Biology

Higher level

Paper 2

Markscheme

Question	Acceptable Answers	Notes	Marks
1 a	1. **Shorter height** in Mut001 ✔. 2. **Fewer brace roots** in Mut001 ✔.		2
1 b(i)	- **44.4%** ✔. (Working: [(180−100)/180]×100)	Correct math required.	1
1 b(ii)	**Statistical Significance**: - **Yes** (asterisks indicate $P < 0.05$) ✔.		1
1 c(i)	- **3.4:1** (wild-type: mutant) ✔.	Accept 152:45 **OR** 3.4:1 .	1
1 c(ii)	- **Monohybrid dominant/recessive** (3:1 ratio) ✔.		1
1 d(i)	- **Heterozygous SNP** (G/A) ✔.		1
1 d(ii)	- **Heterozygosity** at this locus ✔.		1
1 e	- **Acid growth hypothesis** (H^+ pumps loosen wall) ✔. - **Gene expression** for sustained growth ✔.		2
1 f(i)	- Disrupts **auxin gradients** → stunted growth ✔. - **Root/shoot abnormalities** ✔.		2
1 f(ii)	- Maize: **Reduced auxin** in roots under Al stress ✔. - Arabidopsis: **Increased auxin** in roots ✔.		2

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1 g	- **Aluminum tolerance** ✔. - **Continued root growth** in toxic soils ✔.		2

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2 a (i)	Structural Changes**:** **1.** Chromatin condensation **OR** Nuclear envelope breakdown ✔. 2. Centrosome duplication **OR** Spindle formation ✔.	Must identify **two distinct changes**.	2
2 a (ii)	**G1 Advantage**: - Organelles need proteins/lipids (requires synthesis) ✔. - S phase prioritizes **DNA replication** (resources allocated there) ✔.		2
2 b (i)	**Most Affected Phase**: - **G1** ✔.		1
2 b (ii)	**Impact on Mitosis**: - Insufficient cyclins/CDKs for checkpoint passage ✔. - Lack of spindle/mitotic machinery proteins ✔.	Protein synthesis must be linked to **checkpoints OR** structures.	2
2 c	**Opinion**: - **Agree**: Liver cells divide less (longer G0) **OR** **Disagree**: Both require full G1 ✔. **Reason**: Cite **cell type function** (e.g., liver regeneration vs. epithelial turnover) ✔.	Must justify with **biological evidence**.	2

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3 a(i)	- **Hypotonic**: Water enters cell ($\psi_{cell} < \psi_{solution}$) ✔. - **Hypertonic**: Water leaves cell ($\psi_{cell} > \psi_{solution}$) ✔.		2
3 a(ii)	**ψ_w = 0 kPa**: - **Isotonic image** ✔. **Justification**: - No net water movement ($\psi_{cell} = \psi_{solution}$) ✔.		1
3 b(i)	$\psi_w = \psi_s + \psi_p$ = **-150 kPa** ✔.	Correct math is required.	1
3 b(ii)	**Prediction**: - ψ_p increases to **+450 kPa** ✔. **Justification**: - Distilled water ($\psi_w = 0$) causes maximal turgor pressure ✔.		2

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4 a	- Rapid rise to peak (~week 8-10) **OR** Sharp decline after the first trimester ✔.	Must describe **trend** (rise/fall).	1
4 b(i)	- **Week 10-12** ✔.	Must match graph intersection. Accept any of the three numbers	1
4 b(ii)	- **Progesterone**: Maintains endometrium **OR** Prevents contractions ✔. - **Estrogen**: Stimulates placental growth		2

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	OR Prepares mammary glands ✔.		
4 c	- **Miscarriage risk** **OR** Ectopic pregnancy ✔. - **Fetal abnormalities** **OR** Placental insufficiency ✔.	Two **different** implications required.	2

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5 a	- **50% decrease** ✔. - Working: [(1000−500)/1000]×100 = 50%	One mark for working and one for correct percentage.	1
5 b	- **Autoregulation** maintains constant O_2/glucose for brain function ✔. **OR** - Critical for consciousness **OR** metabolic demand stable ✔.		1
5 c	- **Vasoconstriction of afferent arterioles** ✔. **OR** - **Increased filtration fraction** ✔.		1

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6 a	- High tensile strength **OR** Resists turgor pressure ✔.	Must list two distinct properties.	2

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	- Insoluble in water **OR** Forms microfibrils ✔.		
6 b	- **Symbiotic gut bacteria** produce cellulase ✔. - **Fermentation chambers** (e.g., rumen) host microbes ✔. **OR** - **Cecal digestion** (e.g., in rabbits) ✔.	Must explain microbial role + digestive adaptation.	2

Question	Acceptable Answers	Notes	Marks
7 a(i)	- $q=\frac{2\times aa+Aa}{2\times Total}=\frac{80+320}{2000}=0.2$ ✔.	Correct working + answer required.	2
7 a(ii)	- **Expected** **Aa** = $2pq\times N=2\times0.8\times0.2\times1000=320$ ✔. - **Conclusion**: Observed (320) = Expected (320) → **Equilibrium** ✔.	Must show calculation + comparison.	2
7 b	- No natural selection **OR** Random mating **OR** No mutations **OR** Large population ✔.		1

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8 a	**Chargaff's Rules**: 1. **A = T OR Purines = Pyrimidines** ✔. 2. **G = C** ✔.		4

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	Species Variation: 3. **Ratios differ** between species **OR** (A+T)/(G+C) varies ✔. 4. **Example**: Human DNA has ~40% A+T **OR** *E. coli* has ~50% G+C ✔.		
8 b	1. **Base Pairing**: Showed A=T and G=C, suggesting complementary pairing ✔. 2. **Uniform Helix Width**: Equal purine-pyrimidine ratios implied consistent diameter ✔. 3. **Anti-Parallel Strands**: Supported by 1:1 stoichiometry ✔. 4. **Non-Repetitive Sequences**: Falsified tetranucleotide hypothesis ✔. 5. **Quantitative Foundation**: Provided empirical data for model-building ✔. 1. **No 3D Data**: Did not reveal helical shape **OR** hydrogen bonding ✔. 2. **No Backbone Info**: Silent on sugar-phosphate arrangement ✔.	Must explicitly link **≥3** contributions to the model. Must identify **two** gaps in Chargaff's data.	7
8 c	**Strengths**: 1. Confirmed DNA as genetic material (not protein) ✔.	Must include **2 strengths + 2 limitations**.	4

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	2. **Used isotopes** ($^{32}P/^{35}S$) for definitive labeling ✔. **Limitations**: 3. Did not show replication mechanism **OR** structure ✔. 4. **Bacteriophage** not representative of all organisms ✔.		

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9 a	1a. Leaves needle-like → *Pinus* **OR** *Cedrus* ✔. 1b. Leaves broad → Go to 2 ✔. 2a. Leaves serrated → *Quercus* **OR** *Fagus* ✔. 2b. Leaves smooth → *Acer* **OR** *Platanus* ✔.	Must include **2 traits per step**.	4
9 b	**Comparison**: - Dichotomous: Phenotypic; Barcoding: Genetic ✔. - Dichotomous: Subjective; Barcoding: Objective ✔. - Barcoding detects evolutionary relationships ✔. **Dichotomous Keys**: - **Utility**: Fast **OR** low-cost **OR** field-friendly ✔. - **Limitation**: Requires morphological		7

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	expertise **OR** fails for cryptic species ✔. **DNA Barcoding**: - **Utility**: High accuracy **OR** identifies larvae/eggs ✔. - **Limitation**: Expensive **OR** requires lab access ✔.		
9 c	1. **Horizontal Gene Transfer**: Plasmids bypass vertical inheritance ✔. 2. **No Sexual Reproduction**: Cannot apply "reproductive isolation" ✔. 3. **Genetic Fluidity**: Shared genes blur species boundaries ✔. 4. **Example**: Antibiotic resistance spread via plasmids ✔.	Must link plasmid exchange to species concept failure.	4

Question	Acceptable Answers	Notes	Marks
10 a	**Functional Benefits**: 1. **Nuclear Pore Control**: Regulates mRNA/protein transport ✔. 2. **Compartmentalization**: Separates transcription (nucleus) from translation (cytoplasm) ✔. 3. **Protection**: Shields DNA from cytoplasmic enzymes **OR** oxidative damage ✔. 4. **Structural Support**: Maintains nuclear shape during division ✔.		4
10 b	**Free Ribosomes**: - Synthesize mitochondrial/chloroplast proteins ✔. - Products remain in	Must contrast **both roles + destinations**.	4

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	cytoplasm **OR** organelle-targeted ✔. **RER**: - Synthesize **secreted OR membrane-bou nd** proteins ✔. - Products go to Golgi **OR** lysosomes **OR** plasma membrane ✔.		
10 c	**Modification Steps**: - **Cisternal Maturation**: Proteins move through Golgi cisternae ✔. - **Glycosylation**: Adds carbohydrates (e.g., glycoproteins) ✔. - **Proteolytic Cleavage**: Activates enzymes (e.g., insulin maturation) ✔. **Packaging**: - **Vesicle Formation**: Exocytic vesicles bud from *trans*-Golgi ✔. - **Targeting**: Vesicles fuse with plasma membrane ✔. **Example**: Insulin **OR** digestive enzymes **OR** mucus secretion ✔.		7