



Mark Scheme (Results)

General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.
- Mark schemes will indicate within the table where, and which strands of QWC, are being assessed. The strands are as follows:
 - i) ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear
 - ii) select and use a form and style of writing appropriate to purpose and to complex subject matter
 - iii) organise information clearly and coherently, using specialist vocabulary when appropriate

Using the Mark Scheme

Examiners should look for qualities to reward rather than faults to penalise. This does NOT mean giving credit for incorrect or inadequate answers, but it does mean allowing candidates to be rewarded for answers showing correct application of principles and knowledge. Examiners should therefore read carefully and consider every response: even if it is not what is expected it may be worthy of credit.

The mark scheme gives examiners:

- an idea of the types of response expected
- how individual marks are to be awarded
- the total mark for each question
- examples of responses that should NOT receive credit.

/ means that the responses are alternatives and either answer should receive full credit.

() means that a phrase/word is not essential for the award of the mark, but helps the examiner to get the sense of the expected answer.

Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is **essential** to the answer.

ecf/TE/cq (error carried forward) means that a wrong answer given in an earlier part of a question is used correctly in answer to a later part of the same question.

Candidates must make their meaning clear to the examiner to gain the mark. Make sure that the answer makes sense. Do not give credit for correct words/phrases which are put together in a meaningless manner. Answers must be in the correct context.

Quality of Written Communication

Questions which involve the writing of continuous prose will expect candidates to:

- write legibly, with accurate use of spelling, grammar and punctuation in order to make the meaning clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- organise information clearly and coherently, using specialist vocabulary when appropriate.

Full marks will be awarded if the candidate has demonstrated the above abilities.

Questions where QWC is likely to be particularly important are indicated (QWC) in the mark scheme, but this does not preclude others.

Question Number	Answer	Additional Comments	Mark
1(a)	C ;		(1)

Question Number	Answer	Additional Comments	Mark
1(b)	D ;		(1)

Question Number	Answer	Additional Comments	Mark
1(c)	A ;		(1)

Question Number	Answer	Additional Comments	Mark
1(d)	D ;		(1)

Question Number	Answer	Additional Comments	Mark
1(e)	C ;		(1)

Question Number	Answer	Additional Comments	Mark
1(f)	D ;		(1)

Question Number	Answer	Additional Comments	Mark
1(g)	D ;		(1)

Question Number	Answer	Additional Comments	Mark
1(h)	C ;		(1)

Question Number	Answer	Additional Comments	Mark
2(a)	<p>(QWC– Spelling of technical terms must be correct and the answer must be organised in a logical sequence)</p> <ol style="list-style-type: none"> 1. sperm cell {fuses / eq} with egg cell (<i>membrane</i>) ; 2. reference to { <i>cortical granules / vesicles / lysosomes</i> } ; 3. idea of (cortical granules) {moving towards / fusing with } egg cell (surface <i>membrane</i>) ; 4. reference to <i>exocytosis</i> (of <i>cortical granules / vesicles / lysosomes</i>) ; 5. idea of contents (of <i>cortical granules</i>) {secreted /released into jelly layer / eq} OR reference to <i>cortical reaction</i> ; 6. idea of { hardening / thickening / eq } of { <i>zona pellucida / jelly layer</i> } OR formation of <i>fertilisation membrane</i> ; 7. reference to change in charge across egg cell membrane ; 	<p>QWC emphasis is on spelling of technical terms</p> <ol style="list-style-type: none"> 1. NOT the fusion of the nuclei 4. NOT for description of acrosome reaction 5. ACCEPT enzymes / chemicals NOT released into ovum 6. ACCEPT fertilization 	(4)

Question Number	Answer	Additional Comments	Mark
2(b)	<ol style="list-style-type: none"> reference to both { independent / random } assortment and { crossing-over/chiasma(ta) } ; independent assortment gives rise to { new / different / eq } combinations of (paternal and maternal) chromosomes ; crossing over involves swapping of { sections / eq } of { chromatids / chromosomes } ; 	<p>3. NOT swapping genes ACCEPT new combinations of alleles (on a chromosome) / recombinants</p>	(2)

Question Number	Answer	Additional Comments	Mark
2(c)(i)	<ol style="list-style-type: none"> Idea that temperature is a controlled variable e.g. constant temperature removes this variable, so temperature does not affect { results / length of pollen tube } ; idea that (pollen tube) { growth / enzymes / proteins / eq } affected by temperature ; idea that at this temperature { enzymes / proteins } will not be denatured / pollen not destroyed at this temperature / 22.5°C optimum temperature ; idea that the investigation is valid ; 	<p>1. ACCEPT the idea of only changing one variable and keeping all the others constant – or so that only methylpurine affecting pollen tubes</p> <p>NOT 'a control'</p> <p>4. NOT reliable IGNORE fair test, accurate, precise</p>	(2)

Question Number	Answer	Additional Comments	Mark															
2(c) (ii)	<ol style="list-style-type: none"> idea of { no significant / small / 1mm / eq } increase in { mean length / growth } up to 0.0001 mol dm⁻³ ; idea of negative correlation described e.g. { decrease in length of / shorter/ reduced growth of} pollen tubes as concentration increased OR over stated range from 0.0001 to 0.01 ; idea of greatest { change / drop / eq } between 0.0010 and 0.0100 mol dm⁻³ / eq ; credit correct manipulation of the data to illustrate decrease ; 	<p>IGNORE units.</p> <p>2. ACCEPT reference to decreases at specific concentrations of methylpurine IGNORE negative correlation unqualified</p> <p>3. NOT references to rapid decrease.</p> <p>4. Some examples given below</p> <table border="1"> <thead> <tr> <th>Conc. change</th> <th>Difference (mm)</th> <th>% all decreases</th> </tr> </thead> <tbody> <tr> <td>0.0000 – 0.0100 – mp2</td> <td>(94-28) 66</td> <td>70 / 70.2 %</td> </tr> <tr> <td>0.0001 – 0.0100</td> <td>(95-28) 67</td> <td>71 / 70.5 %</td> </tr> <tr> <td>0.0001 – 0.0010</td> <td>(95-90) 5</td> <td>5 / 5.3 %</td> </tr> <tr> <td>0.0010 – 0.0100 – mp3</td> <td>(90-28) 62</td> <td>69 / 68.9 %</td> </tr> </tbody> </table>	Conc. change	Difference (mm)	% all decreases	0.0000 – 0.0100 – mp2	(94-28) 66	70 / 70.2 %	0.0001 – 0.0100	(95-28) 67	71 / 70.5 %	0.0001 – 0.0010	(95-90) 5	5 / 5.3 %	0.0010 – 0.0100 – mp3	(90-28) 62	69 / 68.9 %	(3)
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Question Number	Answer	Additional Comments	Mark
2(c) (iii)	<ol style="list-style-type: none"> { less / no } transcription / idea of inhibition of RNA polymerase ; { less / no } { translation / protein synthesis/ protein made / eq } ; idea that protein needed for (pollen tube) growth e.g. less protein leads to reduced growth (of pollen tubes) ; 	<p>2 & 3 ACCEPT reference to enzyme instead of protein</p> <p>IGNORE repair</p>	(2)

Question Number	Answer	Additional Comments	Mark								
3 (a)	<table border="1"> <thead> <tr> <th>Description of stage</th> <th>Tick / cross</th> </tr> </thead> <tbody> <tr> <td>He tried to isolate digitalis from foxglove plants.</td> <td>✓ ;</td> </tr> <tr> <td>He tested digitalis on healthy humans.</td> <td>× ;</td> </tr> <tr> <td>He used a placebo to make sure digitalis worked.</td> <td>× ;</td> </tr> </tbody> </table>	Description of stage	Tick / cross	He tried to isolate digitalis from foxglove plants.	✓ ;	He tested digitalis on healthy humans.	× ;	He used a placebo to make sure digitalis worked.	× ;	No marks for blank spaces. No mark for hybrid x/✓	(3)
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Question Number	Answer	Additional Comments	Mark
3 (b) (i)	<ol style="list-style-type: none"> inactive substance / no drug / eq ; idea that it is used as a control e.g. comparison with the actual drug ; idea of psychological effect of taking either a drug or a placebo ; 	<ol style="list-style-type: none"> ACCEPT dummy pill, sugar pill, fake pill e.g. patient believes they will improve and ALLOW reference to placebo effect 	(2)

Question Number	Answer	Additional Comments	Mark
3 (b) (ii)	<ol style="list-style-type: none"> idea of one set of patients being given the (new) drug and one set a placebo ; neither patient nor { doctor / scientist / eq } knows if the treatment contains the (new) drug or not ; removal of bias from results / eq ; 	1. ACCEPT pre-existing / old drug instead of placebo	(2)

Question Number	Answer	Additional Comments	Mark
4(a)	<ol style="list-style-type: none"> 1. idea of using part of the seedling ; 2. idea of using agar ; 3. (agar contains) growth substances / hormones / eq ; 4. Idea of using aseptic technique ; 5. Idea of covering the top of the container to prevent contamination OR loss of water ; 6. Idea of supplying light ; 7. allow a suitable length of time for growth e.g. 1 to 6 weeks ; 8. look for { roots / leaves / (complete) plant } forming ; 	<ol style="list-style-type: none"> 1. ACCEPT cuttings, explants IGNORE cells unqualified 3. ACCEPT named plant growth substance 	(4)

Question Number	Answer	Additional Comments	Mark												
4(b)(i)	<ol style="list-style-type: none"> 1. percentage of seedlings (showing totipotency) decreases as age increases up to 21 days / negative correlation up to 21 days / eq ; 2. as age increases { after 21 / from 21-28 / at 28} days percentage of seedlings showing totipotency increases / eq ; 3. 28 days is an anomalous result ; 4. credit correct manipulation of the data ; 	<p>4. Some examples are shown below</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Days</th> <th>Difference (%)</th> </tr> </thead> <tbody> <tr> <td>7-28</td> <td>(76-60) 16</td> </tr> <tr> <td>7-14</td> <td>(76-56) 20</td> </tr> <tr> <td>7-21 – <i>mp1</i></td> <td>(76-40) 36</td> </tr> <tr> <td>14-21</td> <td>(56-40) 16</td> </tr> <tr> <td>21-28 – <i>mp2</i></td> <td>(40-60) (+) 20</td> </tr> </tbody> </table> <p>IGNORE calculated percentage of percentage</p>	Days	Difference (%)	7-28	(76-60) 16	7-14	(76-56) 20	7-21 – <i>mp1</i>	(76-40) 36	14-21	(56-40) 16	21-28 – <i>mp2</i>	(40-60) (+) 20	(2)
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Question Number	Answer	Additional Comments	Mark
4(b) (ii)	<ol style="list-style-type: none"> { repeats / larger number of seedlings } { at each age / in each group } / eq ; more ages of seedlings used / use seedlings older than 28 days / test 35 day old seedlings / eq ; repeat 28-day group / repeat any anomalous results / eq ; 	1. ACCEPT repeated the whole experiment	(2)

Question Number	Answer	Additional Comments	Mark
4(c) (i)	as phenol concentration increases from { 7 to 21 / 7 to 14 / 14 to 21 } days, percentage of seedlings showing totipotency decreases / negative correlation up to 21 days / eq ;		(1)

Question Number	Answer	Additional Comments	Mark
4(c) (ii)	(as phenol concentration increases) at 28 days percentage of seedlings showing totipotency increases / eq ;	ACCEPT reference to after 21 days	(1)

Question Number	Answer	Additional Comments	Mark
4(d)	<ol style="list-style-type: none"> totipotent cells can { give rise to / differentiate to become } { any cell / extra embryonic tissues / eq } ; pluripotent cannot { give rise to / differentiate to become } { all cells in the body / extra embryonic tissues / eq } ; idea that only totipotent cells can give rise to other totipotent cells ; idea that totipotent cells can give rise to an entire human being, pluripotent cells cannot ; 	<p>NOT 'turns into', 'becomes', 'develops into' but penalise once only</p> <ol style="list-style-type: none"> ACCEPT specialised for differentiated 1 & 2 IGNORE reference to embryonic cells/tissues unless it makes the response incorrect, ACCEPT placental cells/tissues ACCEPT can give rise to most cells 	(2)

Question Number	Answer	Additional Comments	Mark
5(a) (i)	<ol style="list-style-type: none"> 1. increasing mass increased the distance up to 150 (g) ; 2. 150 (g) to 200 (g) / after 150 (g) the distance did not change ; 3. relationship is linear to 100(g) and non-linear above 100 (g) ; 4. greatest change in 0 to 100 (g) range ; 	IGNORE UNITS 1. ACCEPT weights instead of masses	(2)

Question Number	Answer	Additional Comments	Mark
5(a) (ii)	<ol style="list-style-type: none"> 1. add smaller masses / add 10 g or 5 g masses ; 2. from 200 g / between 200 and 250 g ; 	1. ACCEPT masses of any value less than 50g, e.g. 20g. Must state units.	(2)

Question Number	Answer	Additional Comments	Mark
5(b)	<ol style="list-style-type: none"> 1. two different fibre variables taken into account e.g. length, width, age, mass, hydration level, part of plant extracted from ; 2. environmental variable controlled, e.g. temperature, humidity, ; 3. named procedural variable controlled, e.g. size of masses used, retting method used to extract fibres ; 4. idea of adding masses until fibre breaks /measure the mass [that breaks the fibre / that the fibre can hold before breaking / eq } ; 5. repeat and find the { mean / average } ; 6. reference to action taken in case of { anomalous result / outlier } ; 7. reference to safety procedure ; 	2. IGNORE light intensity 3. ALLOW descriptions of methodology, e.g. the way in which the masses are added to the fibre	(5)

Question Number	Answer	Additional Comments	Mark															
6(a)	<table border="1"> <thead> <tr> <th>Feature</th> <th>Cellulose molecule</th> <th>Cellulose microfibril</th> </tr> </thead> <tbody> <tr> <td>Alpha (α) glucose</td> <td>×</td> <td>×</td> </tr> <tr> <td>1,4- glycosidic bonds</td> <td>✓</td> <td>✓</td> </tr> <tr> <td>1,6- glycosidic bonds</td> <td>×</td> <td>×</td> </tr> <tr> <td>Hydrogen bonds</td> <td>×</td> <td>✓</td> </tr> </tbody> </table>	Feature	Cellulose molecule	Cellulose microfibril	Alpha (α) glucose	×	×	1,4- glycosidic bonds	✓	✓	1,6- glycosidic bonds	×	×	Hydrogen bonds	×	✓	No marks for blank spaces. No marks for hybrid x/✓	(4)
	Feature	Cellulose molecule	Cellulose microfibril															
	Alpha (α) glucose	×	×															
	1,4- glycosidic bonds	✓	✓															
	1,6- glycosidic bonds	×	×															
Hydrogen bonds	×	✓																
Any 2 correct for 1 mark ; ; ; ;																		

Question Number	Answer	Additional Comments	Mark
6(b)	1. Archaea ; 2. Bacteria ;	Either way around 1. ACCEPT Archaeobacter	(2)

Question Number	Answer	Additional Comments	Mark
6(c)	1. idea that organisms with { specific / particular / shared / common / similar / eq } { characteristics / features / traits / eq } are placed in a group ; 2. detail of how characteristics assessed, e.g. observable characteristics, behavioural similarities, similarities in DNA, molecular phylogeny ;		(2)

Question Number	Answer	Additional Comments	Mark
6(d)	<ol style="list-style-type: none"> 1. scientific findings published e.g. in a journal ; 2. idea of presented at scientific conference / eq ; 3. idea of peer review ; 4. (other scientists) repeat experiments (to confirm or validate findings / test reliability of data) ; 	<p>IGNORE 'critically evaluated' as it is in the stem of the question</p> <ol style="list-style-type: none"> 3. 'peer reviewed journal' gains Mp1 as well 4. must be an indication of further testing being carried out 	(3)

Question Number	Answer	Additional Comments	Mark
7 (a)	X – metaphase ; Y – anaphase ;		(2)

Question Number	Answer	Additional Comments	Mark
7 (b)	<ol style="list-style-type: none"> 1. { chromatin / DNA } condenses / eq ; 2. chromosomes { condense /become visible /eq } ; 3. idea of nuclear { membrane /envelope } breaking down ; 4. nucleolus { disappears /eq} ; 5. reference to centrioles moving to poles or opposite ends of cell ; 6. reference to formation of spindle (fibres) ; 	<ol style="list-style-type: none"> 1. ACCEPT coiling of DNA, not supercoiling 2. ACCEPT shorten or thicken 5. NB – part (b) does not specify plant cells, therefore reference to centrioles is acceptable 	(4)

Question Number	Answer	Additional Comments	Mark
7 (c)	<ol style="list-style-type: none"> 1. interphase; 2. chromosomes not visible / nucleus is visible / eq ; 	<ol style="list-style-type: none"> 1.ACCEPT/ G1 / G2 / S 2. Must be a detail seen in the photograph ACCEPT converse e.g. not mitosis as chromosomes not visible 	(2)

Question Number	Answer	Additional Comments	Mark
8 (a)	<p>QWC – Spelling of technical terms must be correct and the answer must be organised in a logical sequence)</p> <ol style="list-style-type: none"> 1. idea that 18 individuals is a small population / small gene pool / low genetic diversity / may have been closely related / eq ; 2. captive breeding will increase population ; 3. studbooks /records kept of breeding programme / eq ; 4. (zoos) select mates ; 5. inter-zoo exchange of animals for breeding / eq ; 6. idea of the need to prevent inbreeding ; 7. idea of avoiding genetic drift ; 8. use of { IVF / AI / use of surrogates } ; 9. process for measuring genetic diversity described, e.g. DNA profiling / eq ; 	<p>QWC emphasis is clarity of expression</p> <p>ACCEPT reference to 'species' instead of ferret which may arise due to the wording of question.</p> <p>4. Must refer to human intervention – not just the ferrets choosing their mates</p> <p>6. NOT 'interbreeding' in place of 'inbreeding'. ACCEPT 'encourage outbreeding' e.g. ferrets not mated with closely related ferrets</p>	(5)

Question Number	Answer	Additional Comments	Mark
8 (b) (i)	<ol style="list-style-type: none"> (captive) population not large enough / number of births is low / eq ; individuals not mature enough / eq ; zoos preparing ferrets for release / eq ; idea of maintaining a population in zoos ; 		(2)

Question Number	Answer	Additional Comments	Mark												
8 (b) (ii)	<ol style="list-style-type: none"> number of <u>births</u> is rising / eq ; increase in population : idea that more are born than are released e.g. at least 200 births each year ; identification of years when number of <u>births</u> fell, i.e. 1994 or 2000 ; correct manipulation of data ; 	<p>3. Or some understanding that the increases outweigh the decreases, e.g. between 1991-1999 it increased by 230, but only fell by 170 to 2000 from 1999</p> <p>5. Some examples are shown below</p> <table border="1"> <thead> <tr> <th>Year</th> <th>Difference</th> <th>%</th> </tr> </thead> <tbody> <tr> <td>1991-2000 – mp3</td> <td>(220-280) 60</td> <td>(+) 27 / 27.3</td> </tr> <tr> <td>1991- 1999</td> <td>(220-450) 230</td> <td>(+) 105 / 104.5</td> </tr> <tr> <td>1999-2000</td> <td>(450-280) 170</td> <td>(-) 38 / 37.8</td> </tr> </tbody> </table>	Year	Difference	%	1991-2000 – mp3	(220-280) 60	(+) 27 / 27.3	1991- 1999	(220-450) 230	(+) 105 / 104.5	1999-2000	(450-280) 170	(-) 38 / 37.8	(2)
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8 (c)	<ol style="list-style-type: none"> 1. idea of habitat as a factor, e.g. loss of habitat / wider range of habitats / eq ; 2. availability of { prey / food / prairie dogs /eq }; 3. competition with other ferrets (for resources) ; 4. competition with other species (for resources) / eq ; 5. effect of eating { poisoned prairie dogs / poison put out for prairie dogs } / eq ; 6. presence of { predators / hunters } / eq ; 7. preparation for living in the wild improves chance of survival / if reliant on humans would not survive ; 8. idea of too few to be a viable breeding population ; 9. idea of presence of disease ; 	<p>Factors provided may either improve or reduce survival chances</p> <ol style="list-style-type: none"> 1. climate change can be accepted here as a factor affecting availability of suitable habitat ACCEPT description of human activity that could lead to loss or gain of habitat 3. Intraspecific competition 4. Interspecific competition 7. e.g. kept in semi-wild conditions initially and hunting behaviour encouraged 	(3)