fungus has infected an *Anopheles* mosquito • consideration of protein synthesis / detail of the role of rER and Golgi apparatus • evaluation of methodology / limitations of method e.g. mosquitoes escaping, small sample size • consideration of wider effects on biodiversity e.g. toxin will not poison other insects / humans / organisms whereas insecticides would kill other insects / effect on food chains / biodiversity

	• transfer of (spider venom) gene to other fungal species **(6)**		
			Additional guidance
Level 0	0	No awardable content	
Level 1	1-2	Limited scientific judgment made with a few strengths /weaknesses identified. A conclusion may be attempted, demonstrating isolated elements of biological knowledge and understanding but with limited evidence to support the judgement being made.	1 mark – description of results using table data.2 marks consideration of one from: consideration of most effective treatment resistance / inheritance of resistance mutation gene expression protein synthesis limitations of method biodiversity and transfer of gene to other fungi
Level 2	3-4	A scientific judgment is made through the application of relevant evidence, with strengths / weaknesses identified. A conclusion is made, demonstrating linkages to elements ofbiological knowledge and understanding, with occasional evidence to support the judgement being made.	all level one plus: 3 marks – two from list 4 marks – three from list consideration of: consideration of most effective treatment resistance / inheritance of resistance mutation gene expression protein synthesis limitations of method biodiversity and transfer of gene to other fungi
Level 3	5-6	A scientific judgment is made which is supported throughoutby sustained application of relevant evidence from the analysis and interpretation of the scientific information. A conclusion is made, demonstrating sustained linkages tobiological knowledge and understanding, with evidence to support the judgement being made.	all level 2 content 5 marks – consideration of four from the list 6 marks – consideration of five from the list consideration of most effective treatment resistance / inheritance of resistance mutation gene expression protein synthesis limitations of method biodiversity and transfer of gene to other fungi

Q28.

Question Number	Answer	Additional guidance	Mark
(a)(i)	An answer that makes reference to the following points: • centrioles and spindle fibres shown (1) • 6 chromosomes being pulled to each pole (1)	Example of diagram: 	**(2)**

Question Number	Answer	Additional guidance	Mark
(a)(ii)	A calculation in which: • calculation of number of degrees per minute (1) • calculation of number of degrees (including unit) (1)	<u>Example of calculation:</u> $270 \div (9 \times 60) = 0.5°$ $0.5 \times 20 = 10°$ Correct answer scores full marks	**(2)**

Question Number	Answer	Additional guidance	Mark
(b)(i)	• location of gene(s) on a(n Indian muntjac) chromosome	ACCEPT {nucleotide base pairs / allele} for gene ACCEPT chromatid for chromosome	**(1)**

Question Number	Answer	Additional guidance	Mark
(b)(ii)	An explanation that makes reference to the following points: • (egg cells are) haploid (1) • (egg cell chromosomes) have {an altered base sequence / different alleles} (than body cell chromosomes) (1) • due to {(random) mutations (during DNA replication) / crossing over / random assortment / independent assortment} (1)	ACCEPT contain {3 / half the number of} chromosomes do not accept genes ACCEPT chromosomes mutations due to errors in separation of {chromatids / chromosomes}	**(3)**

Question Number	Answer	Additional guidance	Mark
(c)	An answer that makes reference to two of the following points: • (because the parents are) different species (1) • (because {maternal and paternal / 3 and 23}) chromosomes would not pair up (1) • (therefore) cannot make {haploid / sperm / egg} cells (1)	ACCEPT because diploid number (of either species) could not be restored ignore parents have different number of chromosome pairs ACCEPT meiosis cannot occur	**(2)**

Q29.

Question number	Answer	Mark
(a)(i)	• Archaea	**(1)**

Question number	Answer	Mark
(a)(ii)	A diagram that includes any three of the following structures: • circular DNA (1) • plasmid (1) • (70S) ribosomes (1) • membrane (1) • flagellum (1) • pili (1) • capsule (1)	**(3)**

Question number	Answer	Mark
(b)	Answers will be credited according to candidate's 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 indicated as relevant. Additional content included in the response must be scientific and relevant. **Indicative content** • numbers of bacteria increase along the digestive system • *Veillonella* can tolerate only low pHs • *Streptococcus* found in pH 6 - 8 with reasonably high oxygen content • *Streptococcus* requires oxygen for aerobic respiration • *Enterobacterium* can tolerate low oxygen concentrations • *Enterobacterium* requires less ATP or can respire anaerobically • pH affects enzyme activity • pH affects the ionisation of R groups • small change in pH drastically affects enzyme activity	(6)

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

Q30.

Question Number	Answer	Additional guidance	Mark
(a)	A description that includes five from the following points: • (pollen) tube grows down (style) to {ovary / ovule / egg cell / micropyle} • (by releasing) {digestive / hydrolytic} enzymes (1) • the generative nucleus {divides / undergoes mitosis} • to form two {male / haploid} nuclei (1) • one {male / haploid} nucleus fertilises the egg cell (to form thezygote) (1) • one {male / haploid} nucleus fertilises the (two) polar nuclei toform the endosperm (nucleus) (1)	{Male / haploid} only needs to be stated once and then will apply for subsequentmp piece together mp1 Accept pollen tube transports {generative nucleus / male nuclei} downthe style Accept male gamete / sperm nucleus Accept male gamete / sperm nucleus Accept female {nucleus / gamete} foregg cell Accept male gamete / sperm nucleus ignore polar nucleus (singular)	**(5)**

Question Number	Answer	Additional guidance	Mark
(b)	An explanation that includes the following points: • each male nucleus and egg cell nucleus (from silver trumpet trees) is genetically different (from each other) / (each ovule) mayhave been fertilised by {pollen / gamete} from (many) different trees (1) • due to crossing over of {alleles / DNA} (between chromatids) / mutation (1) • due to {independent / random} assortment (of chromosomes)(1) • in meiosis (1)	accept each male and female gamete is genetically different (from each other) accept description of crossing over forming {recombinant chromatids/ different combinations of alleles}	**(4)**

Mark Scheme

Q1.

Question number	Answer	Mark
(a)	• {expressed / observable} characteristics	(1)

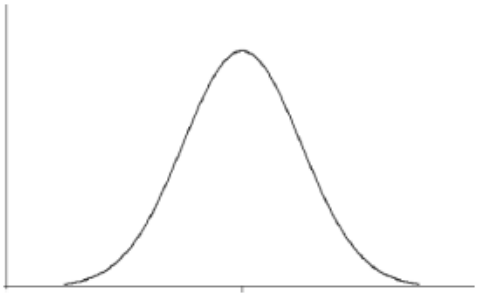
Question number	Answer	Mark
(b)(i)	• genotype	(1)

Question number	Answer	Mark
(b)(ii)	B 1, 4	(1)

Question number	Answer	Mark
(c)(i)	B bar chart, histogram	(1)

Question number	Answer	Mark
(c)(ii)	• calculation of one correct difference (1) or • mean height for male and female calculated Example of calculation: 3.2 ÷ 2.2 = 1.5 3.2 ÷ 2.6 = 1.2 4.0 ÷ 2.2 = 1.8 4.0 ÷ 2.6 = 1.5 3.6 and 2.4 • range of difference given **1.2 – 1.8** (1)	**(2)**

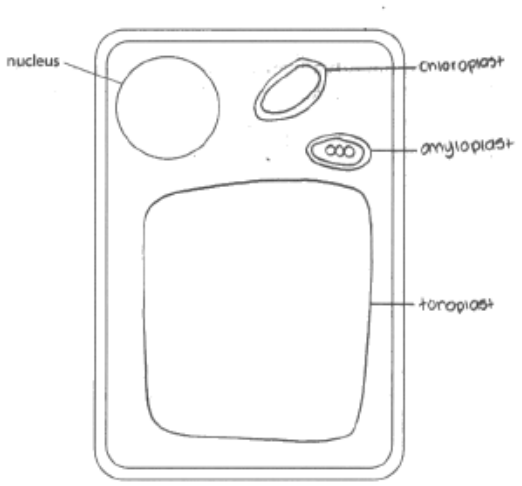
Q2.

Question Number	Answer	Additional guidance	Mark
(a)	• graph showing normal distribution (1) • both axes labelled (1)	Accept peak shifted to left or right Accept suitable labels e.g. phenotype / characteristic / height (cm) on x axis frequency / number of individuals on y axis ignore population <u>Example of graph shape</u> 	**(2)**

Question Number	Answer	Additional guidance	Mark
(b)	An explanation that includes the following points: • (because) mutation resulted in these genes {becoming switched on / being expressed / not beingswitched off / remaining switched on} (1) • {transcription of / (active) mRNA made from} (active tooth production) genes (1) • (therefore) translation (of mRNA) occurs / proteins formed(for teeth development) (1) • (proteins cause) structural change to (beak) cells changes theminto teeth cells (1)	Accept differential gene expression Accept proteins result in (embryo) cells differentiating into teeth cells	**(4)**

Question Number	Answer	Additional guidance	Mark
(c)	A calculation showing the following steps: • calculation of q^2 (1) • value for q (1) • value for p to two decimal places (1)	Mark the answer on answer line firstExample of calculation 140 ÷ 610 = 0.23 √0.23 / 0.48 0.52 Correct answer with no workingscores full marks Allow 52.04% for 3 marks	**(3)**

Q3.

Question Number	Answer	Additional guidance	Mark
(a)	An answer that makes reference to the following points: • amyloplast drawn and labelled (1) • chloroplast drawn and labelled (1) • tonoplast drawn and labelled (1)	<u>Example of diagram</u>  {amyloplast/chloroplast} < nucleus < tonoplast ignore internal details of structure do not accept the wrong location for the structures do not accept double membrane on tonoplast tonoplast label should touch membrane	**(3)**

Question Number	Answer	Additional guidance	Mark
(b)	• modifies and packages {proteins/enzymes} / processes and packages lipids	ACCEPT modifies {proteins/enzymes/lipids} / packages {proteins/enzymes/lipids} do not accept synthesises proteins do not accept ref to proteins being packaged for transport to GA	**(1)**

Question Number	Answer					Mark
(c)						
	Structure	Archaea only	Bacteria only	Eukarya only	More than one domain	
	Cell membrane	☒	☒	☒	☒	
	nucleolus	☒	☒	☒	☒	
	cell wall	☒	☒	☒	☒	
	70S (small) ribosome	☒	☒	☒	☒	**(4)**

Q4.

Question Number	Answer	Additional guidance	Mark
(a)	A calculation showing the following steps: • mass of bran calculated (1) • mass of fibre calculated (1) • correct answer to two significant figures (1)	<u>Example of calculation</u> (48÷100) x 14 = 6.72 (mg) (6.72÷100) x 43 = 2.889 (mg) 2.9 mg Correct answer with no working scores full marks	**(3)**

Question Number	Answer	Additional guidance	Mark
(b)	An explanation that includes the following points: • more sustainable (than oil-based plastic) (1) • biodegradable / can be broken down by decomposers (1) • carbon neutral (1)	ACCEPT ORA for oil-based plastic ACCEPT renewable / can be regrown / available for future generations ALLOW can decompose ACCEPT {does not contribute to /reduces} {greenhouse effect / global warming}	**(3)**

Question Number	Answer	Additional guidance	Mark
(c)	An explanation that includes three of the following points: • pollen tube transports {generative nucleus/male nuclei} to {embryo sac / ovary / micropyle} (1) • (by releasing) digestive enzymes (1) • one of the male nuclei {fertilises / fuses with} the (two) polar nuclei (1) • (causing) the formation of a {<u>3n/ triploid</u>} endosperm (nucleus) (1)	ACCEPT pollen tube transports {generative nucleus/male nuclei} down the style ACCEPT male gamete / sperm nucleus ACCEPT male gamete / {sperm / haploid} nucleus	**(3)**

Q5.

Question Number	Answer	Additional guidance	Mark
(a)	• (adding a stain) allows structures to be seen / {differentiate / increase contrast} between structures	e.g. chromosomes, DNA, lignin, organelles etc ACCEPT show detail more clearly ACCEPT converse argument for specimens which are not stained ignore to make specimens more visible	**(1)**

Question Number	Answer	Additional guidance	Mark
(b)	An explanation that includes four of the following points: • cellulose molecules can be organised into microfibrils. (1) • (due to layers of) {cellulose / microfibrils} arranged in {different directions / a mesh} (1) • {hydrogen bonds in cellulose molecules / hydrogen bonds in microfibrils / layers (of microfibrils) / lignin / secondary thickening / pectate} add {strength / support / stability} (1) • {(cellulose) microfibrils / mesh} held together by {pectin / pectate} (1) • lignin makes {outside of xylem vessels / cell wall} impermeable (to water) (1) • the structure of lignin described (1)	ACCEPT lignin arrangement contributes to {rigidity / flexibility} (of vessel) ACCEPT cellulose microfibrils can't slide over each other ACCEPT lignin makes {cell walls / xylem} waterproof e.g. rings, spirals, ladders	**(4)**

Q6.

Question Number	Answer	Additional guidance	Mark
(a)(i)	• an alternative form of a gene	accept version of a gene	**(1)**

Question Number	Answer	Mark
(a)(ii)	The only correct answer is A ccddee B is not correct because all alleles need to be recessive C is not correct because all alleles need to be recessive D is not correct because all alleles need to be recessive	**(1)**

Question Number	Answer	Additional guidance	Mark
(a)(iii)	A description that includes the following points: • polypeptide chain enters the rER (1) • {secondary/ tertiary} structure formed (1) • polypeptide is packaged into vesicles (by rER) / {(rER) vesicles fuse with / protein enters} Golgi (1) • carbohydrate added (to protein in Golgi) (1) • (glyco)protein is packaged into vesicles (by Golgi) and transported to cell surface membrane (1)	accept 3D structure formed / bonds form between different R groups accept transported in vesicle to the Golgi accept glycosylation occurs (in the Golgi) ignore modification occurs in Golgi without reference to carbohydrate being added accept (glyco)protein is packaged into vesicles (by Golgi) and vesicle fuses with cell surface membrane	**(5)**

Question Number	Answer	Additional guidance	Mark
(b)	An explanation that includes three of the following points: • the greater the number of recessive alleles the lighter the colour of the seed / the greater the number of dominant alleles the deeper the red colour (1) • random assortment and crossing over results in (gamete) variation (1) • random fertilisation (of gametes) results in (seed) variation (1) • low probability of {inheriting 0/6 recessive alleles / egg cell with no recessive alleles being randomly fertilised by sperm cell with no recessive alleles} (1)	accept converse accept correct statement using information from table e.g. linking a colour to number of recessive alleles / linking colour to frequency / normal distribution accept the gametes vary in the number of {recessive/dominant} alleles they contain accept converse for chance of inheriting {3 recessive / 3 dominant} alleles	**(3)**

Q7.

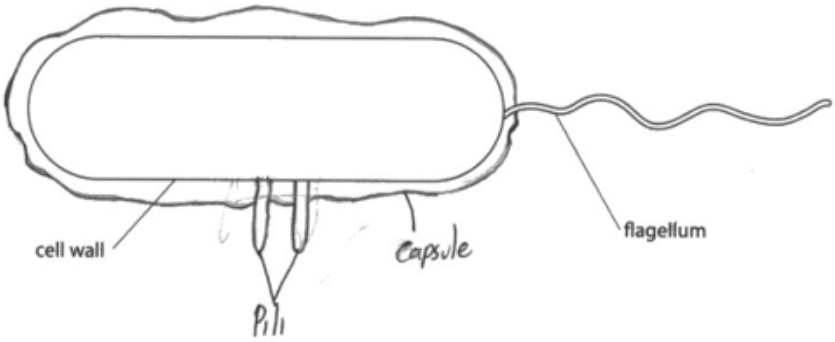
Question Number	Answer	Additional guidance	Mark
(a)(i)	An answer that includes two of the following points: • many genes / genes at different loci (1) • {contribute to / code for} the same {characteristic / trait} (1)	ignore alleles unless correctly qualified Accept different positions on a chromosome	**(2)**

Question Number	Answer	Additional guidance	Mark
(a)(ii)	The only correct answer is B *A is not correct because it does not show a normal distribution* *C is not correct because it does not show a normal distribution* *D is not correct because it does not show a normal distribution*		**(1)**

Question Number	Answer	Additional guidance	Mark
(b)(i)	1.61(m)		**(1)**

Question Number	Answer	Additional guidance	Mark
(b)(ii)	An explanation that includes three of the following points: • {height / phenotype / a characteristic} is also affected by the environment (1) • {malnutrition / lack of nutrients} (1) • example of another environmental factor (which would reduce energy available for growth) (1) • height depends on the combination of alleles inherited (1)	Accept named nutrient Accept (could be taller) due to more nutrients than her parents e.g. disease, lives in very cold climate and more energy used for heat production, idea of excessive exercise, death of child, mutation Accept reverse argument (for child being taller)	**(3)**

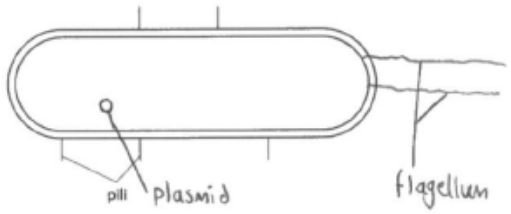
Q8.

Question Number	Answer	Additional guidance	Mark
(a)	An answer that includes the following points: • capsule correctly drawn and labelled (1) • (at least) two pili correctly drawn and labelled (1)	Example of diagram  	**(2)**

Question Number	Answer	Additional guidance	Mark
(b)	An answer that makes reference to four of the following points: • increasing sodium chloride concentrations (above 10 g dm^3) decreases the growth rate (of both bacteria) (1) • (salt concentration between 0-6 g dm^3 caused) an initial {increase / constant} rate (1) • more rapid decrease in *L. piscium* growth rate (1) • *B. thermosphacta* had a larger growth rate (than *L. piscium* at all sodium chloride concentrations) (1) • *B. thermosphacta* was able to continue growing in sodium chloride concentrations above {22-25} g dm^3 whereas *L. piscium* had no growth / *L. piscium* stopped growing at a concentration {38-46} g dm^3 below the concentration that *B. thermosphacta* stopped growing (1) • data is more scattered about the line of best fit for *B. thermosphacta* (than *L. piscium*)	ACCEPT negative correlation (between sodium chloride concentration and growth rate) ACCEPT converse ACCEPT converse Accept *B. thermosphacta* is more {tolerant / resistant} (than *L. piscium*) of higher sodium chloride concentrations Accept *B. thermosphacta* stopped growing at {62-70} g dm^3 whereas *L. piscium* stopped growing at {22-24} g dm^3 ACCEPT converse	**(4)**

Q9.

Question Number	Answer	Mark
(a)	The only correct answer is C two A is not correct because eukarya does not contain prokaryotic organisms B is not correct because both archaea and bacteria contain prokaryotic organisms D is not correct because both archaea and bacteria contain prokaryotic organisms	(1)

Question Number	Answer	Additional guidance	Mark
(b)(i)	An answer that makes reference to the following point: • flagellum drawn with origin on cell membrane and labelled (1) • plasmid drawn and labelled (1)	Example of diagram  	(2)

Question Number	Answer	Additional guidance	Mark
(b)(ii)	• contains {genes / DNA / (genetic) information} to make proteins	Accept to enable horizontal transfer of (genetic) information / used to exchange (genetic) information with other (prokaryotic) cells Accept contains {DNA / (genetic) information} for antibiotic resistance	(1)

Question Number	Answer	Additional guidance	Mark
(c)(i)	An answer that makes reference to the following point: • prokaryotic ribosomes are {70S / small} whereas eukaryotic are {80S / large}	Accept {fewer / only three} strands of rRNA in prokaryote (four in eukaryote) Accept all prokaryotic ribosomes are free floating whereas some eukaryotic ribosomes are attached to membranes	(1)

Question Number	Answer	Mark
(c)(ii)	The only correct answer is B one A is not correct because ribosomes are located inside chloroplasts and mitochondria C is not correct because ribosomes are located on rER and are involved in translation D is not correct because ribosomes are located on rER and are involved in translation	(1)

Q10.

Question Number	Answer
* (a)	Answers will be credited according to candidate's 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 indicated as relevant. Additional content included in the response must be scientific and relevant. • description of table data e.g., the more dominant alleles present in the zygote increases the darkness of the skin, • description of polygenic inheritance • recognition that {3 genes / 6 alleles} involved with this phenotype / each gamete contains 3 alleles involved with this phenotype • description of graph data • e.g., phenotype shows normal distribution / phenotype shows continuous variation • e.g., offspring have highest probability of inheriting {3 dominant alleles/medium skin colour} • consideration that large variation due to crossing over of {genetic material / allele / DNA} in prophase I • description of crossing over • consideration that large variation due to random assortment of chromosomes in metaphase I • description of random assortment • consideration that random fertilisation of genetically different gametes increases variation • consideration of probability of different types of mutation e.g., silent • consideration of {environmental variation / mutation} increasing variation e.g. sun tan, DNA methylation • explanation of how {environmental variation / mutation} would increase variation e.g. pigment production **(6)**

			Additional guidance
Level 0	0	No awardable content	
Level 1	1-2	Limited number of the most important or relevant scientific factors from the data/information provided are synthesised. No judgement is made.	1-2 sections
Level 2	3-4	Some of the most important or relevant scientific factors from the data/information provided are synthesised. A limited accurate judgement is made.	3-4 sections
Level 3	5-6	Most of the important or relevant scientific factors from the data/information provided are synthesised. A detailed and accurate judgement is made.	5-6 sections

Question Number	Answer	Additional guidance	Mark
(b)	An answer that makes reference to two of the following points: • {increased/ more} exposure to {UV/sun} light (would result in a darker skin tone) (1) • mutation could result in {production of a protein which would result in a darker skin tone / fewer melanocytes} (1) • limited food source containing materials for pigment synthesis / disease killing pigment cells (1)	ignore different exposure to sunlight ignore may be using fake tan (unless qualified with a drug form) ACCEPT mutation may have occurred ACCEPT epigenetic modification ACCEPT skin cancer / disease	**(2)**

Q11.

Question Number	Answer	Additional guidance	Mark
(a)(i)	The only correct answer is C - R *A is not correct because ribosomes are not produced in cytoplasm* *B is not correct because ribosomes are not produced in endoplasmic reticulum* *D is not correct because ribosomes are not produced in the nuclear membrane*		**(1)**

Question Number	Answer	Additional guidance	Mark
(a)(ii)	An answer that includes two of the following points: • viewed from a different angle / one was transverse and one is longitudinal (1) • when the cell was {sliced / cut} (1) • different sizes due to different stages of {growth / development} (1)	Accept when the mitochondria / structure {T / U} was {sliced / cut}	**(2)**

Question Number	Answer	Additional guidance	Mark
(a)(iii)	A calculation showing the following steps: • conversion of units (1) • calculation of magnification (1)	Example of calculation: 52 × 1000 = 52 000 (52 000 ÷ 3.0) = (×) 17300 / 17333/ 17333.3 Correct answer with no working shown scores full marks Incorrect unit loses one mark	**(2)**

Question Number	Answer	Additional guidance	Mark
(b)	A description that includes the following points: • rER packages insulin (protein) in vesicle (1) • vesicle fuses to become part of Golgi apparatus and insulin (protein) {enters Golgi apparatus / is modified} (1) • Golgi packages insulin (protein) in (secretory) vesicle / vesicle containing insulin (protein) pinched off Golgi (1) • (secretory) vesicles fuse with the cell (surface) membrane (1) • the insulin (protein) exits (beta cell) via exocytosis (1)		**(5)**

Question Number	Answer	Additional guidance	Mark
(c)	An explanation that includes the following points: • cell specialisation (1) • because gene (for insulin production) switched off in (other pancreas cells) due to {epigenetic modification / DNA methylation / histone modification} (1) • because gene (for insulin production) {active / switched on / expressed} in these (beta) cells (1) • therefore transcription of (active insulin) gene / (active) mRNA produced (1) • translation of (active) mRNA leads to synthesis of insulin protein (1)	Accept differential gene expression in these cells Accept transcription of insulin gene only occurs in beta cells Accept reverse argument for other pancreas cells Accept reverse argument for other pancreas cells	**(5)**

Q12.

Question Number	Answer	Additional guidance	Mark
(a)(i)	• calculation of surface area and volume (1) • correct ratio (1)	**Example of calculation:** surface area = $6 \times 2.5^2 = 37.5$ volume = $2.5^3 = 15.625$ 2.4:1 ECF applies Correct answer with no workingshown scores full marks	**(2)**

Question Number	Answer	Additional guidance	Mark
(a)(ii)	An answer that includes the following point: • place where {organisms / species} live (1)		**(1)**

Question Number	Answer	Additional guidance	Mark
(a)(iii)	An answer that includes the following point: • organisms that can reproduce with others to formfertile offspring (1)		**(1)**

Question Number	Answer	Additional guidance	Mark
(b)	An answer that includes one of the following points: • (inheritance of) {many/multiple/several/different} genes {contribute to / code for} height (of wombat) (1) • genes at different loci {contribute to / code for} height(of wombat) (1)	Accept different positions on a chromosome	**(1)**

Question Number	Answer	Additional guidance	Mark
(c)	A description that includes two of the following points: • {long/sharp} claws / large paws (for digging) (1) • {short / powerful} legs (for digging) (1) • ears face backwards / small eyes (so don't fill with soil)(1)	ACCEPT big feet / long nails ACCEPT short ears / large pupils	**(2)**

Q13.

Question Number	Answer	Additional guidance	Mark
(a)(i)	The only correct answer is D 1.6×10^3 µm *B is incorrect because the diameter is 1.6×10^3 µm* *C is incorrect because the diameter is 1.6×10^3 µm* *D is incorrect because the diameter is 1.6×10^3 µm*		**(1)**

Question Number	Answer	Additional guidance	Mark
(a)(ii)	A calculation showing the following steps: • correct volume from frog egg cell (1) • correct calculation (1) • correct calculated answer to 2 significant figures (1)	Mark the answer on answer line first Example of calculation v of frog (=4/3 ∏ 800^3) = 2.14 x 10^9 (2.14 x 10^9) ÷ 1.8 x 10^6 = 1189 Allow ECF = 1200 times larger Correct answer (1200 or 1.2 x10^3) to 2 sig figs with no working gains full marks	(3)

Question Number	Answer	Additional guidance	Mark
(b)	An explanation that makes reference to four of the following: • egg cell contains {23 chromosomes/ half the genetic material of the skin cell} / egg cell is haploid (whereas skin cell is diploid) (1) • (therefore) fertilisation can occur to form a {diploid cell / zygote} (1) • (the egg cell genetic material is different from the skin cell) due to meiosis (1) • (the egg cell genetic material is different from the skin cell) due to crossing over (1) • (the egg cell genetic material is different from the skin cell) due to {random / independent} assortment (of homologous chromosomes) (1)	Accept {full set / original number} of chromosomes formed after fertilisation Accept fusion of nuclei Accept egg cell is formed by meiosis	(4)

Q14.

Question number	Answer	Mark
(a)	C they can produce some types of cell	(1)

Question number	Answer	Mark
(b)	A description that includes the following points: • ribosomes involved in translation resulting in two different polypeptides (1) • endoplasmic reticulum involved in folding each polypeptide into tertiary structure (1) • endoplasmic reticulum involved in transporting each polypeptide (1)	(3)

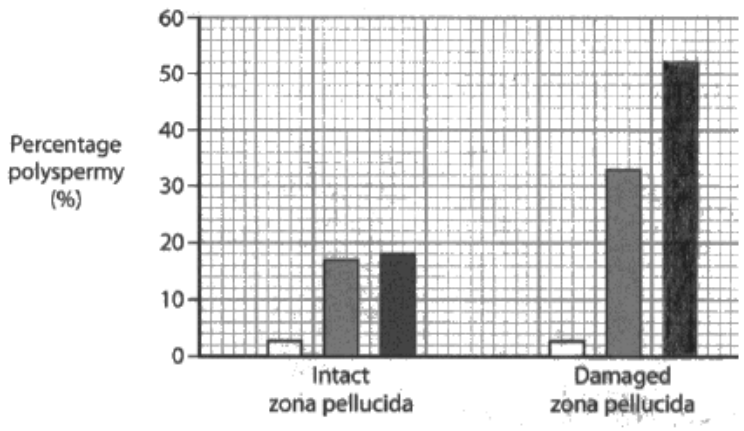
Question number	Answer	Mark
(c)(i)	A description that includes the following points: • α polypeptide increases to maximum by 6 months before birth and then stays constant (1) • β polypeptide rises slowly during pregnancy but then increases rapidly after birth (1) • γ polypeptide increases to maximum by 6 months before birth and then drops rapidly after birth (1)	(3)

Question number	Answer	Additional guidance	Mark
(c)(ii)	An explanation that includes the following points: • gene for α polypeptide remains switched on as this polypeptide is present both before and after birth (1) • gene for γ polypeptide is switched off at birth so levels fall (1) • gene for β polypeptide switched on during pregnancy so levels rise (1) • credit given for an epigenetic mechanism that switches {on / off} gene expression (1)	For example, {DNA / histone} methylation switches off {genes / gene for γ polypeptide} or transcription factors switch on {genes / gene for β polypeptide}	(4)

Q15.

Question Number	Answer	Additional guidance	Mark
(a)	An answer that makes reference to the following points: • packaged into a (secretory) vesicle by the Golgi {apparatus / body} (1) • (vesicle) fuses with cell surface membrane to release them outside of the cell (1)	ACCEPT transported from the Golgi {apparatus / body} in (secretory) vesicles ACCEPT exocytosis ACCEPT exocytosis in wrong context e.g. acrosomes	(2)

Question Number	Answer	Additional guidance	Mark
(b)	An answer that makes reference to the following points: • individual sperm have slower speeds than bundled sperm (in all resistances) (1) • increase in resistance (above 0.5) decreased the speed of individual sperm more than bundled sperm / individual sperm speed decreases with increased resistance whereas bundled sperm speed {increases / stays relatively constant} (1) • (because) {bundles of sperm / more flagella} can generate more force (1) • {lower confidence / no significant difference} in results for 0.5 resistance due to overlap of {SD / error / range} bars / resistance has little effect on the speed of the sperm bundle as the error bars for each of the resistance overlap (1)	ACCEPT converse ACCEPT {largest / quoted comparative} difference in speed at 4.0 resistance / bundled sperm have double the speed at 4.0 resistance ACCEPT converse ACCEPT converse for other viscosities	**(4)**

Question Number	Answer	Additional guidance	Mark
(c)(i)	• correctly plotted bar with shading (1)		**(1)**

Question Number	Answer	Additional guidance	Mark
(c)(ii)	An explanation that makes reference to four of the following points: • there was more polyspermy of egg cells when the zona pellucida was damaged / converse for intact zona pellucida (1) • due to cortical reactions only occurring over some part of the egg cell (1) • (therefore some) areas of the egg cell not being covered by a hardened zona pellucida (1) • there was more polyspermy of egg cells with a higher sperm concentration • increased sperm cell concentration increased the likelihood of sperm cells entering {egg cell before cortical reaction occurred / through gap in hardened zona pellucida} (1)	ACCEPT {fewer/no} cortical reactions (with damaged zona pellucida) / converse for intact zona pellucida ACCEPT (therefore damaged) zona pellucida does not {harden / thicken} / converse for intact zona pellucida ACCEPT increased sperm cell concentration increased the {concentration of digestive enzymes / rate of digestion of zona pellucida} ignore increased {concentration / damaged to zona pellucida} increases number of sperm reaching the egg cell	**(4)**

Q16.

Question Number	Answer	Additional guidance	Mark
(a)	An explanation that includes the following points: • they are all (genetically identical due to being) derived from the **zygote** (cell) (1) • {DNA/ chromosomes} are replicated (in interphase / in semi-conservative replication) (1) • (therefore) each cell receives one identical copy of each {strand of DNA / chromosome} (1)	Accept the cells have divided by mitosis / mitosis results in daughter cells that are genetically identical ignore genetic material	**(2)**

Question Number	Answer	Additional guidance	Mark
(b)(i)	blastocyst		**(1)**

Question Number	Answer	Additional guidance	Mark
(b)(ii)	An answer that includes the following points: • pluripotent stem cells have the ability to differentiate into {most cells types / heart (muscle) cells} (1) • replace the dead heart (muscle) cells / so the heart will have improved function (1)	Accept repair damage caused (to the heart muscle) by the heart attack ignore repair heart muscle cells ignore references to regeneration	**(2)**

Q17.

Question Number	Answer Additional guidance	Mark
(a)(i)	The only correct answer is B one *A is not correct because the first statement is correct* *C is not correct because the generative nucleus divides to form two haploid male gametes* *D is not correct because the generative nucleus divides to form two haploid male gametes*	**(1)**

Question Number	Answer	Additional guidance	Mark
(a)(ii)	• surface area calculated (1) • difference in standard form with units (1)	4.128 (μm^2) 9.02×10^{-1} μm^2	**(2)**

Question Number	Answer	Additional guidance	Mark
(b)	A description that makes reference to the following points: • differential gene expression (1) • by {epigenetic modification / histone modification / DNA methylation} (1) • {proteins / enzymes} synthesised (from active genes) which (permanently) modify the cell (1) • description of modification to become a sclerenchyma cell	ACCEPT only some genes are {active / switched on} / some genes are switched off ACCEPT {proteins / enzymes} {made / synthesised} produce a {structural / functional / metabolic} change e.g. synthesis of {cellulose/ microfibrils / lignin} / secondary thickening / lignification of cell walls	**(4)**

Question Number	Answer	Additional guidance	Mark
(c)	An answer that makes reference to four of the following points: • meiosis increases genetic variation / crossing over and {random / independent} assortment occur in meiosis (1) • the {genes / alleles / loci} for colour and grain length are linked (1) • (therefore alleles for these traits) will be inherited together / (therefore alleles for these traits) unlikely to be separated during crossing over (1) • the {genes / alleles / loci} for pea pod wrinkles and {colour/grain length} are not linked (1) • (therefore) the alleles for these traits will be inherited independently due to independent assortment (1)	ACCEPT meiosis results in haploid cells ACCEPT linkage is when {genes / alleles} are close together on the same chromosome ACCEPT allele for this trait may be separated from {colour/grain length/ other alleles} due to independent assortment	**(4)**

Q18.

Question Number	Answer	Additional guidance	Mark
(a)(i)	• to make the {chromosomes / chromatids} visible (1)	Accept DNA ignore organelles / cells	**(1)**

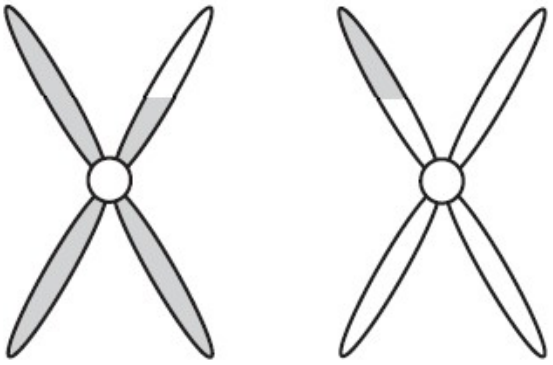
Question Number	Answer	Additional guidance	Mark
(a)(ii)	The only correct answer is C R *A is not correct because the cell is in telophase* *B is not correct because the cell is in prophase* *D is not correct because the cell is in anaphase*		**(1)**

Question Number	Answer	Additional guidance	Mark
(a)(iii)	• addition (1) • correct calculation (1)	Example of calculation: 33 and 150 (33 ÷ 150) x 100=22 (%) or (33 ÷ 150) = 0.22 Correct answer with no working shown scores full marks	**(2)**

Question Number	Answer	Additional guidance	Mark
(b)	An answer that includes the following points: • (tendrils coiling) {secures / gives support to} the pea shoot / prevents the pea shoot falling over (1) • allows the pea plant to {grow taller / climb higher} (than other plants) (1) • (therefore) the pea plant will {outcompete other plants / absorb more light (energy) / carry out more photosynthesis} (1)	Accept allows the plant to climb up other {plants / structures} Accept allows the pea plant to divert fewer resources into {strengthening stem / producing (named) supporting tissue (in stem)} ignore increase surface area	**(3)**

Question Number	Answer	Additional guidance	Mark
(c)	An explanation that includes the following points: • independent assortment (of chromatids) (1) • will result in {mixture of (maternal and paternal) chromatids / different combination of alleles} in the gametes (1) • which gametes are involved (in fertilisation) are random (1)	Accept random assortment Accept chromosomes	(3)

Q19.

Question Number	Answer	Additional guidance	Mark
(a)	An answer in which: • crossing over section shaded correctly (1) • non crossing over sections shaded correctly (1)		(2)

Question Number	Answer	Mark
(b)(i)	The only correct answer is B Q *A is incorrect because that cell is in metaphase* *C is incorrect because that cell is in anaphase* *D is incorrect because that cell is in telophase*	(1)

Question Number	Answer	Additional guidance	Mark
(b)(ii)	0.5 / half / ½ (hour)	ALLOW answer 30 **minutes** if clear	(1)

Question Number	Answer	Additional guidance	Mark
(b)(iii)	256		**(1)**

Question Number	Answer	Mark
(c)(i)	The only correct answer is A anaphase *B is incorrect because spindle fibres do not shorten in metaphase* *C is incorrect because spindle fibres do not shorten in prophase* *D is incorrect because spindle fibres do not shorten in telophase*	**(1)**

Question Number	Answer	Additional guidance	Mark
(c)(ii)	An answer that makes reference to the following: • Vincristine is the most effective and SRT1720 is the least effective (when given on their own) (1) • Resveratrol reduces the effectiveness of Vincristine / Vincristine increases the effectiveness of Resveratrol (1) • SRT1720 increases the effectiveness of Vincristine / Vincristine and SRT1720 is the most effective treatment (tested) (1) • comment on variability of data (1)	Accept description of correct order (V>R>SRT) Ignore drug combinations Accept Resveratrol and Vincristine more effective than Resveratrol by itself / Resveratrol and Vincristine less effective than Vincristine by itself e.g. {range / SD / error} bars do not overlap / size of error bars	**(4)**

Q20.

Question Number	Answer	Additional guidance	Mark
(a)(i)	• Tabebuia		**(1)**

Question Number	Answer	Mark
(a)(ii)	The only correct answer is A amyloplast *B is incorrect because middle lamella is not a structure that stores starch* *C is incorrect because plasmodesmata is not a structure that stores starch* *D is incorrect because tonoplast is not a structure that stores starch*	**(1)**

Question Number	Answer	Additional guidance	Mark
(b)(i)	An answer that includes the following points: • slime capsule prevents dehydration of cell (1) • pili allow bacteria to adhere (to surfaces) (1)	Accept protection of cell from a correct factor e.g. {white blood cells / phagocytes / antibodies / antibiotics / from harsh conditions} Accept conjugation / exchange of genetic information / exchange plasmids / attachment Ignore sexual reproduction	**(2)**

Question Number	Answer
(b)(ii)	Answers will be credited according to candidate's 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 indicated as relevant. Additional content included in the response must be scientific and relevant. • compound needs to be extracted from trees and used to make a drug • compounds tested on *Y. pestis in vitro* • tested on {animals / human cells} • (phase 1 / preliminary) (small scale) tests on healthy {people / volunteers} • review by independent {scientists / medics} to see if work can progress to stage 2 • (phase 2) - drug tested on {small / 100 to 500} groups of {patients / people} who have the {plague / disease} • appropriate concentrations identified • (phase 3) - drug tested on {larger groups of / 1000 to 3000} {patients / people} who have the plague • placed randomly in two groups - one group receives {treatment / drug containing the chemical compounds} and the other receives placebo • double blind test • analyse results with (appropriate) statistical test / test for significant difference **(6)**

			Additional guidance
Level 0	0	No awardable content	
Level 1	1-2	Demonstrates isolated elements of biological knowledge related to the given context with generalised comments made. The description will contain basic information with some attempt made to link knowledge and understanding to the given context.	outline of drug test given but no reference to either the plague or *Y. pestis* or bacteria core prac only = 1 mark other human drug trial = 2 marks
Level 2	3-4	Demonstrates adequate knowledge by selecting and applying some relevant biological facts/concepts to provide the description being presented. The description shows some linkages and lines of scientific reasoning with some structure.	Testing on {animal / human cells} plus at least two other phases correctly described In context of people having the disease / plague or *Y. pestis* or bacteria gives lower mark plus reference to double blind test or placebos gives higher mark
Level 3	5-6	Demonstrates comprehensive knowledge by selecting and applying relevant knowledge of biological facts/concepts to provide the description being presented. The description is clear, coherent and logically structured.	Testing on {animal / human cells} plus three phases correctly described including double blind test and placebos In context of people having the disease / plague or *Y. pestis* or bacteria gives lower mark plus correct ref to use of stats / analysis of significant difference to placebo gives higher mark
			or in vitro testing of drug on *Y. pestis* or bacteria gives higher mark

Q21.

Question Number	Answer	Mark
(a)(i)	The only correct answer is B heterozygosity index *A is incorrect because the Hardy-Weinberg equation is not used to calculate genetic diversity* *C is incorrect because index of diversity is not used to calculate genetic diversity* *D is incorrect because mitotic index is not used to calculate genetic diversity*	**(1)**

Question Number	Answer	Additional guidance	Mark
(a)(ii)	An answer that makes reference to the following: • genetic diversity considers one species whereas species richness considers {different / number of} species (1)	Mark as a whole Accept genetic diversity considers one population whereas species richness considers {one habitat / several populations}	**(2)**
	• genetic diversity considers {alleles / genotypes} whereas species richness {is within a habitat / considers whole organisms / counts number of species (in an area)} (1)	Accept gene pool Ignore genes Accept specific area / ecosystem	

Question Number	Answer	Additional guidance	Mark
(b)	An answer that makes reference to two of the following: • can store more seeds as they {take up less space / are smaller} (1) • seeds need less {maintenance / cost} (1) • seeds can {survive longer than plants / be frozen} (1)	Accept growing plants takes up more space Accept more seeds stored aids maintenance of genetic diversity Accept converse for plants Accept seeds can be stored for longer	**(2)**

Question Number	Answer	Additional guidance	Mark
(c)(i)	A calculation showing the following steps: • correct difference (1) • correct percentage increase (1)	Mark the answer on answer line first <u>Example of calculation:</u> $8.2 - 3.3$ / $8.2\times10^5 - 3.3\times10^5$ / 4.9 / 4.9×10^5 / 490000 $(4.9 \div 3.3) \times 100 = 148$ / 148.48 / 148.5 Correct answer (148 / 148.48 / 148.5) with no working shown gains full marks Accept for one mark only 59.8 / 59.756 / 59.76 / 60	**(2)**

Question Number	Answer	Additional guidance	Mark
(c)(ii)	An explanation that makes reference to four of the following: • (all Cavendish plants) are susceptible to the fungus because they are {genetically identical / clones} (1) • whereas different varieties may have resistance to the fungus / contain an allele for resistance (to fungus) (1) • (therefore breeding could) increase genetic {diversity / variation} (1) • resulting in (new banana) plants with resistance to {fungus / Panama disease} (1)	Ignore mutations / immunity Accept do not contain an allele for resistance (to fungus) Accept contain an advantageous allele Ignore 'genes' unless qualified with alleles Accept increase gene pool Accept {offspring / new varieties} survive and reproduce	**(4)**

Q22.

Question Number	Answer	Additional guidance	Mark
(a)	The correct answer is **C** Y *A is incorrect because the nucleus contains the genetic information used in the synthesis of acrosomal enzymes* *B is incorrect because the nucleus contains the genetic information used in the synthesis of acrosomal enzymes* *D is incorrect because the nucleus contains the genetic information used in the synthesis of acrosomal enzymes*		**(1)**

Question Number	Answer	Additional guidance	Mark
(b)	• morula		**(1)**

Question Number	Answer	Additional guidance	Mark
(c)(i)	A description that makes reference to one of the following pairs: Either: • DNA methylation / adds methyl groups to **DNA** (1) • (DNA methylation) causes the {switching off / silencing} of gene(s) (1) Or: • histone modification / {methylation / phosphorylation/ acetylation} of histone (1) • (histone modification) causes the {switching off / silencing / activation} of gene(s) / (1)	 Accept prevents {transcription / expression} of gene(s) Accept activates genes Accept ubiquitylation / sumoylation Accept prevents {transcription / expression} of gene(s) / allows {transcription / expression} of gene(s)	 **(2)**

Question Number	Answer	Additional guidance	Mark
(c)(ii)	An explanation that makes reference to the following: • transcription of active genes / active mRNA produced (1) • therefore {certain / specific} proteins produced / (1) • these proteins {determine / change} cell {structure / function} (1)	 Accept named example Accept translation at the ribosomes produces proteins Accept description Ignore modifies the cell unqualified	 **(3)**

Question Number	Answer
(d)	Answers will be credited according to candidate's 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 indicated as relevant. Additional content included in the response must be scientific and relevant. Basic information • genotype is shown by the different allele combinations • the gene has {multiple / four} alleles • one copy of each allele is inherited from each {parent / gamete} • phenotype is the result of interaction between the genotype and the environment / phenotype can sometimes just be determined by genotype • fur colour is affected by {genotype /allele combinations} and the {environment /(body) temperature} • colour may be camouflage Enzyme production • the {gene / alleles} code(s) for the production of an enzyme involved in producing fur colour • (active) mRNA is produced from the allele(s) leading to synthesis of {protein / enzyme} Black rabbit • black rabbit has the dominant allele (C) / is homozygous dominant / heterozygous dominant • C is the dominant allele Albino rabbit • albino has recessive alleles / is homozygous recessive Himalayan linked to enzyme • {Himalayan albino / c^hc^h, c^hc^a} produce the enzyme which becomes inactive at high temperatures • the enzyme must be involved in producing the dark colour of the fur Himalayan explanation • the colour is not produced at body temperatures in Himalayan albino, causing the {warmer part of the body to have white fur / cooler parts of the body to have dark fur} **(6)**

			Additional guidance
Level 0	0	No awardable content	
Level 1	1-2	Demonstrates isolated elements of biological knowledge and understanding to the given context with generalised comments made. Vague statements related to consequences are made with limited linkage to a range of scientific ideas, processes, techniques and procedures. The discussion will contain basic information with some attempt made to link knowledge and understanding to the given context.	1 aspect correctly discussed with some attempt made to link knowledge and understanding to the given context = 1 mark 2 aspects correctly discussed with some attempt made to link knowledge and understanding to the given context = 2 marks
Level 2	3-4	Demonstrates adequate knowledge and understanding by selecting and applying some relevant biological facts / concepts. Consequences are discussed which are occasionally supported through linkage to a range of scientific ideas, processes, techniques and procedures. The discussion shows some linkages and lines of scientific reasoning with some structure.	3 aspects correctly discussed which some linkages and lines of scientific reasoning with some structure = 3 marks 4 aspects correctly discussed which some linkages and lines of scientific reasoning with some structure = 4 marks
Level 3	5-6	Demonstrates comprehensive knowledge and understanding by selecting and applying relevant knowledge of biological facts / concepts. Consequences are discussed which are supported throughout by sustained linkage to a range of scientific ideas, processes, techniques and procedures. The discussion shows a well-developed and sustained line of scientific reasoning which is clear and logically structured.	A well-developed and sustained line of scientific reasoning for 5 of the 6 aspects which is clear and logically structured = 5 marks A well-developed and sustained line of scientific reasoning for all 6 aspects which is clear and logically structured = 6 marks

Q23.

Question Number	Answer	Mark
(a)(i)	The only correct answer is B Golgi apparatus *A is incorrect because centrioles do not have several curved membrane-bound sacs of decreasing size* *C is incorrect because rough endoplasmic reticulum does not have several curved membrane-bound sacs of decreasing size* *D is incorrect because smooth endoplasmic reticulum does not have several curved membrane-bound sacs of decreasing size*	**(1)**

Question Number	Answer	Additional guidance	Mark
(a)(ii)	An explanation that includes the following points: • the {magnification / resolution} of a light microscope is not high enough (to see this organelle) (1) • because it is very small (1)	Accept higher {magnification / resolution} of electron microscope is needed to see this organelle Accept small	**(2)**

Question Number	Answer	Additional guidance	Mark
(a)(iii)	An answer that includes the following points: • organ has many functions whereas a tissue has {one / fewer} (1) • organ has {many / several / group of} {cell types / tissues} wherea a tissue has {one cell type / similar cells } (1)	Do not piece together	**(2)**

Question Number	Answer	Additional guidance	Mark
(b)	An answer that includes two of the following: • cilia (1) • glycogen (granules) (1) • flagella (1)	Accept centrioles, lysosomes Ignore vesicles, temporary vacuoles	**(2)**

Question Number	Answer	Additional guidance	Mark
(c)	An explanation that includes four of the following points: • (the percentage of) labelled amino acids {decreases inside the cell / increases outside the cells} (1) • polypeptide is packaged into vesicles by rER / {(rER) vesicles fuse with / protein enters} Golgi (1) • {protein is modified / carbohydrate added to protein} (in Golgi) (1) • (enzyme(s) / glycoprotein(s)) packaged into (secretory) vesicles (by Golgi) (1) • {enzyme(s) / (glyco)protein(s)} leave cell by exocytosis / some (intracellular) {enzyme(s) / (glyco)protein(s)} remain in cells (1)	Accept green fluorescence Accept modified proteins ignore amino acids Accept vesicles fuse with cell (surface) membrane and release {enzyme(s) / (glyco)protein(s)} outside cell ignore amino acids	**(4)**

Q24.

Question Number	Answer	Additional guidance	Mark
(a)(i)	An answer that includes one of the following points: • (analysis of/ comparison of/ similarities in / differencesin) {DNA / RNA / proteins / amino acid sequences / enzymes / ribosomes / membrane components / cell wall components} (1)	ACCEPT patterns in non-coding DNA ACCEPT genes ignore organelles	**(1)**

Question Number	Answer	Additional guidance	Mark
(a)(ii)	A description that includes three of the following points: • peer review (1) • repetition of experiments (by other scientists to see if samedata are collected) (1) • {analysis / evaluation / discussion / comparison} of data (1)	ACCEPT extend the analysis e.g. look for {similarities / differences} in moregenes (1)	**(2)**

Q	Answer	Mark
(b)	one mark for each correct row	**(4)**

Feature	Archaea only	Archaea and Bacteria only	Archaea and Eukarya only	Archaea and Bacteria and Eukarya
absence of a nuclear envelope		☒		
presence of circular DNA				☒
presence of a cell membrane				☒
presence of ribosomes				☒

Q25.

Question Number	Answer	Mark
(a)(i)	The only correct answer is B covered in 80S (large) ribosomes *A is not correct because rER is covered in 80S (large) ribosomes* *C is not correct because rER forms vesicles containing polypeptides* *D is not correct because rER forms vesicles containing polypeptides*	**(1)**

Question Number	Answer	Additional guidance	Mark
(a)(ii)	An answer that includes the following point: • (smooth endoplasmic reticulum synthesises) lipid /steroids / named steroid hormone	ACCEPT hormones IGNORE (named) peptide hormone	**(1)**

Question Number	Answer	Additional guidance	Mark
(a)(iii)	A description that includes the following points: • nucleolus (1) • named genetic material (1)	ACCEPT ribosomes / rRNA e.g. DNA / chromatin / chromatid / chromosomes / nucleosome / mRNA ACCEPT histones	**(2)**

Question Number	Answer	Additional guidance	Mark
(b)	An explanation that includes the following points: • because of water uptake / increased {volume of cytoplasm / size of vacuole} (1) • (increase in size due to) {synthesis/production} of {organelles / (named) proteins / enzymes} (1) • therefore {synthesis/production} of {new/more} cell {membrane / wall} (1)	ACCEPT organelles increase in size	**(3)**

Q26.

Question Number	Answer	Additional guidance	Mark
(a)(i)	The only correct answer is B X *A is not correct because W is chromosomal DNA / nucleoid* *C is not correct because Y is a pilus* *D is not correct because Z is the cell wall*		**(1)**

Question Number	Answer	Additional guidance	Mark
(a)(ii)	The only correct answer is C Y *A is not correct because V is a ribosome* *B is not correct because X is a plasmid* *D is not correct because Z is the cell wall*		**(1)**

Question Number	Answer	Additional guidance	Mark
(a)(iii)	An answer that includes one of the following points: • ribosomes in prokaryotic cells are smaller (than those in eukaryotic cells) (1) Or • ribosomes in prokaryotic cells are 70S whereas those in eukaryotic cells are 80S (1)	Accept ribosomes in prokaryotic cells contain less RNA (than those in eukaryotic cells)	**(1)**

Question Number	Answer	Additional guidance	Mark
(b)	An answer that includes the following points: • (capsule) prevents dehydration of cell (1) • (flagellum) for (cell) motility (1)	Mark first answer Accept capsule has adhesive properties / covers antigens / protection of cell from a correct factor e.g. {bacteriophages / phagocytes / antibodies / antibiotics / (described) harsh conditions} Accept movement of cell	**(2)**

Q27.

Question number	Answer	Mark
(a)	A J	(1)

Question number	Answer	Additional guidance	Mark
(b)	An explanation that includes the following points: • because this structure is very small (1) • and only an electron microscope has the ability to magnify this much (1)	Accept converse statement	(2)

Question number	Answer	Mark
(c)	An explanation that includes the following points: • because the two membranes are very close together (1) • and the resolution of this microscope is not high enough (1)	(2)

Question number	Answer	Mark
(d)(i)	An explanation that includes the following points: • mitosis results in two cells that each have a nucleus (1) • each bud contains a full set of chromosomes (1) • so the buds are genetically identical to the parent yeast cell (1)	(3)

Question number	Answer	Mark
(d)(ii)	An answer that includes the following points: • because new cell structures need to be made in order for the bud to grow (1) • therefore oxygen is needed to produce the ATP (1) • therefore {glucose is needed to produce the ATP / amino acids are needed to make proteins} (1)	(3)

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