Revision practice

International Baccalaureate · IB Diploma · Biology · HL

Original open focus revision; complete specification coverage remains unfinished.

1 Water: a molecular cause for a biological property

- cohesion
- adhesion

■ Question 1

What accounts for cohesion in liquid water?

- Covalent bonds joining every molecule into one giant molecule
- Intermolecular attractions including hydrogen bonding
- Water having no molecular motion

Available marks: 2.

Worked answer

Intermolecular attractions including hydrogen bonding

- The same intermolecular interactions help explain surface tension and the energy needed to change temperature. Heating changes molecular motion and interactions; it does not normally break the covalent O–H bonds.

■ Question 2

Use c = 4,180 J/(kg K). Calculate Q for 0.200 kg water heated through 5.0 K. Give the energy in joules to two significant figures.

Available marks: 4.

Worked answer

4200 J

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

Hydrogen bonds between molecules differ from covalent bonds within a water molecule. Polarity alone does not make every substance dissolve well in water.

2 DNA, protein synthesis and evidence

- transcription
- translation

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■ Question 1

Which change can leave the amino-acid sequence unchanged?

- A substitution producing a synonymous codon
- Every deletion of one base
- Every insertion of one base

Available marks: 2.

Worked answer

A substitution producing a synonymous codon

- A codon comprises three bases. The genetic code is degenerate: more than one codon can specify the same amino acid. A substitution can therefore be silent, while insertions or deletions can shift the reading frame.

■ Question 2

A coding mRNA segment has 63 bases including a stop codon. Find peptide length.

Available marks: 4.

Worked answer

20 amino acids

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

The number of bases is not automatically the number of amino acids. Real genes include regulatory regions and, in eukaryotes, often introns; a whole gene length is not a peptide-length calculation.

3 Origins of cells: evidence and limits

- endosymbiosis
- inference

■ Question 1

Which observation is relevant evidence for mitochondrial endosymbiosis?

- Mitochondria have their own DNA
- All cells have exactly the same size
- Every organelle has a nucleus

Available marks: 2.

Worked answer

Mitochondria have their own DNA

- Independent observations strengthen a model when they make a consistent prediction. Similarity is evidence to evaluate alongside ancestry, sequence comparisons and alternative explanations, rather than proof from one feature.

■ Question 2

21 of 28 compared sites match. Calculate percentage identity.

Available marks: 4.

Worked answer

75 %

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

The endosymbiotic model does not say that every organelle arose from an engulfed bacterium. A laboratory model of early chemistry is not a recreation of the whole historical event.

4 Cell measurements and scale

- magnification
- resolution

■ Question 1

Which comparison of two cell images is reliable?

- Compare screen lengths only
- Convert both lengths using their own scale bars
- Assume both images have the same zoom

Available marks: 2.

Worked answer

Convert both lengths using their own scale bars

- A scale bar provides a known real distance in the same image. Convert the image length and real length to the same unit before dividing. Magnification is a ratio and has no unit.

■ Question 2

An image is 12 mm long; the cell is 40 micrometres long. Calculate magnification.

Available marks: 4.

Worked answer

300

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

A nucleus is not the only cell structure. Do not claim bacteria have no DNA, or that more magnification always means better resolution.

5 Disease transmission and immune response

- pathogen
- antigen

■ Question 1

What explains the spread of antibiotic resistance?

- Bacteria deliberately change all their genes
- Resistant variants survive and reproduce more successfully
- Antibiotics turn viruses into bacteria

Available marks: 2.

Worked answer

Resistant variants survive and reproduce more successfully

- After vaccination, memory cells can support a faster secondary response. Antibiotic resistance arises through heritable variation and selection; an individual bacterium does not choose to become resistant because it needs to survive.

■ Question 2

12 cases occur among 600 people. Find cases per 1,000 people.

Available marks: 4.

Worked answer

20

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

Antibiotics do not act on viruses in the same way they act on bacteria. A vaccine is not an immediate cure for an established infection.

6 Diversity, classification and a branching model

- taxon
- clade

■ Question 1

What remains the same when branches rotate around a node?

- The evolutionary relationships
- Every printed tip position

- An unstated time scale

Available marks: 2.

Worked answer

The evolutionary relationships

- Read relationships from the branching order. Rotating branches at a node does not change ancestry. A branch length represents time or change only when the diagram gives a scale.

■ Question 2

There are 8 differences in 50 aligned sites. Calculate percentage difference.

Available marks: 4.

Worked answer

16 %

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

A modern species is not automatically the ancestor of another modern species. Similarity caused by convergent evolution can mislead a classification based on one trait.

7 Adaptation: a function in an environment

- adaptation
- acclimatization

■ Question 1

Which statement distinguishes acclimatization?

- It is an individual adjustment during life
- It must change the allele frequency of a whole population
- It always produces a new species

Available marks: 2.

Worked answer

It is an individual adjustment during life

- Explain both a benefit and a cost. Reducing stomatal opening conserves water but can limit carbon dioxide entry. A feature cannot be judged as universally best without its ecological context.

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■ Question 2

Water loss is 8 g from 0.20 m^2 over 2 h. Calculate rate per area per hour.

Available marks: 4.

Worked answer

20 g/(m^2 h)

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

An individual organism does not evolve a new inherited trait because it needs it. A plausible story about function is a hypothesis requiring evidence.

8 Biodiversity, conservation and sampling evidence

- species richness
- evenness

■ Question 1

Two sites have three species each. Which can still differ?

- Their evenness
- The definition of a species must change
- They must have identical conservation value

Available marks: 2.

Worked answer

Their evenness

- Compare surveys with similar area, effort, season and identification rules. A diversity index is meaningful only with its formula and conventions specified. Habitat fragmentation can affect movement and gene flow even when total area changes little.

■ Question 2

A survey records 6, 5, 3 and 2 individuals in four species. Find species richness.

Available marks: 4.

Worked answer

4 species

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

An index cannot by itself explain the cause of a difference. A newly recorded species may reflect improved observation rather than a recent ecological arrival.

9 Biomolecule structure: bonds, polarity and function

- peptide bond
- hydrolysis

■ Question 1

What distinguishes a triglyceride in this model?

- Glycerol with three fatty acids joined by ester bonds
- A chain consisting only of peptide bonds
- A DNA sequence with thymine

Available marks: 2.

Worked answer

Glycerol with three fatty acids joined by ester bonds

- Condensation forms a linkage with a small molecule such as water released in the simplified model; hydrolysis uses water to break such a linkage. Polymer sequence, branching, polarity and three-dimensional shape matter. Saturated fatty acids have no carbon-carbon double bond, while unsaturated fatty acids have at least one; this difference can influence packing under stated conditions.

■ Question 2

A single unbranched peptide contains 35 amino-acid residues. How many peptide bonds join them?

Available marks: 4.

Worked answer

34 bonds

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

Not every protein is an enzyme, and not every catalyst is a protein. Lipids are not all polymers of repeating monomers. A protein can lose function when its folding changes without every peptide bond being broken.

10 Osmosis and a fair potato experiment

- osmosis
- control variable

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■ Question 1

Why blot all samples before the final weighing?

- To remove surface solution consistently
- To remove water lost from inside the cells
- To make the final masses larger and easier to read

Available marks: 2.

Worked answer

To remove surface solution consistently

- Use percentage change to compare samples with different initial masses. A zero percentage change estimates a solution concentration with no net water movement. This is an estimate from a trend, not proof that water molecules stop moving.

■ Question 2

A 4.00 g cylinder ends at 3.60 g. Find percentage mass change.

Available marks: 4.

Worked answer

-10 %

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

Blotting removes surface solution. Weighing a wet cylinder without blotting adds liquid that did not enter the cells. Repeats reduce random variation but do not correct a miscalibrated balance.

11 Specialized cells: structure linked to function

- differentiation
- gene expression

■ Question 1

What best explains many differences between specialized cells?

- They express different sets of genes
- Every cell has a different genetic code
- They have no shared ancestry

Available marks: 2.

Worked answer

They express different sets of genes

- Link a named feature to a mechanism and then to the function. Increased area can support exchange, but membrane proteins, gradients and metabolic demand also matter. Stem cells retain different degrees of developmental potential.

■ Question 2

For a sphere, surface area/volume = 3/r. Find this ratio when r = 6 units.

Available marks: 4.

Worked answer

0.5 per unit

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

Specialization does not usually require a cell to lose most of its genes. The spherical calculation models geometry; it does not describe every actual cell shape.

12 Gas exchange: maintaining diffusion gradients

- ventilation
- perfusion

■ Question 1

What maintains an oxygen gradient across the lung exchange surface?

- Ventilation and blood flow
- Stopping all blood flow
- Making the diffusion path longer

Available marks: 2.

Worked answer

Ventilation and blood flow

- Distinguish movement of the whole medium from diffusion across the membrane. Ventilation and perfusion work together, while haemoglobin helps transport oxygen in blood. A change in breathing rate alone does not measure oxygen uptake.

■ Question 2

Tidal volume is 0.60 L and breathing rate is 10 breaths/min. Find minute ventilation.

Available marks: 4.

Worked answer

6 L/min

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

Air entering the lungs is not all exchanged with blood. Oxygen and carbon dioxide diffuse in opposite net directions because their own gradients differ.

13 Digestion, transport and health evidence

- digestion
- absorption

■ Question 1

Which statement about bile is correct?

- It is a protease
- It emulsifies lipids
- It breaks every nutrient into monomers

Available marks: 2.

Worked answer

It emulsifies lipids

- Absorption moves soluble products into blood or lymph. Thin exchange surfaces and a large surface area shorten diffusion paths and increase transfer. Enzyme activity and transport are different processes.

■ Question 2

9 of 36 participants report an outcome. Calculate the percentage.

Available marks: 4.

Worked answer

25 %

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

Bile is not an enzyme. A positive food test identifies a component under the test conditions; it does not show that a food is healthy or unhealthy in every diet.

14 Muscle contraction: filaments slide

- sarcomere
- cross-bridge

■ Question 1

What happens to thick-filament length during normal contraction?

- It remains approximately constant
- It halves whenever the muscle shortens
- It becomes zero

Available marks: 2.

Worked answer

It remains approximately constant

- During shortening, overlap increases. The A-band length stays approximately constant while I bands and the H zone become smaller. Movement at a joint also depends on tendon insertion, lever geometry and opposing muscle activity.

■ Question 2

A sarcomere shortens from 3.0 to 2.4 micrometres. Calculate percentage shortening.

Available marks: 4.

Worked answer

20 %

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

ATP is required for myosin detachment as well as the continuing cycle. A muscle pulling harder does not mean all its fibres become shorter under every load.

15 Ecological niches: resources, conditions and interactions

- ecological niche
- resource partitioning

■ Question 1

What evidence concerns a niche rather than only a habitat location?

- Recorded resource use and conditions with interactions considered
- A map coordinate alone
- The name of the site without observations

Available marks: 2.

Worked answer

Recorded resource use and conditions with interactions considered

- Separate a habitat observation from a causal claim about a niche boundary. Absence from a site can reflect dispersal, detection, abiotic conditions or interactions. Resource partitioning can reduce overlap, but an observational difference alone does not prove that competition caused it. Compare alternative explanations and the timescale of evidence.

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Question 2

A species uses one resource in 12 of 40 feeding observations. Calculate the observed percentage.

Available marks: 4.

Worked answer

30 %

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

A niche is not identical to a trophic level or a habitat. A realized niche is a context-dependent model, and an incomplete survey cannot establish every tolerance limit or competitive interaction.

16 Enzyme rate and controlled measurements

- enzyme
- denaturation

Question 1

Which change best tests the effect of pH?

- Change pH and temperature together
- Use buffers of different pH at one temperature
- Change enzyme concentration at each pH

Available marks: 2.

Worked answer

Use buffers of different pH at one temperature

- Measure rate using product formed per unit time or a fixed endpoint. For an endpoint test, 1/time is a rate proxy if the same amount of product or substrate change defines the endpoint each time.

Question 2

A fixed endpoint takes 50 s. Calculate the rate proxy 1/time.

Available marks: 4.

Worked answer

0.02 1/s

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

An optimum is specific to the enzyme and conditions. Low temperature usually slows the reaction; it does not necessarily denature the enzyme. Endpoint intervals limit precision.

17 Respiration, ATP and energy transfers

- respiration
- ATP

■ Question 1

Why use a temperature-controlled water bath for respirometry?

- To make every organism the same mass
- To reduce gas-volume changes unrelated to respiration
- To stop oxygen uptake

Available marks: 2.

Worked answer

To reduce gas-volume changes unrelated to respiration

- Anaerobic processes allow ATP production when oxygen supply cannot support the required aerobic rate, but give less ATP per glucose. In humans lactate can accumulate; yeast can produce ethanol and carbon dioxide.

■ Question 2

0.60 cubic centimetres are used in 3.0 minutes by 2.0 g of tissue. Find the mass-specific rate.

Available marks: 4.

Worked answer

0.1 cm^3/min/g

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

Breathing ventilates the lungs; respiration consists of chemical reactions in cells. A moving respirometer marker can also reflect temperature or pressure changes.

18 Photosynthesis and limiting factors

- limiting factor
- photosynthesis

■ Question 1

A rate-light graph reaches a plateau. What follows?

- Light is still certainly the only limit
- Another factor may now limit the rate
- Photosynthesis has stopped

Available marks: 2.

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Worked answer

Another factor may now limit the rate

- Change only one factor when testing a limiting factor. At low light, extra light may increase rate. At a plateau, the changed factor is no longer the main limit in that range; the graph alone does not identify which other factor is limiting.

■ Question 2

9.0 cubic centimetres of gas are collected in 3.0 minutes. Find the rate.

Available marks: 4.

Worked answer

3 cm^3/min

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

Moving a lamp changes light and may also change temperature. A photosynthesis experiment needs control of heating, not just a ruler.

19 Cell signalling: a receptor selects the response

- receptor
- signal transduction

■ Question 1

Why can one signal produce different effects in two cell types?

- Their receptors or internal pathways differ
- Signals always act without receptors
- Every cell must give the same response

Available marks: 2.

Worked answer

Their receptors or internal pathways differ

- Distinguish signal reception, transduction and response. Amplification can allow a small extracellular change to produce a larger intracellular effect. Different receptors or pathways can give different responses to one signal.

■ Question 2

Response rises from 10 to 50 units. Calculate the fold change.

Available marks: 4.

Worked answer

5

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- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

A receptor is not interchangeable with every signalling molecule. Greater signal concentration does not imply unlimited response once the system saturates.

20 Neural signalling: impulses and synapses

- action potential
- synapse

■ Question 1

How can stimulus intensity affect an all-or-none signalling system?

- Through impulse frequency or recruitment
- By giving every impulse unlimited amplitude
- By removing all ion gradients

Available marks: 2.

Worked answer

Through impulse frequency or recruitment

- The all-or-none principle applies to an individual action potential. Stimulus information can be encoded by frequency and recruitment. Myelination permits saltatory conduction between nodes rather than making ions move freely through myelin.

■ Question 2

24 impulses occur in 0.40 s. Find impulse frequency.

Available marks: 4.

Worked answer

60 Hz

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

A neurotransmitter diffuses across the synaptic cleft; an action potential does not jump intact through the liquid gap. Excitatory input does not guarantee the postsynaptic cell reaches threshold.

21 Feedback and internal conditions

- homeostasis
- negative feedback

■ Question 1

Which response opposes a rise in blood glucose?

- Increased insulin action
- Increased release of glucose from glycogen
- Stopping all cellular respiration

Available marks: 2.

Worked answer

Increased insulin action

- When blood glucose is high, insulin helps increase glucose uptake and storage as glycogen. When it is low, glucagon supports release of glucose from stores. These responses are coordinated, not identical effects of two hormones.

■ Question 2

A value rises from 4.0 to 5.0. Calculate the percentage increase.

Available marks: 4.

Worked answer

25 %

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

Negative feedback does not mean the response is harmful or the measured value becomes negative. Diabetes has different mechanisms; do not treat every case as a failure to make insulin.

22 Sampling populations without choosing the answer

- quadrat
- population

■ Question 1

Which method investigates change from a path into woodland?

- Choose only large plants
- Use a transect with fixed sampling distances
- Take one convenient sample

Available marks: 2.

Worked answer

Use a transect with fixed sampling distances

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- Estimate total abundance by multiplying mean density by area, with consistent units. This assumes sampled areas represent the habitat. Patchiness and too few samples widen uncertainty.

Question 2

Mean count is 6 in a 0.5 square metre quadrat. Find density per square metre.

Available marks: 4.

Worked answer

12

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

Quadrats suit organisms that do not move quickly. A food chain arrow shows the direction of energy transfer, not the direction a predator travels.

23 Energy transfer: use production and a stated boundary

- trophic transfer efficiency
- assimilation

Question 1

Which pair can be used for the stated transfer-efficiency calculation?

- Two production values with common area, time and energy units
- Animal count divided by plant biomass
- Standing biomass divided by an unrelated yearly energy total

Available marks: 2.

Worked answer

Two production values with common area, time and energy units

- Use the same energy units and period in numerator and denominator. Distinguish ingestion, assimilation and production: consumed energy is not all assimilated, and assimilated energy is not all stored as new biomass. An energy pyramid records a flow per area per time; a standing biomass snapshot is a different quantity.

Question 2

Producer production is 8,000 and primary-consumer production is 800 kJ/m^2/year. Calculate transfer efficiency.

Available marks: 4.

Worked answer

10 %

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- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

Energy is not destroyed when respiration transfers it as heat. Material can cycle through an ecosystem, while usable energy flow depends on continuing input. A count pyramid or biomass snapshot cannot automatically be substituted into an energy-efficiency calculation.

24 DNA replication: retain one strand in each daughter molecule

- semi-conservative replication
- DNA polymerase

■ Question 1

What does each daughter double helix retain after one ideal replication round?

- One parental strand
- Both parental strands together in every molecule
- No parental material

Available marks: 2.

Worked answer

One parental strand

- New DNA is synthesized in the 5′ to 3′ direction. In a simplified fork model, one new strand can be synthesized continuously while the other is produced in fragments that are joined. Distinguish these molecular mechanisms from the later separation of chromosomes during cell division. Copying errors can occur despite proofreading and repair.

■ Question 2

One labelled double helix replicates for three complete rounds in unlabelled nucleotides. What percentage of the eight molecules contain an original strand?

Available marks: 4.

Worked answer

25 %

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

Replication uses DNA as a template to make DNA; transcription uses a DNA template to make RNA. A predicted label distribution assumes complete rounds and no degradation or exchange of the labelled material.

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25 Cell division: count nuclei and chromosomes carefully

- mitotic index
- chromatid

■ Question 1

What happens to DNA amount during replication before mitosis?

- It doubles
- It disappears
- It always halves

Available marks: 2.

Worked answer

It doubles

- Count chromosomes by centromeres under the stated convention. DNA amount and chromosome number are different quantities. Crossing over and independent assortment contribute to meiotic variation.

■ Question 2

18 of 120 scored cells are dividing. Calculate mitotic index as a percentage.

Available marks: 4.

Worked answer

15 %

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

Replication doubles DNA amount without immediately doubling the chromosome count. Meiosis does not simply produce two identical diploid cells.

26 Gene expression: regulate products, not just genes

- transcription factor
- epigenetic modification

■ Question 1

What is justified by higher measured mRNA abundance?

- More of that transcript under the measured conditions
- A guaranteed equal increase in protein activity
- Proof that the gene sequence mutated

Available marks: 2.

Worked answer

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More of that transcript under the measured conditions

- Distinguish a measured mRNA change from a protein or functional change. Translation, degradation and protein modification can all intervene. Regulation is specific to a cell context and environmental conditions.

■ Question 2

Transcript abundance is 15 in treatment and 5 in control. Find fold change.

Available marks: 4.

Worked answer

3

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

An epigenetic change is not automatically a DNA-sequence mutation. More mRNA does not guarantee proportionally more active protein.

27 Water potential: include solute and pressure effects

- water potential
- pressure potential

■ Question 1

A cell is at −0.6 MPa and its surroundings at −0.1 MPa. Which net movement is predicted?

- Into the cell
- Out of the cell
- No possible movement because both values are negative

Available marks: 2.

Worked answer

Into the cell

- Compare the complete water potentials of the two sides rather than solute concentrations alone. A turgid cell can have the same total water potential as its surroundings despite unequal solute potential. At equilibrium there is no net transfer, but water molecules can continue moving in both directions.

■ Question 2

Solute potential is −0.7 MPa and pressure potential is +0.4 MPa. Find total water potential.

Available marks: 4.

Worked answer

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-0.3 MPa

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

More negative is lower, not higher. The additive cell model has stated boundaries and does not require pretending that every real tissue has one uniform value. Loss of turgor and cell-wall support differ from a rigid wall directly controlling solute concentration.

28 Sexual reproduction: meiosis and fertilization have different roles

- haploid
- fertilization

■ Question 1

Which process restores diploid chromosome number in this model?

- Fertilization
- Meiosis II alone
- DNA replication alone

Available marks: 2.

Worked answer

Fertilization

- Distinguish homologous chromosomes from sister chromatids, and chromosome number from DNA quantity. Replication before meiosis copies DNA without doubling the number of chromosome sets. Crossing over and independent assortment contribute to genetic variation, while random fertilization further changes combinations. These processes do not make every offspring genetically distinct under every conceivable condition.

■ Question 2

A model organism has diploid chromosome number 20. How many chromosomes are normally in a gamete?

Available marks: 4.

Worked answer

10 chromosomes

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

A gamete is not made by halving the size of an ordinary cell. Independent assortment counts assume distinct homologous alternatives and do not include crossing-over outcomes. Human and plant reproduction cannot be fully replaced by a monohybrid

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Punnett grid.

29 Inheritance, variation and probability

- allele
- genotype

■ Question 1

What does a 25% probability in Aa × Aa mean?

- One in four of the children will have genotype aa
- Each fertilization has probability one quarter of aa under this model
- The fourth child is more likely to be aa

Available marks: 2.

Worked answer

Each fertilization has probability one quarter of aa under this model

- In a simple monohybrid cross Aa × Aa, gametes carry A or a. Combining independent gametes gives AA, Aa, Aa and aa. The predicted probabilities describe many possible fertilizations, not a fixed order of children.

■ Question 2

In Aa × aa, what percentage of offspring are predicted to be aa?

Available marks: 4.

Worked answer

50 %

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

A dominant allele can be rare. Mutation is a source of new variation; selection changes the relative success of existing variants rather than directing mutations toward a goal.

30 Climate evidence, energy budgets and policy

- mitigation
- adaptation

■ Question 1

Which action is adaptation to flood risk?

- Raising vulnerable electrical equipment above expected flood level
- Measuring global CO_2 more often to track the cause
- Assuming the risk is zero until a flood happens

Available marks: 2.

Worked answer

Raising vulnerable electrical equipment above expected flood level

- Distinguish mitigation, which addresses drivers, from adaptation, which reduces harm from impacts. A policy assessment needs evidence about effectiveness, cost, equity and uncertainty; one criterion is not the entire decision.

■ Question 2

Incoming energy is 240 units and reflected energy 72. Find reflected percentage.

Available marks: 4.

Worked answer

30 %

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

The greenhouse effect is not the same process as ozone depletion. A carbon footprint estimate depends on its system boundary.

31 Uncertainty, gradients and model testing

- uncertainty
- systematic error

■ Question 1

Which is most likely a systematic error?

- A balance reads 0.20 g when empty
- Repeated values fluctuate either side of the mean
- Random differences in reaction time

Available marks: 2.

Worked answer

A balance reads 0.20 g when empty

- For a product or quotient, adding fractional uncertainties is a common maximum-uncertainty approximation. For a difference, add absolute uncertainties. A nonzero intercept can reveal an offset or an incomplete model.

■ Question 2

A 40 cm reading has an absolute uncertainty of 1 cm. Find percentage uncertainty.

Available marks: 4.

Worked answer

2.5 %

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

Repeating readings reduces random uncertainty in a mean but does not automatically remove a zero error. Do not quote more decimal places than your measurement can support.