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International Education

Cambridge International AS & A Level

BIOLOGY **9700/41**

Paper 4 A Level Structured Questions **October/November 2024**

MARK SCHEME

Maximum Mark: 100

Published

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GENERIC MARKING PRINCIPLE 1:

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- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
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- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

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GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
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Science-Specific Marking Principles

1	Examiners should consider the context and scientific use of any keywords when awarding marks. Although keywords may be present, marks should not be awarded if the keywords are used incorrectly.
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4	The error carried forward (ecf) principle should be applied, where appropriate. If an incorrect answer is subsequently used in a scientifically correct way, the candidate should be awarded these subsequent marking points. Further guidance will be included in the mark scheme where necessary and any exceptions to this general principle will be noted.
5	‘List rule’ guidance For questions that require ***n*** responses (e.g. State **two** reasons …): • The response should be read as continuous prose, even when numbered answer spaces are provided. • Any response marked *ignore* in the mark scheme should not count towards ***n***. • Incorrect responses should not be awarded credit but will still count towards ***n***. • Read the entire response to check for any responses that contradict those that would otherwise be credited. Credit should **not** be awarded for any responses that are contradicted within the rest of the response. Where two responses contradict one another, this should be treated as a single incorrect response. • Non-contradictory responses after the first ***n*** responses may be ignored even if they include incorrect science.

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Correct answers to calculations should be given full credit even if there is no working or incorrect working, **unless** the question states 'show your working'.

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Unless a separate mark is given for a unit, a missing or incorrect unit will normally mean that the final calculation mark is not awarded. Exceptions to this general principle will be noted in the mark scheme.

7 Guidance for chemical equations

Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme.

State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme.

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Mark scheme abbreviations

;	separates marking points
/	alternative answers for the same point
A	accept (for answers correctly cued by the question, or by extra guidance)
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max	indicates the maximum number of marks that can be given
ora	or reverse argument
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AVP	alternative valid point

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Question	Answer	Marks
1(a)(i)	**A** = dendrite(s) **;** **B** = nuclei **;** **C** = synaptic knob(s) **;**	**3**
1(a)(ii)	**1** rat has, myelin sheath / Schwann cell / myelinated axon / myelinated neurone **;** **2** (rat has) saltatory conduction **OR** (rat) impulse / action potential, jumps / leaps / AW, from (one) node of Ranvier to, the next / another **;**	**2**
1(b)	*any **three** from:* **snail / Fig. 1.3** **1** greater depolarisation **OR** (membrane potential) gets more positive / has higher increase / has higher peak **;** **2** action potential, slower / takes longer / takes more time **OR** longer time to return to resting potential **;** **3** longer (absolute / relative) refractory period **;** **4** longer hyperpolarisation **;** **5** AVP **;**	**3**

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Question	Answer	Marks
2(a)	*any **three** from:* **1** open in, day / light **;** **2** to take in carbon dioxide for, photosynthesis / light-independent stage / Calvin cycle **;** **3** close in, night / dark **;** **4** to decrease water loss by transpiration **;**	**3**
2(b)	*any **six** from:* **1** hydrogen ions / protons / H ions / H^+, leave (cell) using, energy / ATP **;** **2** low H^+ (in cell) / more negative charge **;** **3** K^+ / potassium ion, channel (proteins) open **OR** K^+, move into / enter, cell (by facilitated diffusion) **;** **4** C*l*$^-$ ions, move into / enter (cell) **;** **5** water potential of cell decreases **;** **6** water moves in (to cell) by osmosis **;** **7** (cells) become turgid / swell / increase in volume / expand **;** **8** (guard cell) inner wall thicker / outer wall thinner, so cells, bend / curve **;**	**6**
2(c)	**1** (environment) light needed, to keep cycle normal / to achieve same peak % of stomata opening **;** **2** genes have a role as (regular), rhythm / pattern / cycle, continues, in darkness / without light **;**	**2**

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>3(a)</td><td>
<table>
<tr><td rowspan="2">event</td><td colspan="4">stage</td><td></td></tr>
<tr><td>G</td><td>LR</td><td>KC</td><td>OP</td><td></td></tr>
<tr><td>catabolism</td><td>✓</td><td>✓</td><td>✓</td><td>×</td><td>;</td></tr>
<tr><td>coenzyme is reduced or oxidised</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>;</td></tr>
<tr><td>a coenzyme forms a covalent bond with a respiratory intermediate</td><td>×</td><td>✓</td><td>×</td><td>×</td><td>;</td></tr>
<tr><td>carbon dioxide is released</td><td>×</td><td>✓</td><td>✓</td><td>×</td><td>;</td></tr>
</table>
</td><td>4</td></tr>
<tr><td>3(b)(i)</td><td>any four from:

1 (RQ =) ratio of carbon dioxide (exhaled) to oxygen (inhaled) ;
2 air flow meter measures oxygen inhaled ;
3 carbon dioxide sensor measures concentration of CO_2 exhaled ;
4 carbohydrate RQ = 1 ;
5 lipid RQ = 0.7 ;</td><td>4</td></tr>
<tr><td>3(b)(ii)</td><td>any three from:

1 lipid has higher energy (value) OR
carbohydrate 15–17 kJ g^{-1} and lipid 37–40 kJ g^{-1} ;
2 more, hydrogen (atoms) / C-H bonds, in lipid ;
3 more reduced, NAD / FAD ;
4 greater proton gradient / more protons in intermembrane space / more protons pass through ATP synth(et)ase ;</td><td>3</td></tr>
</table>

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Question	Answer	Marks
4(a)	*any **three** from:* *in Venus fly traps* **1** touch two (sensory hairs) **;** **2** protons, leave hinge cells / enter hinge cell walls **;** **3** Ca^{2+} ions move into (hinge) cells **;** **4** water moves into (hinge) cells **;** **5** (hinge) cells, become turgid / swell / increase in volume / expand **;**	**3**
4(b)	*any **two** from:* **1** less / decreased, surface area (of leaf exposed) **;** **2** less light absorbed by, chloroplasts / thylakoid membranes / grana / pigments / chlorophyll / light harvesting complexes / photosystems **;** **3** fewer stomata, exposed / available (to air) **;** **4** less carbon dioxide, enters / absorbed **;**	**2**
4(c)	*any **six** from*: *similarities* **1** photoactivation of chlorophyll **;** **2** (energetic) electrons move, along / down, ETC **;** **3** chemiosmosis **;** **4** ATP produced **;** *differences* **5** PSI and PSII in non-cyclic **and** only PSI in cyclic **;** **6** photolysis / oxygen produced, in non-cyclic only **;** ORA **7** reduced NADP in non-cyclic only **;** ORA **8** electrons return to, same photosystem / PSI, in cyclic **;**	**6**

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Question	Answer	Marks
5(a)	*any **two** from:* **1** one / single, set of chromosomes **;** **2** have **n** (number of) chromosomes / half of diploid number **;** **3** chromosomes not in homologous pairs / only one of each homologous pair **;** **4** each chromosome is different in, size / shape / genes / loci **;**	**2**
5(b)	*sexual reproduction*: **B** and **D ;** *mitosis*: *two from* **A**, **B**, **C**, **D ;** *meiosis*: **D ;**	**3**
5(c)	*any **three** from:* **1** to maintain, chromosome / diploid, number **;** **2** from parents to offspring / from generation to generation **;** **3** to give genetic variation in, gametes / offspring / horses **;** **4** too many / extra, sets of chromosomes cause (named) problems **;**	**3**

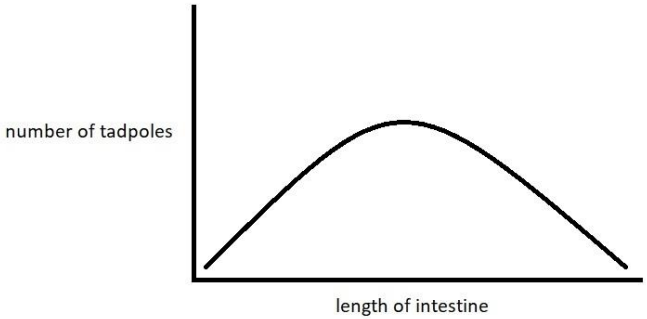
Question	Answer	Marks
6(a)(i)	**1** (excess) amino acids, deaminated / have amino group removed **;** **2** in the liver **;**	**2**
6(a)(ii)	*any **three** from:* **1** osmoreceptors in hypothalamus (detect change / are receptors) **;** **2** effector(s): collecting duct / distal convoluted tubule / nephron **;** **3** target cells: collecting duct (cells) **;**	**3**

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Question	Answer	Marks
6(b)	*any **three** from:* **1** ultrafiltration / forms glomerular filtrate **;** **2** high, hydrostatic / blood, <u>pressure</u> in, glomerulus / capillaries **;** **3** so, water / (named) solutes, move (out of glomerulus / into Bowman's capsule) **;** **4** through *two of*: fenestrae / fenestrations basement membrane slit pores / filtration slits / between podocytes **;** **5** AVP **;**	**3**
6(c)	*any **three** from:* **1** high(er / est), U:P / ratio → can tolerate water shortage **;** **2** high(er / est), U:P / ratio → much water reabsorbed / small volume of urine produced **;** **3** high(er / est), U:P / ratio → can, concentrate urine / conserve water **OR** high(er / est), U:P / ratio → (well) adapted to dry environment **;** **4** AVP **;**	**3**

Question	Answer	Marks
7(a)(i)	*any **three** from:* **1** disruptive / diversifying (selection) **;** **2** extremes / carnivores and detritus feeders, survive / are selected for **and** intermediates, die / are selected against **;** **3** high / intense, competition **;** **4** intermediates, outcompeted for / don't get enough, detritus / algae, and, (fairy) shrimp / small animals **;** **5** lack of / limited, food is selection pressure **;** **6** AVP **;**	**3**

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Question	Answer	Marks
7(a)(ii)	*any **three** from:* **1** stabilising (selection) **;** **2** extremes / carnivores and detritus feeders, die / are selected against / are not selected for, **and** intermediates, survive / are selected for **;** **3** low / less / prevents, competition **;** **4** intermediates can eat, both types / all / a wider range, of food **;** **5** greater variety in the diet improves the growth and development of (intermediate) tadpoles **;**	**3**
7(a)(iii)	 normal distribution curve **;**	**1**
7(a)(iv)	*any **two** from*: **1** new species form due to reproductive isolation **;** **2** caused by, ecological / behavioural, separation / isolation / differences **;** **3** in same geographical region **;** **4** AVP **;**	**2**
7(b)	*any **three** from*: **1** *ref. to* DNA sequence (for all / three species) **;** **2** find / count, nucleotide / base, differences / similarities **;** **3** fewer differences means, more closely related / less time since divergence / less time to common ancestor **;** **4** bioinformatics / database / software / BLAST **;** **5** *S. hammondii* and *S. bombifrons,* have the fewest genetic differences / are the most genetically similar **;**	**3**

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>8(a)</td><td>any three from:

1 make cDNA from, messenger RNA / mRNA ;
2 using reverse transcriptase ;
3 synthesise (gene chemically) from nucleotides / join nucleotides ;
4 (using known) amino acid / nucleotide, sequence from database ;</td><td>3</td></tr>
<tr><td>8(b)</td><td>
<table>
<tr><th>role in genetic engineering</th><th>DNA ligase</th><th>DNA polymerase</th><th></th></tr>
<tr><td>joins two sections of sugar phosphate backbone in DNA</td><td>✓</td><td>×</td><td>;</td></tr>
<tr><td>adds a gene to a plasmid</td><td>✓</td><td>×</td><td>;</td></tr>
<tr><td>adds free activated DNA nucleotides to a polynucleotide</td><td>×</td><td>✓</td><td>;</td></tr>
</table>
</td><td>3</td></tr>
<tr><td>8(c)</td><td>1 90–98°C – DNA, denatures / strands separate ;
2 50–65°C – primers, bind / base pair / anneal (to DNA) ;
3 68–75°C – Taq / DNA, polymerase, makes, DNA / (new) strand ;</td><td>3</td></tr>
</table>

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Question	Answer	Marks
9(a)	*any **four** from:* **1** both, eukaryotic / eukaryotes / in domain Eukarya **;** **2** example of eukaryotic feature **;** *Protoctista* **3** example of way in which they vary *(must give both)* **;** *Fungi (max 3)* **4** cell wall of, chitin / mannan / glucan **;** **5** hyphae / mycelium **;** **6** multinucleate / syncytium / many nuclei per cell **;** **7** heterotrophic / saprotrophic / parasitic **;** **8** store glycogen **;** **9** reproduce by spores **;**	**4**
9(b)(i)	*any **three** from:* **1** measures / gives information about, air, quality / pollution **;** **2** other species may be harmed by, sulfur dioxide / acid rain / decrease in lichen (abundance / diversity) **;** **3** *ref. to* food web / species that feed on lichens **;** **4** AVP **;**	**3**
9(b)(ii)	*any **two** from:* **1** role in food web / eaten by other (named) species **;** **2** provide, shelter / camouflage (for insects / invertebrates) **;** **3** clean the air / remove (named) pollutants / absorb toxins **;** **4** may have medical use **;** **5** *ref. to* other practical use **;** **6** primary colonisers / pioneer species / soil formation **;** **7** ethical / moral / aesthetic, reason **;** **8** to conserve genetic diversity / future use for genes **;**	**2**

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>10(a)</td><td>(melanic x melanic)
Aa x Aa
(Gametes) A a and A a ;

(Offspring) AA Aa Aa aa ;
(melanic, melanic, melanic, typical)

(Ratio) 3 melanic : 1 typical ;</td><td>3</td></tr>
<tr><td>10(b)</td><td>it / (melanic) allele, is dominant ;</td><td>1</td></tr>
<tr><td>10(c)(i)</td><td>melanic / dominant phenotype, is crossed with homozygous recessive ;</td><td>1</td></tr>
<tr><td>10(c)(ii)</td><td><table>
<tr><th></th><th>same locus
(A / a)</th><th>different loci
(A / a and B / b)</th></tr>
<tr><td>genotypes of melanic
moths from cross 1</td><td>AA
Aa
(aA) ;</td><td>AaBb
Aabb
aaBb ;</td></tr>
<tr><td>proportion of test crosses
(cross 2) giving 100%
melanic offspring</td><td>1 in 3</td><td>none / 0 ;</td></tr>
</table></td><td>3</td></tr>
<tr><td>10(d)</td><td>(24 × 29) ÷ 8 ;
= 87 ;</td><td>2</td></tr>
</table>

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B – (capillary) endothelial cell ;</td><td>2</td></tr>
<tr><td>1(a)(ii)</td><td>high(er), hydrostatic / blood, pressure ; Ignore ref. to water potential
<u>basement membrane</u> acts as a filter / only small molecules can pass through <u>basement membrane</u> ;</td><td>2</td></tr>
<tr><td>1(b)</td><td>
<table>
<tr><th>component of blood plasma in glomerulus</th><th>component in newly formed glomerular filtrate</th><th>component in urine</th><th></th></tr>
<tr><td>glucose</td><td>same</td><td>not present</td><td>;</td></tr>
<tr><td>large proteins</td><td>not present</td><td>not present</td><td>;</td></tr>
<tr><td>urea</td><td>same</td><td>increased</td><td>;</td></tr>
</table>
</td><td>3</td></tr>
<tr><td>1(c)</td><td>posterior pituitary gland – releases (more) ADH ; A secretes

kidney – reabsorbs more water / urine more concentrated / lower volume of urine ;
OR
(more) aquaporins added to membrane of collecting duct (cells) / membrane of collecting duct (cells) more permeable to water ;</td><td>2</td></tr>
</table>

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Question	Answer	Marks
2(a)	*any **six** from:* 1 mutation / described **;** 2 genetic drift / described **;** 3 founder effect / group separated from main population to found a new population **;** 4 bottleneck effect / large fall in population **;** 5 natural / directional / disruptive, selection **; Ignore** artificial / stabilising selection 6 migration / gene flow / interbreeding between populations **;** 7 genetic recombination / linkage groups broken / crossing over **;** 8 AVP **;** e.g. effect larger in small populations	**6**
2(b)	*any **three** from:* 1 inbreeding / described **;** 2 produces homozygous plants / increases homozygosity **;** 3 outbreeding / described **;** 4 hybridisation / producing a hybrid **;** 5 hybrids / offspring / F1, are (all) heterozygotes / have increased heterozygosity **;**	**3**

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Question	Answer	Marks
3(a)	*any **three** from:* 1 manipulation of, genetic material / gene / DNA **or** described **;** 2 *ref. to* gene / allele, transfer (into, cell / organism) **or** described **;** 3 expression of gene **;** 4 (named) phenotype modified / (named) protein produced **;** 5 AVP **;** e.g. *ref. to* gene editing / produce GMO	**3**
3(b)(i)	*any **three** from:* 1 **add**, healthy / normal / correct / functional, gene / allele, to virus **;** 2 inject virus into eye **;** 3 gene integrated into (eye cell) genome / DNA **;** 4 gene / allele, expressed to produce functioning, protein / enzyme **;** 5 AVP **;** e.g. adeno-associated virus / AAV voretigene neparvovec (drug)	**3**
3(b)(ii)	*any **one** from:* 1 easily accessible / easy to inject **;** 2 low risk of immune response **;** 3 (eye small in size so) small amount of gene therapy treatment needed / AW **;**	**1**

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<table>
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<tr><td>3(c)(i)</td><td>
any three from:

1 (overall) improvement in acuity of both eyes or (overall visual) acuity of both eyes becomes more negative ;

2 treated eye, has more improved acuity / has more negative (visual) acuity ; ora

3 ref. to anomalous result at month 9 / result that does not fit the pattern at month 9 ;

4 data quote – values of one eye at two months or values of both eyes at one month ;

<table>
<tr><td>time / months</td><td colspan="2">change in visual acuity / au</td></tr>
<tr><td></td><td>eye not treated</td><td>eye treated</td></tr>
<tr><td>0</td><td>0.00</td><td>0.00</td></tr>
<tr><td>1</td><td>-0.12</td><td>-0.20</td></tr>
<tr><td>2</td><td>+0.02</td><td>-0.40</td></tr>
<tr><td>3</td><td>0.00</td><td>-0.50</td></tr>
<tr><td>4</td><td>-0.13</td><td>-0.52</td></tr>
<tr><td>5</td><td>-0.22 or -0.23</td><td>-0.52</td></tr>
<tr><td>6</td><td>-0.15</td><td>-0.54</td></tr>
<tr><td>7</td><td>-0.12</td><td>-0.50</td></tr>
<tr><td>9</td><td>-0.15</td><td>-0.33</td></tr>
<tr><td>10</td><td>-0.08</td><td>-0.52</td></tr>
<tr><td>12</td><td>-0.12</td><td>-0.54</td></tr>
</table>
</td><td>3</td></tr>
</table>

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Question	Answer	Marks
3(c)(ii)	*any **three** from:* 1 **mutated** DNA is, deleted / removed / cut out **or** DNA replaced with **normal** DNA **;** **Ignore** exon X is deleted as this is mRNA not DNA **Reject** gene deleted / cut out 2 specific (locations) / between exon 26 and exon 27, (in the genome) **;** 3 functional protein / CEP290, now made **OR** correct functioning of photoreceptors **;** 4 acts on person's own DNA **;** 5 AVP **;** e.g. STOP codon no longer present	**3**

Question	Answer	Marks
4(a)	*parental genotype* **Rr** x **Rr** ***AND*** *gametes* (**R**) (**r**) (**R**) (**r**) **;** *offspring genotype* RR Rr (Rr) rr **;** red red red yellow **;**	**3**

Question	Answer	Marks
4(b)	1 *ratio*=9:3:3:1 **;** *any **two** from:* 2 independent / random, assortment **;** 3 of, homologous chromosomes / bivalents / sister chromatids **;** 4 stage of meiosis **;** e.g. metaphase 1 or metaphase 11 **Ignore** *ref. to* crossing over / recombinants	**3**

Question	Answer	Marks
5(a)	<table><tr><th>statement</th><th>discontinuous variation</th><th>continuous variation</th></tr><tr><td>often involves one gene only</td><td>✓</td><td></td></tr><tr><td>environmental factors may affect gene expression</td><td></td><td>✓</td></tr><tr><td>there is an additive effect of genes that contributes to the phenotype</td><td></td><td>✓</td></tr><tr><td>there are distinct differences between the various forms of a characteristic</td><td>✓</td><td></td></tr></table> **;;;;**	**4**
5(b)(i)	*ref. to* spread of results about the <u>mean</u> **;**	**1**

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Question	Answer	Marks
5(b)(ii)	*t* = 4.255 **;;;** *give 2 marks:* *if answer is 4.25 or 4.26* *if answer is more than 4 significant figures e.g. 4.255439871* *if answer is incorrectly rounded to 4 significant figures e.g. 4.256* *if answer incorrect then max 2 for working* numerator = 4.2 denominator = 0.986972 ecf - if no working mark given then allow one mark for 12.02 as the answer	**3**
5(b)(iii)	1 there is a higher (mean) concentration of serum 25-OHD in summer **; ora** *any **two** from:* 2 value of *t* / 4.255 > critical value / 3.773 **;** 3 there is a significant difference between the two means **;** 4 any difference is not due to chance / difference due to chance less than 0.0001% **;** ecf from incorrect answer to 5bii	**3**
5(b)(iv)	genetic **AND** environmental **OR** an example of a genetic cause **AND** an example of an environmental cause **;**	**1**

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Question	Answer	Marks
6(a)(i)	redox **;**	**1**
6(a)(ii)	blue to colourless **;**	**1**
6(b)(i)	*any **two** from:* 1 volume / mass / concentration, of yeast suspension **;** 2 volume / mass / concentration, of glucose (solution) **;** 3 volume / concentration, of DCPIP **;** 4 AVP **;** e.g. time when DCPIP is added / pH	**2**
6(b)(ii)	*any **three** from:* 1 the less time taken (for DCPIP) to change colour the higher the rate of respiration **; ora** *rate increases up to 40 °C* 2 due to increase in, kinetic energy / KE **;** 3 due to **more** enzyme-substrate complexes formed **or** due to **more** (successful / effective) collisions between enzymes and substrates **or more** enzyme catalysed reactions **;** *rate decreases after 40 °C* 4 due to denaturation of (named respiration) enzyme **;** 5 further detail **;** e.g. active site shape change / optimum temperature 40 °C	**3**

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Question	Answer	Marks
7(a)	1 calculate R_f value(s) **;** 2 (R_f =) <u>distance moved by pigment (from baseline)</u> distance moved by solvent (from baseline) **;** 3 compare with, known / standard / table, values **;**	**3**
7(b)	*any **three** from:* 1 absorb light wavelengths **not** absorbed by, reaction centre / primary pigment / chlorophyll a **; A** harvest 2 so extend the range of wavelengths absorbed **;** 3 pass **energy** to, reaction centre / primary pigment / chlorophyll a **;** 4 *ref. to* accessory pigments **;**	**3**

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Question	Answer	Marks
7(c)	*any **seven** from:* 1 carbon dioxide, **reacts / combines**, with, ribulose bisphosphate / RuBP **;** 2 (catalysed by) rubisco **;** 3 *ref. to* carbon (dioxide) fixation **;** 4 unstable 6C compound **;** 5 forms 2 (molecules of) glycerate 3-phosphate / GP **;** 6 glycerate 3-phosphate / GP, **reduced** to, triose phosphate / TP **;** 7 **by** reduced NADP and ATP **;** 8 triose phosphate / TP, used to regenerate RuBP **;** 9 glycerate 3-phosphate / GP, forms amino acids **;** 10 (some) TP forms, (named) hexoses / sucrose / maltose / starch / cellulose / glycerol / lipids / amino acids **;** 11 *ref. to* Calvin cycle **;**	**7**

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>8(a)(i)</td><td>X – Schwann (cell) ; Ignore myelin sheath (as not a cell)

Y – cell body ; A cytoplasm</td><td>2</td></tr>
<tr><td>8(a)(ii)</td><td>intermediate neurone ; A relay neurone / sensory neurone</td><td>1</td></tr>
<tr><td>8(b)</td><td>
<table>
<tr><th>correct order</th><th>letter of stage</th></tr>
<tr><td>1</td><td>C</td></tr>
<tr><td>2</td><td>F</td></tr>
<tr><td>3</td><td>A</td></tr>
<tr><td>4</td><td>E</td></tr>
<tr><td>5</td><td>J</td></tr>
<tr><td>6</td><td>I</td></tr>
<tr><td>7</td><td>G</td></tr>
<tr><td>8</td><td>B</td></tr>
<tr><td>9</td><td>H</td></tr>
<tr><td>10</td><td>D</td></tr>
</table>
C F A E all above J ;
C F A E in correct order ;

I G B H between J and D ;
I G B H in correct order ;</td><td>4</td></tr>
</table>

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Question	Answer	Marks
8(c)	*any **four** from:* *allow 'no' for 'less' or 'fewer'* 1 less / fewer, Ca^{2+} enter (pre)synaptic knob **;** 2 less / fewer, vesicles, move to / fuse with, presynaptic membrane **;** 3 less, ACh released / exocytosis of ACh **;** 4 less binding of ACh to receptors (on sarcolemma) **;** 5 fewer, Na^+ channels open / Na^+ enter (muscle fibre) **;** 6 less depolarisation of sarcolemma / threshold potential not reached / fewer action potentials generated **;** **Ignore** postsynaptic membrane 7 less Ca^{2+} released from SR / less binding of Ca^{2+} to troponin / fewer sites exposed / fewer cross bridges **;**	**4**

Question	Answer	Marks
9(a)	*any **three** from:* 1 loss of habitat / example **;** 2 hunted **/** poaching / increased predation **;** 3 climate change / example **;** 4 competition for, food / resources / example **;** 5 **new** disease **;** 6 illegal pet / fur, trade **;**	**3**

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>9(b)</td><td>1 large / steep, increase from 1980 to 1990 ;
2 plateau / remains constant or slight changes / fluctuates ;
3 data quote (two numbers and two years) ;
<table>
<tr><th>year</th><th>number of lemurs born</th></tr>
<tr><td>1970</td><td>5</td></tr>
<tr><td>1980</td><td>32 / 33</td></tr>
<tr><td>1990</td><td>175</td></tr>
<tr><td>2000</td><td>175</td></tr>
<tr><td>2010</td><td>184 / 185</td></tr>
<tr><td>2020</td><td>170</td></tr>
</table></td><td>3</td></tr>
<tr><td>9(c)(i)</td><td>any three from:
1 stress (in captivity) ;
2 reproductive cycle disrupted ;
3 may reject mate / refuse to breed / do not have correct (courtship) behaviour ;
4 lack of suitable mates ;
5 enclosure too small / not natural environment ;
6 expensive ;
7 AVP ; e.g. inbreeding</td><td>3</td></tr>
</table>

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Question	Answer	Marks
9(c)(ii)	increase / maintain, **genetic** diversity / heterozygosity / hybrid vigour / gene pool **OR** reduce, inbreeding depression / homozygosity **;**	**1**

Question	Answer	Marks
10(a)	*any **four** from:* 1 changes in factor / stimulus, detected by receptor **;** 2 *ref. to* CNS / brain / coordinator **;** 3 impulses / (named) hormone, sent to, (named) effector / muscle / gland **;** 4 (named) effector / muscle / gland, carries out response **;** 5 factor **returns** to, set point / norm **;** 6 negative feedback **;** 7 AVP **;** e.g. cell signalling	**4**

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Question	Answer	Marks
10(b)	*any **three** from:* *cell signalling carries on* 1 / 2 two details **;;** e.g. glucagon binds to receptors / adenylyl cyclase stimulated / G protein activated / cAMP formed / protein kinase A activated / enzyme cascade 3 no / less, (functioning) glycogen phosphorylase (produced) **OR** non-functioning glycogen phosphorylase (produced) **OR** no / less, glycogen phosphorylase activated **;** 4 change in, tertiary structure / active site **;** 5 (so) less / no, glycogen converted to glucose / glycogenolysis **;**	**3**
10(c)	*any **three** from:* 1 no / less, (functioning) glycogen synthase (produced) **or** non-functioning glycogen synthase (produced) **or** no / less, glycogen synthase activated **;** 2 high **/** increase in, blood glucose <u>concentration</u> (following this meal) **;** 3 (so) glucose (excreted) in urine **;** 4 more lipid synthesis **;** 5 inhibits release of glucagon **;** 6 AVP **;** e.g. affects blood water potential / dehydration / thirst / tiredness / coma / affects blood pressure	**3**

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CAMBRIDGE
International Education

Cambridge International AS & A Level

BIOLOGY **9700/43**

Paper 4 A Level Structured Questions **October/November 2024**

MARK SCHEME

Maximum Mark: 100

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the October/November 2024 series for most Cambridge IGCSE, Cambridge International A and AS Level components, and some Cambridge O Level components.

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PUBLISHED

Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptions for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

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GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

Science-Specific Marking Principles

1	Examiners should consider the context and scientific use of any keywords when awarding marks. Although keywords may be present, marks should not be awarded if the keywords are used incorrectly.
2	The examiner should not choose between contradictory statements given in the same question part, and credit should not be awarded for any correct statement that is contradicted within the same question part. Wrong science that is irrelevant to the question should be ignored.
3	Although spellings do not have to be correct, spellings of syllabus terms must allow for clear and unambiguous separation from other syllabus terms with which they may be confused (e.g. ethane / ethene, glucagon / glycogen, refraction / reflection).
4	The error carried forward (ecf) principle should be applied, where appropriate. If an incorrect answer is subsequently used in a scientifically correct way, the candidate should be awarded these subsequent marking points. Further guidance will be included in the mark scheme where necessary and any exceptions to this general principle will be noted.
5	‘List rule’ guidance For questions that require ***n*** responses (e.g. State **two** reasons …): • The response should be read as continuous prose, even when numbered answer spaces are provided. • Any response marked *ignore* in the mark scheme should not count towards ***n***. • Incorrect responses should not be awarded credit but will still count towards ***n***. • Read the entire response to check for any responses that contradict those that would otherwise be credited. Credit should **not** be awarded for any responses that are contradicted within the rest of the response. Where two responses contradict one another, this should be treated as a single incorrect response. • Non-contradictory responses after the first ***n*** responses may be ignored even if they include incorrect science.

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6 Calculation specific guidance

Correct answers to calculations should be given full credit even if there is no working or incorrect working, **unless** the question states 'show your working'.

For questions in which the number of significant figures required is not stated, credit should be awarded for correct answers when rounded by the examiner to the number of significant figures given in the mark scheme. This may not apply to measured values.

For answers given in standard form (e.g. $a \times 10^n$) in which the convention of restricting the value of the coefficient (a) to a value between 1 and 10 is not followed, credit may still be awarded if the answer can be converted to the answer given in the mark scheme.

Unless a separate mark is given for a unit, a missing or incorrect unit will normally mean that the final calculation mark is not awarded. Exceptions to this general principle will be noted in the mark scheme.

7 Guidance for chemical equations

Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme.

State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme.

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Mark scheme abbreviations

;	separates marking points
/	alternative answers for the same point
A	accept (for answers correctly cued by the question, or by extra guidance)
R	reject
I	ignore
( )	the word / phrase in brackets is not required, but sets the context
AW	alternative wording (where responses vary more than usual)
underline	actual word given must be used by candidate (grammatical variants accepted)
max	indicates the maximum number of marks that can be given
ora	or reverse argument
mp	marking point (with relevant number)
ecf	error carried forward
AVP	alternative valid point

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Question	Answer	Marks
1(a)(i)	**A** = dendrite(s) **;** **B** = nuclei **;** **C** = synaptic knob(s) **;**	**3**
1(a)(ii)	**1** rat has, myelin sheath / Schwann cell / myelinated axon / myelinated neurone **;** **2** (rat has) saltatory conduction **OR** (rat) impulse / action potential, jumps / leaps / AW, from (one) <u>node of Ranvier</u> to, the next / another **;**	**2**
1(b)	*any **three** from:* **snail / Fig. 1.3** **1** greater depolarisation **OR** (membrane potential) gets more positive / has higher increase / has higher peak **;** **2** action potential, slower / takes longer / takes more time **OR** longer time to return to resting potential **;** **3** longer (absolute / relative) <u>refractory period</u> **;** **4** longer hyperpolarisation **;** **5** AVP **;**	**3**

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Question	Answer	Marks
2(a)	*any **three** from:* **1** open in, day / light **;** **2** to take in carbon dioxide for, photosynthesis / light-independent stage / Calvin cycle **;** **3** close in, night / dark **;** **4** to decrease water loss by transpiration **;**	**3**
2(b)	*any **six** from:* **1** hydrogen ions / protons / H ions / H^+, leave (cell) using, energy / ATP **;** **2** low H^+ (in cell) / more negative charge **;** **3** K^+ / potassium ion, channel (proteins) open **OR** K^+, move into / enter, cell (by facilitated diffusion) **;** **4** C*l*$^-$ ions, move into / enter (cell) **;** **5** water potential of cell decreases **;** **6** water moves in (to cell) by osmosis **;** **7** (cells) become turgid / swell / increase in volume / expand **;** **8** (guard cell) inner wall thicker / outer wall thinner, so cells, bend / curve **;**	**6**
2(c)	**1** (environment) light needed, to keep cycle normal / to achieve same peak % of stomata opening **;** **2** genes have a role as (regular), rhythm / pattern / cycle, continues, in darkness / without light **;**	**2**

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>3(a)</td><td>
<table>
<tr><td rowspan="2">event</td><td colspan="4">stage</td><td></td></tr>
<tr><td>G</td><td>LR</td><td>KC</td><td>OP</td><td></td></tr>
<tr><td>catabolism</td><td>✓</td><td>✓</td><td>✓</td><td>×</td><td>;</td></tr>
<tr><td>coenzyme is reduced or oxidised</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>;</td></tr>
<tr><td>a coenzyme forms a covalent bond with a respiratory intermediate</td><td>×</td><td>✓</td><td>×</td><td>×</td><td>;</td></tr>
<tr><td>carbon dioxide is released</td><td>×</td><td>✓</td><td>✓</td><td>×</td><td>;</td></tr>
</table>
</td><td>4</td></tr>
<tr><td>3(b)(i)</td><td>any four from:

1 (RQ =) ratio of carbon dioxide (exhaled) to oxygen (inhaled) ;
2 air flow meter measures oxygen inhaled ;
3 carbon dioxide sensor measures concentration of CO_2 exhaled ;
4 carbohydrate RQ = 1 ;
5 lipid RQ = 0.7 ;</td><td>4</td></tr>
<tr><td>3(b)(ii)</td><td>any three from:

1 lipid has higher energy (value) OR
carbohydrate 15–17 kJ g^{-1} and lipid 37–40 kJ g^{-1} ;
2 more, hydrogen (atoms) / C-H bonds, in lipid ;
3 more reduced, NAD / FAD ;
4 greater proton gradient / more protons in intermembrane space / more protons pass through ATP synth(et)ase ;</td><td>3</td></tr>
</table>

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Question	Answer	Marks
4(a)	*any **three** from:* *in Venus fly traps* **1** touch two (sensory hairs) **;** **2** protons, leave hinge cells / enter hinge cell walls **;** **3** Ca^{2+} ions move into (hinge) cells **;** **4** water moves into (hinge) cells **;** **5** (hinge) cells, become turgid / swell / increase in volume / expand **;**	**3**
4(b)	*any **two** from:* **1** less / decreased, surface area (of leaf exposed) **;** **2** less light absorbed by, chloroplasts / thylakoid membranes / grana / pigments / chlorophyll / light harvesting complexes / photosystems **;** **3** fewer stomata, exposed / available (to air) **;** **4** less carbon dioxide, enters / absorbed **;**	**2**
4(c)	*any **six** from*: *similarities* **1** photoactivation of chlorophyll **;** **2** (energetic) electrons move, along / down, ETC **;** **3** chemiosmosis **;** **4** ATP produced **;** *differences* **5** PSI and PSII in non-cyclic **and** only PSI in cyclic **;** **6** photolysis / oxygen produced, in non-cyclic only **;** ORA **7** reduced NADP in non-cyclic only **;** ORA **8** electrons return to, same photosystem / PSI, in cyclic **;**	**6**

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Question	Answer	Marks
5(a)	*any **two** from:* **1** one / single, set of chromosomes **;** **2** have **n** (number of) chromosomes / half of diploid number **;** **3** chromosomes not in homologous pairs / only one of each homologous pair **;** **4** each chromosome is different in, size / shape / genes / loci **;**	**2**
5(b)	*sexual reproduction*: **B** and **D ;** *mitosis*: *two from* **A**, **B**, **C**, **D ;** *meiosis*: **D ;**	**3**
5(c)	*any **three** from:* **1** to maintain, chromosome / diploid, number **;** **2** from parents to offspring / from generation to generation **;** **3** to give genetic variation in, gametes / offspring / horses **;** **4** too many / extra, sets of chromosomes cause (named) problems **;**	**3**

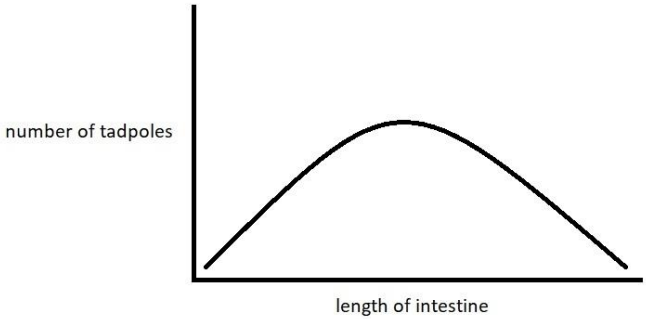
Question	Answer	Marks
6(a)(i)	**1** (excess) amino acids, deaminated / have amino group removed **;** **2** in the liver **;**	**2**
6(a)(ii)	*any **three** from:* **1** osmoreceptors in hypothalamus (detect change / are receptors) **;** **2** effector(s): collecting duct / distal convoluted tubule / nephron **;** **3** target cells: collecting duct (cells) **;**	**3**

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Question	Answer	Marks
6(b)	*any **three** from:* **1** ultrafiltration / forms glomerular filtrate **;** **2** high, hydrostatic / blood, <u>pressure</u> in, glomerulus / capillaries **;** **3** so, water / (named) solutes, move (out of glomerulus / into Bowman's capsule) **;** **4** through *two of*: fenestrae / fenestrations basement membrane slit pores / filtration slits / between podocytes **;** **5** AVP **;**	**3**
6(c)	*any **three** from:* **1** high(er / est), U:P / ratio → can tolerate water shortage **;** **2** high(er / est), U:P / ratio → much water reabsorbed / small volume of urine produced **;** **3** high(er / est), U:P / ratio → can, concentrate urine / conserve water **OR** high(er / est), U:P / ratio → (well) adapted to dry environment **;** **4** AVP **;**	**3**

Question	Answer	Marks
7(a)(i)	*any **three** from:* **1** disruptive / diversifying (selection) **;** **2** extremes / carnivores and detritus feeders, survive / are selected for **and** intermediates, die / are selected against **;** **3** high / intense, competition **;** **4** intermediates, outcompeted for / don't get enough, detritus / algae, and, (fairy) shrimp / small animals **;** **5** lack of / limited, food is selection pressure **;** **6** AVP **;**	**3**

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Question	Answer	Marks
7(a)(ii)	*any **three** from:* **1** stabilising (selection) **;** **2** extremes / carnivores and detritus feeders, die / are selected against / are not selected for, **and** intermediates, survive / are selected for **;** **3** low / less / prevents, competition **;** **4** intermediates can eat, both types / all / a wider range, of food **;** **5** greater variety in the diet improves the growth and development of (intermediate) tadpoles **;**	**3**
7(a)(iii)	 normal distribution curve **;**	**1**
7(a)(iv)	*any **two** from*: **1** new species form due to reproductive isolation **;** **2** caused by, ecological / behavioural, separation / isolation / differences **;** **3** in same geographical region **;** **4** AVP **;**	**2**
7(b)	*any **three** from*: **1** *ref. to* DNA sequence (for all / three species) **;** **2** find / count, nucleotide / base, differences / similarities **;** **3** fewer differences means, more closely related / less time since divergence / less time to common ancestor **;** **4** bioinformatics / database / software / BLAST **;** **5** *S. hammondii* and *S. bombifrons,* have the fewest genetic differences / are the most genetically similar **;**	**3**

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>8(a)</td><td>any three from:

1 make cDNA from, messenger RNA / mRNA ;
2 using reverse transcriptase ;
3 synthesise (gene chemically) from nucleotides / join nucleotides ;
4 (using known) amino acid / nucleotide, sequence from database ;</td><td>3</td></tr>
<tr><td>8(b)</td><td>
<table>
<tr><th>role in genetic engineering</th><th>DNA ligase</th><th>DNA polymerase</th><th></th></tr>
<tr><td>joins two sections of sugar phosphate backbone in DNA</td><td>✓</td><td>×</td><td>;</td></tr>
<tr><td>adds a gene to a plasmid</td><td>✓</td><td>×</td><td>;</td></tr>
<tr><td>adds free activated DNA nucleotides to a polynucleotide</td><td>×</td><td>✓</td><td>;</td></tr>
</table>
</td><td>3</td></tr>
<tr><td>8(c)</td><td>1 90–98°C – DNA, denatures / strands separate ;
2 50–65°C – primers, bind / base pair / anneal (to DNA) ;
3 68–75°C – Taq / DNA, polymerase, makes, DNA / (new) strand ;</td><td>3</td></tr>
</table>

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Question	Answer	Marks
9(a)	*any **four** from:* **1** both, eukaryotic / eukaryotes / in domain Eukarya **;** **2** example of eukaryotic feature **;** *Protoctista* **3** example of way in which they vary *(must give both)* **;** *Fungi (max 3)* **4** cell wall of, chitin / mannan / glucan **;** **5** hyphae / mycelium **;** **6** multinucleate / syncytium / many nuclei per cell **;** **7** heterotrophic / saprotrophic / parasitic **;** **8** store glycogen **;** **9** reproduce by spores **;**	**4**
9(b)(i)	*any **three** from:* **1** measures / gives information about, air, quality / pollution **;** **2** other species may be harmed by, sulfur dioxide / acid rain / decrease in lichen (abundance / diversity) **;** **3** *ref. to* food web / species that feed on lichens **;** **4** AVP **;**	**3**
9(b)(ii)	*any **two** from:* **1** role in food web / eaten by other (named) species **;** **2** provide, shelter / camouflage (for insects / invertebrates) **;** **3** clean the air / remove (named) pollutants / absorb toxins **;** **4** may have medical use **;** **5** *ref. to* other practical use **;** **6** primary colonisers / pioneer species / soil formation **;** **7** ethical / moral / aesthetic, reason **;** **8** to conserve genetic diversity / future use for genes **;**	**2**

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>10(a)</td><td>(melanic x melanic)
Aa x Aa
(Gametes) A a and A a ;

(Offspring) AA Aa Aa aa ;
(melanic, melanic, melanic, typical)

(Ratio) 3 melanic : 1 typical ;</td><td>3</td></tr>
<tr><td>10(b)</td><td>it / (melanic) allele, is dominant ;</td><td>1</td></tr>
<tr><td>10(c)(i)</td><td>melanic / dominant phenotype, is crossed with homozygous recessive ;</td><td>1</td></tr>
<tr><td>10(c)(ii)</td><td><table>
<tr><th></th><th>same locus
(A / a)</th><th>different loci
(A / a and B / b)</th></tr>
<tr><td>genotypes of melanic
moths from cross 1</td><td>AA
Aa
(aA) ;</td><td>AaBb
Aabb
aaBb ;</td></tr>
<tr><td>proportion of test crosses
(cross 2) giving 100%
melanic offspring</td><td>1 in 3</td><td>none / 0 ;</td></tr>
</table></td><td>3</td></tr>
<tr><td>10(d)</td><td>(24 × 29) ÷ 8 ;
= 87 ;</td><td>2</td></tr>
</table>

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