Revision practice

AQA · GCSE · Biology

Original open focus revision; complete specification coverage remains unfinished.

1 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.

2 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.

3 Eukaryotes and prokaryotes: location of genetic material

- prokaryote
- plasmid

Question 1

Which observation supports identifying the model as a bacterial cell?

- A main DNA loop without a nucleus
- A nucleus enclosing chromosomes
- A cellulose wall alone

Available marks: 2.

Worked answer

A main DNA loop without a nucleus

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- Use structures rather than size alone to identify a cell type. A plant cell has a cellulose cell wall, but a bacterial wall is not made of cellulose. Not every bacterium has a plasmid. A small cell image can be enlarged, so image size cannot by itself show real cell size.

■ Question 2

A 30 micrometre plant cell is compared with a 3 micrometre bacterial cell. Find the length ratio plant/bacterium.

Available marks: 4.

Worked answer

10

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

Prokaryotes have DNA even though they lack a nucleus. Magnification changes the displayed size; it does not turn one cell type into another. Order-of-magnitude estimates give a scale comparison rather than a precise identity test.

4 Cell structures: explain a function for every label

- ribosome
- cell membrane
- permanent vacuole
- cellulose

■ Question 1

Which structure is directly associated with making proteins?

- Ribosome
- Permanent vacuole
- Cellulose wall

Available marks: 2.

Worked answer

Ribosome

- Link structure to function: chloroplasts contain chlorophyll to absorb light; the vacuole helps support a turgid cell; the membrane is a selective boundary rather than a rigid support. Most animal cells have the five named structures, but specialized cells can differ. Not all structures can be resolved clearly with a school light microscope.

Question 2

A 15 mm drawing represents a 0.030 mm cell. Calculate magnification.

Available marks: 4.

Worked answer

500

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

A cell wall is outside the membrane and does not replace it. Root and storage cells need not contain chloroplasts. A nucleus is not responsible for every reaction directly; many reactions occur in the cytoplasm and specialized structures.

5 Specialized cells: connect a feature to the task

- specialized cell
- root hair cell

Question 1

Which explanation correctly links a root-hair feature with its function?

- Its projection increases area available for absorption
- Its projection means it never needs respiration
- Its cell wall replaces the membrane

Available marks: 2.

Worked answer

Its projection increases area available for absorption

- A root hair cell has a long projection increasing surface area for absorption. Xylem vessels are dead hollow cells joined into tubes, with strengthened lignified walls carrying water and supporting the plant. Phloem transports dissolved sugars through living tissue; its conducting cells work with companion cells. GCSE explanations should link each named feature to its role rather than give an unsupported list.

Question 2

Absorbing surface changes from 0.8 to 2.4 square units. Calculate the surface-area ratio.

Available marks: 4.

Worked answer

3

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

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More mitochondria does not mean mitochondria themselves contract or propel the cell. Xylem and phloem are different tissues and do not carry the same substances by the same mechanism. A cell adaptation is explained in the context of its task.

6 Differentiation: a developing cell gains a particular role

- differentiation
- repair

■ Question 1

What distinguishes differentiation from mitosis?

- It changes a cell's specialized structures and role
- It always doubles the number of cells in the tissue it acts on
- It removes the genes a cell will not need in its new role

Available marks: 2.

Worked answer

It changes a cell's specialized structures and role

- In a mature animal, cell division mainly supports repair and replacement. Differentiation and mitosis have different roles: division increases cell number, while differentiation changes the functional type. Cells in a growing root can continue producing new plant tissues because developing cells can still specialize.

■ Question 2

One precursor completes three rounds of model division before differentiation. How many cells result?

Available marks: 4.

Worked answer

8 cells

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

Differentiation does not mean a cell simply gets larger, and it does not usually mean the cell receives a completely new genome. Mature animal repair still depends on some cells dividing, even though most differentiated cells have restricted roles.

7 Microscopy: magnification and resolution answer different questions

- magnification
- resolving power

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■ Question 1

What improvement reveals two nearby structures as separate?

- Greater resolving power
- Only stretching the same blurred image
- Changing its colour without new detail

Available marks: 2.

Worked answer

Greater resolving power

- Choose the relation for the unknown: real size = image size/magnification, and image size = real size×magnification. Convert to the same length unit first. A stated scale bar continues to describe the particular image even if the displayed image is resized, provided the bar is resized with it.

■ Question 2

A 12 mm image is magnified 3,000 times. Find real length in micrometres.

Available marks: 4.

Worked answer

4 μm

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

Resolution and magnification are not synonyms. A larger screen image does not change the real cell size. Misusing millimetres and micrometres gives a thousandfold error even if the calculator division is otherwise correct.

8 Culturing microorganisms: growth and contamination are separate

- binary fission
- aseptic technique
- antibiotic
- disinfectant

■ Question 1

Why are school cultures generally incubated at 25 °C?

- To reduce the chance of growing harmful human pathogens
- To kill bacteria that might contaminate the plate
- To make the bacteria divide faster so colonies form sooner

Available marks: 2.

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Worked answer

To reduce the chance of growing harmful human pathogens

- Sterilized dishes and media reduce unwanted microorganisms. Sterilizing an inoculating loop prevents it transferring contaminants. The lid is secured with small pieces of tape rather than sealed all around; the plate is stored upside down to reduce condensation falling onto the agar. School cultures are generally incubated at 25 °C to reduce the chance of growing harmful human pathogens.

■ Question 2

A model starts with 25 bacteria and completes four division rounds. Find its population.

Available marks: 4.

Worked answer

400 cells

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

Twenty minutes is not a universal division time. An apparently clear plate is not proof of sterility, and a contaminated culture cannot be made a fair comparison by ignoring the extra colonies. Practical precautions protect people and the validity of the evidence.

9 Zones of inhibition: measure radius and control the comparison

- inhibition zone
- control disc

■ Question 1

Which value belongs in πr^2 for a zone of diameter 20 mm?

- 10 mm
- 20 mm
- 40 mm

Available marks: 2.

Worked answer

10 mm

- For a circular region, area = πr^2. Radius is half the diameter. State whether the reported area includes the disc or subtracts its area: use the same convention for every treatment. A bigger zone does not on its own prove that the substance will treat a particular infection in a person.

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■ Question 2

A circular zone has radius 5 mm. Using π=3.14, calculate total area.

Available marks: 4.

Worked answer

78.5 mm^2

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

Do not put the diameter directly into πr^2. Matched incubation and a control are necessary for interpreting inhibition, and changing both substance and concentration prevents attributing the difference to one variable.

10 Chromosomes, genes and DNA: keep the levels distinct

- chromosome
- gene

■ Question 1

Which statement distinguishes a gene from a chromosome?

- A gene is a section of DNA and a chromosome carries many genes
- Each gene contains many chromosomes, packed along its length
- A chromosome is one gene, and a gene is a whole strand of DNA

Available marks: 2.

Worked answer

A gene is a section of DNA and a chromosome carries many genes

- Keep three levels separate: DNA is the chemical genetic material, a chromosome is an organized DNA-containing structure, and a gene is a section of DNA. A replicated chromosome has copied genetic material ready for division. Replication and the later distribution into daughter cells have different effects.

■ Question 2

A model body cell has 18 chromosomes in pairs. How many pairs are present?

Available marks: 4.

Worked answer

9 pairs

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

DNA, gene and chromosome are not interchangeable terms. A chromosome count alone does not tell how many genes an organism has. Copying DNA before mitosis is

not the same as permanently doubling the chromosome number of each daughter cell.

11 The cell cycle: prepare, divide the nucleus, divide the cell

- mitosis
- cell cycle

■ Question 1

Which event must occur before chromosome copies are separated?

- DNA replication
- Loss of all chromosomes
- Formation of gametes by mitosis

Available marks: 2.

Worked answer

DNA replication

- Use three overall stages: growth and DNA copying, mitosis, then cell division. AQA does not require the named phases within mitosis at this point. Mitosis supports growth and development in multicellular organisms and repair or replacement in mature animals; it does not produce genetically varied haploid gametes.

■ Question 2

Three model starting cells each complete three division rounds. Calculate the final number.

Available marks: 4.

Worked answer

24 cells

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

Mitosis divides a nucleus; the complete cell cycle includes preparation and division of the cell. “Identical” concerns the normal copied genetic information in this model, not a claim that every cell is physically the same size at every moment.

12 Stem cells: compare potential, matching and ethical choices

- stem cell
- meristem
- therapeutic cloning

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Question 1

Which comparison matches the stated GCSE model?

- Embryonic stem cells have broader differentiation potential than bone-marrow stem cells
- Bone-marrow stem cells can form every cell type, like embryonic ones
- Meristems occur only in animal embryos, not in plant shoots or roots

Available marks: 2.

Worked answer

Embryonic stem cells have broader differentiation potential than bone-marrow stem cells

- Therapeutic cloning produces an embryo with the patient's genes, so its stem cells offer a genetic match and reduced rejection in the specification's model. Potential applications include conditions such as diabetes or paralysis. These are potential benefits, not guaranteed cures. Viral transfer and ethical or religious objections must be considered with the evidence.

Question 2

Six retained model parent plants each produce three new clones. Find the total including parents.

Available marks: 4.

Worked answer

24 plants

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

Adult bone-marrow stem cells are not assumed to form every body cell type. Genetic matching does not remove every medical risk. Cloning a rare species can increase its number, while habitat protection and genetic diversity still require attention.

13 Diffusion: random motion can give directional net transfer

- diffusion
- concentration gradient

Question 1

Which change increases net diffusion rate when other conditions match?

- A larger concentration difference
- A smaller exposed membrane area
- Identical concentration on both sides

Available marks: 2.

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Worked answer

A larger concentration difference

- A larger concentration difference produces a greater net diffusion rate under comparable conditions. Higher temperature increases particle motion, and a larger membrane surface area allows more transfer at once. A thinner exchange surface provides a shorter route, as developed in the exchange-surface case.

■ Question 2

In one interval 62 particles cross A→B and 22 cross B→A. Calculate net transfer A→B.

Available marks: 4.

Worked answer

40 particles

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

Diffusion does not require respiration to supply energy for the particles' net movement. A concentration gradient is specific to a substance; oxygen and carbon dioxide can have opposite gradients across the same surface.

14 Exchange surfaces: small size and thin barriers matter

- surface-area-to-volume ratio
- exchange surface

■ Question 1

Why does a thin alveolar wall support rapid gas exchange?

- It gives a short diffusion path
- It prevents every molecule crossing
- It increases the animal's chromosome number

Available marks: 2.

Worked answer

It gives a short diffusion path

- Villi give the small intestine a large absorbing area. Lungs have many alveoli with thin surfaces, a blood supply and ventilation. Fish gills provide a large exchange surface supplied with blood. Root hairs increase plant absorbing area, while leaves provide a large gas-exchange surface and short paths through their tissues.

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■ Question 2

A cube has side 3 cm. Calculate surface area divided by volume.

Available marks: 4.

Worked answer

2 per cm

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

A bigger object has more total surface area but can have less surface per unit volume. Blood flow and ventilation maintain gradients rather than make molecules choose a direction. Plant roots and leaves do not use animal blood vessels.

15 Osmosis: mass changes and rates use different denominators

- osmosis
- percentage mass change

■ Question 1

Which denominator is used for percentage mass change?

- Initial mass
- Final mass and time
- Length of the potato cylinder

Available marks: 2.

Worked answer

Initial mass

- Percentage change = (final−initial)/initial×100. Mean water-uptake rate compares an estimated water amount with elapsed time. These are different quantities: percentage change adjusts for starting mass, while a rate describes change per unit time. Plot a concentration series and estimate where the trend crosses zero rather than expecting every individual repeat to lie on one line.

■ Question 2

A 2.00 g sample gains 0.20 g in 20 min. Calculate mean mass-gain rate.

Available marks: 4.

Worked answer

0.01 g/min

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

Surface liquid adds mass without entering the cells, so blotting is essential. A negative

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percentage indicates loss. An estimated zero-change concentration does not mean water molecules stop moving or that every cell is undamaged and identical.

16 Active transport: uptake against the gradient needs energy

- active transport
- mineral ion

■ Question 1

Which observation requires active transport in the stated model?

- Net ion uptake into a cell with higher ion concentration
- Net gas movement out of a cell, down its concentration gradient
- Water moving into a cell by osmosis through a partially permeable membrane

Available marks: 2.

Worked answer

Net ion uptake into a cell with higher ion concentration

- Compare three processes. Diffusion gives net movement of particles down their gradient. Osmosis concerns water crossing a partially permeable membrane from dilute toward more concentrated solution. Active transport can move selected solutes against their gradient using respiratory energy. The same membrane can support more than one process for different substances.

■ Question 2

A model root absorbs 0.30 mg ions in 15 min. Calculate mean uptake rate.

Available marks: 4.

Worked answer

0.02 mg/min

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

"Active" does not mean faster under every condition. Energy comes from respiration, not from the mineral ion automatically being nutritious. Water movement by osmosis is not defined as active transport of water against a gradient.

17 Digestion, transport and health evidence

- digestion
- absorption

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■ 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.

18 Organisation: several tissues can form one organ

- tissue
- organ system

■ Question 1

Which level contains several tissues working together for a function?

- Organ
- One cell
- A molecule only

Available marks: 2.

Worked answer

Organ

- In the digestive system, organs including the stomach and small intestine work together to digest and absorb food. Within an organ, muscle tissue can move contents while glandular tissue releases substances. A list of levels becomes an explanation when each example is placed at the correct level.

■ Question 2

A 3 mm tissue strip is compared with a 0.03 mm cell. Calculate their length ratio.

Available marks: 4.

Worked answer

100

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

An organ is not necessarily made from one tissue type. A named blood vessel is an organ structure, while blood is a tissue. Real organ boundaries and cooperating systems can overlap in function without changing the meaning of the hierarchy.

19 Digestion: make soluble products, then absorb them

- digestion
- emulsification

■ Question 1

How does bile help lipid digestion?

- It creates smaller droplets and suitable alkaline conditions
- It acts as the enzyme that breaks lipids into fatty acids and glycerol
- It stores the digested lipid droplets inside the gall bladder

Available marks: 2.

Worked answer

It creates smaller droplets and suitable alkaline conditions

- Bile is made in the liver and stored in the gall bladder. Its alkaline character helps neutralize stomach acid entering the small intestine. It emulsifies fat into small droplets, increasing surface area for lipase. Bile is not an enzyme. Digestion products can build new carbohydrates, proteins and lipids, and some glucose is used in respiration.

■ Question 2

A model divides 15 fat droplets into 60 smaller droplets. Calculate the count ratio final/initial.

Available marks: 4.

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Worked answer

4

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

Absorption does not mean breaking the food molecule down. Bile helps lipase but does not itself digest lipid. The stomach is not the main site where every nutrient is absorbed, and digested food does not travel through the trachea.

20 Food tests: identify the tested group and the observation

- qualitative test
- positive control

■ Question 1

Which observation is a positive starch test?

- Iodine changes to blue-black
- Biuret turns purple
- Ethanol emulsion becomes cloudy

Available marks: 2.

Worked answer

Iodine changes to blue-black

- Keep the test and result paired. A negative iodine observation does not show that all carbohydrates are absent, because the test concerns starch. Qualitative colour observations can indicate presence under the test conditions; a precise concentration requires calibration and controlled measurements.

■ Question 2

Five of eight model samples give a positive test. Calculate the percentage positive.

Available marks: 4.

Worked answer

62.5 %

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

Heating is part of Benedict's test, not a reason to heat every reagent in the same way. A colour chart without matched time, temperature and amounts is not an exact sugar assay. A food can contain several tested groups at once.

21 Amylase and pH: define the endpoint before comparing rates

- active site
- buffer

Question 1

Why should iodine be placed in separate sampling spots?

- To test removed samples without changing the main reaction mixture
- To remove the starch before the amylase is added to the mixture
- To keep the water-bath temperature the same across all the tests

Available marks: 2.

Worked answer

To test removed samples without changing the main reaction mixture

- Amylase breaks starch into sugars. In an iodine sampling method, the endpoint is reached when a sample no longer turns iodine blue-black. With a fixed starting amount and endpoint, 1/time gives a comparative rate proxy. This proxy is not an independently measured amount of product per second.

Question 2

A fixed endpoint is first recorded at 80 s. Calculate the inverse-time rate proxy.

Available marks: 4.

Worked answer

0.0125 1/s

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

Low temperature usually slows activity rather than permanently denaturing the enzyme. A buffer controls pH, not temperature. An optimum observed with this amylase and setup cannot be assumed for every enzyme or every biological condition.

22 Double circulation: the heart pumps to lungs and body

- double circulation
- pacemaker

Question 1

Which vessel carries blood from the lungs back to the heart?

- Pulmonary vein
- Pulmonary artery

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- Vena cava from body tissues

Available marks: 2.

Worked answer

Pulmonary vein

- Air moves through trachea and bronchi to alveoli. Many alveoli provide a large area; thin walls, nearby capillaries and ventilation support gas exchange. Blood flow maintains concentration differences for oxygen entering blood and carbon dioxide leaving it. The natural resting rate is controlled by pacemaker cells in the right atrium; an artificial electrical pacemaker can correct some rhythm irregularities.

■ Question 2

A model circulation moves 3,600 cm^3 in 60 s. Calculate mean flow.

Available marks: 4.

Worked answer

60 cm^3/s

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

The pulmonary artery carries blood toward the lungs and has lower oxygen content than the pulmonary vein. Coronary arteries are not the route carrying all blood into the heart chambers. An artificial pacemaker concerns electrical rhythm, not removal of every artery blockage.

23 Blood vessels: structure fits pressure and exchange

- artery
- capillary

■ Question 1

Which feature directly supports exchange across a capillary?

- A very thin wall
- A thick muscle wall preventing transfer
- A label saying artery

Available marks: 2.

Worked answer

A very thin wall

- Use structure → effect → function. A capillary wall only one cell thick reduces diffusion distance. Arterial muscle and elastic tissue cope with and modify blood flow under pressure. Venous valves aid one-way flow, particularly when pressure is low. Direction defines artery versus vein, while exchange defines the key capillary

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role.

Question 2

Two model circular lumens have radii 1 and 3 units. Calculate larger/smaller area ratio.

Available marks: 4.

Worked answer

9

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

A vein does not necessarily carry oxygen-poor blood: the pulmonary vein returns oxygen-rich blood. Large lumen area is not by itself evidence that a vessel's flow rate is greater. Capillaries are small exchange vessels, not tiny versions with all arterial wall layers.

24 Blood: a tissue with several transport and defence roles

- plasma
- platelet

Question 1

Which component is most directly involved in clot formation?

- Platelets
- The cell wall of a red cell
- Chloroplasts in plasma

Available marks: 2.

Worked answer

Platelets

- A red-cell adaptation explains oxygen transport, not every blood function. White cells can engulf pathogens or produce antibodies and antitoxins, developed in infection teaching. Platelets are cell fragments involved in reducing blood loss through clots. Plasma and cells should be identified separately in an image or diagram.

Question 2

A model field contains 76 red cells and 4 white cells. Calculate white cells as a percentage of counted cells.

Available marks: 4.

Worked answer

5 %

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

Platelets are not whole red blood cells, and plasma is not empty space. A picture count cannot diagnose health without a validated sampling and measurement system. Red cells transport oxygen; they do not manufacture it in the lungs.

25 Cardiovascular treatment: match the intervention to the problem

- stent
- statin

■ Question 1

Which mechanism describes a coronary stent?

- It holds a narrowed artery open
- It provides the heart's genetic material
- It neutralizes stomach acid

Available marks: 2.

Worked answer

It holds a narrowed artery open

- A donor heart, or heart and lungs, can be transplanted for severe failure. Artificial hearts are sometimes used while a donor is awaited or to let the heart rest. Evaluate benefit against procedural risk, infection, rejection or long-term management where relevant. A device treating one mechanism is not automatically a treatment for all cardiovascular disease.

■ Question 2

A fictional study records 15 complications among 250 observations. Calculate the percentage.

Available marks: 4.

Worked answer

6 %

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

Statins do not mechanically prop open an artery, and a stent does not act as an artificial pacemaker. A lower recorded complication rate is not enough to prove that one option is best for every condition or person.

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26 Health evidence: physical and mental well-being interact

- health
- incidence

Question 1

Which comparison is most useful for unequal population sizes?

- Rates with a common denominator and interval
- Raw case counts alone
- The area name without population data

Available marks: 2.

Worked answer

Rates with a common denominator and interval

- An incidence comparison needs a population denominator and time period. A scatter diagram can show an association between two variables, but an association alone does not establish direction or cause. Selection, access to diagnosis, age and other factors can change recorded rates.

Question 2

A fictional area records 24 new cases among 1,200 people. Calculate cases per 1,000.

Available marks: 4.

Worked answer

20 per 1,000

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

Mental well-being is part of health, not merely an optional addition. Correlation does not prove that one factor is the only cause, and a self-selected sample may not represent the wider population.

27 Risk factors: a population association is not a prediction of certainty

- risk factor
- carcinogen

Question 1

What does a risk factor indicate?

- Increased probability in relevant evidence
- A direct cause of the disease in each case

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- That the factor alone explains the disease

Available marks: 2.

Worked answer

Increased probability in relevant evidence

- Many diseases involve several interacting factors, including genetic ones. A causal mechanism is established for some risks, while other associations remain less well explained. Population consequences include illness, reduced quality of life, care demands and financial costs for families, communities and health systems.

■ Question 2

Two fictional event rates are 30 and 15 per 1,000. Calculate their ratio.

Available marks: 4.

Worked answer

2

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

A risk factor is not a certain outcome. A scatter plot alone cannot eliminate confounding or show an established causal mechanism. Financial totals and event counts must be interpreted with their period, population and included costs stated.

28 Tumours: location and spread distinguish the models

- benign tumour
- malignant tumour

■ Question 1

Which feature distinguishes malignant from benign in this model?

- Invasion and possible spread
- The presence of any cells
- A nucleus in each observed cell

Available marks: 2.

Worked answer

Invasion and possible spread

- Uncontrolled division is different from normal regulated growth, repair and replacement. Lifestyle risk factors and inherited genetic risk factors can contribute to cancer risk, often with several factors interacting. A diagram of spread is a model of a mechanism, not a clinical diagnosis from appearance.

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Question 2

A model cell count rises from 30 to 120. Calculate the fold increase.

Available marks: 4.

Worked answer

4

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

Benign does not mean a growth can never affect an organ, but it does not invade other body sites in this GCSE distinction. A single risk factor does not guarantee cancer, and a rapidly dividing normal tissue is not automatically malignant.

29 A leaf is an organ: tissue layers have different tasks

- palisade mesophyll
- stoma

Question 1

Which tissue is especially associated with many chloroplasts?

- Palisade mesophyll
- A hollow mature xylem vessel
- A stomatal air opening itself

Available marks: 2.

Worked answer

Palisade mesophyll

- A tissue is defined by its cells and role, while the whole leaf is an organ. Light reaching palisade cells supports photosynthesis, and a short gas pathway through air spaces supports exchange. A vascular bundle contains distinct transport tissues; it is not one tube carrying every substance in the same way.

Question 2

A field of 0.25 mm^2 contains 10 stomata. Calculate stomatal density.

Available marks: 4.

Worked answer

40 per mm^2

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

A stoma is the opening, while guard cells are the cells around it. Meristem is plant growth tissue, not a vessel moving sap. Every plant leaf need not have exactly the

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same arrangement as a standard schematic.

30 Plant transport: water loss draws water through xylem

- transpiration
- translocation

■ Question 1

Which change generally reduces transpiration with other conditions matched?

- Increasing surrounding humidity
- Increasing air movement around the leaves
- Increasing the surrounding temperature

Available marks: 2.

Worked answer

Increasing surrounding humidity

- Transpiration is water loss by evaporation from leaf surfaces, mainly through stomata after water evaporates from moist internal tissues. Guard cells control stomatal opening. Higher temperature and greater air movement generally increase loss; greater humidity reduces the water-vapour gradient. More light usually opens stomata, increasing loss under comparable conditions.

■ Question 2

A potometer has tube area 0.40 mm^2 and bubble distance 20 mm over 4 min. Calculate volume uptake rate.

Available marks: 4.

Worked answer

2 mm^3/min

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

Phloem and xylem do not both carry only water upward. A faster bubble can reflect a leak or unmatched leaf area. Closing stomata conserves water but also affects carbon-dioxide entry and therefore photosynthesis.

31 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.

32 Pathogens: distinguish spread from damage

- pathogen
- toxin

■ Question 1

Which explanation matches a viral infection?

- Viruses reproduce inside host cells and can damage them
- Viruses are bacteria that release toxins and can be killed by antibiotics
- All microorganisms are pathogens that reproduce inside host cells

Available marks: 2.

Worked answer

Viruses reproduce inside host cells and can damage them

- A prevention must interrupt the stated transmission route. Safe food and clean water reduce ingestion of pathogens; hygiene can reduce contact transmission. Ventilation and limiting exposure can reduce some airborne transmission. Controlling

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a vector interrupts a different route. These measures reduce risk rather than prove that every infection has been prevented.

■ Question 2

A fictional record has 12 affected individuals among 240. Calculate the percentage.

Available marks: 4.

Worked answer

5 %

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

A toxin is not the same thing as a virus. An infectious disease can affect a plant as well as an animal. Not all microorganisms cause disease, and a high observed disease rate does not by itself identify the transmission route.

33 Measles, HIV and tobacco mosaic virus

- antiretroviral drug
- tobacco mosaic virus

■ Question 1

Why can TMV reduce plant growth?

- Leaf discolouration can reduce photosynthesis and glucose production
- It blocks the xylem so that water cannot reach the leaves
- It causes a rash on the leaves that stops them making starch

Available marks: 2.

Worked answer

Leaf discolouration can reduce photosynthesis and glucose production

- HIV spreads through sexual contact or exchange of body fluids such as blood, including shared needles. Tobacco mosaic virus, TMV, causes a mosaic pattern of leaf discolouration. Less effective photosynthetic tissue means less glucose production, reducing plant growth. A symptom describes an effect; it is not itself the mechanism of transmission.

■ Question 2

Model photosynthetic output falls from 60 to 45 units. Calculate percentage decrease.

Available marks: 4.

Worked answer

25 %

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

HIV infection and AIDS are not interchangeable labels for every stage. Antibiotics do not kill these viruses. TMV affects plants rather than causing the human symptoms described for measles or HIV. Classroom facts do not prescribe a treatment or vaccination schedule.

34 Salmonella and gonorrhoea: route-specific control

- Salmonella
- antibiotic resistance

■ Question 1

Which measure directly reduces the specified sexual transmission route?

- Barrier contraception
- Changing a microscope lens
- Using a food thermometer alone

Available marks: 2.

Worked answer

Barrier contraception

- Gonorrhoea spreads through sexual contact. Barrier contraception such as condoms reduces transmission risk, while appropriate antibiotic treatment targets the bacteria. Some strains are resistant to antibiotics; the historical use of penicillin does not imply that it will now treat every strain. A named symptom alone cannot prove which organism caused it.

■ Question 2

A fictional sample has 4 contaminated items among 200. Calculate the percentage.

Available marks: 4.

Worked answer

2 %

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

Resistance belongs to the bacterial population, not a person becoming resistant to a medicine. Food hygiene and barrier contraception address different routes. Treatment choices require current clinical guidance; this lesson teaches the specified mechanisms rather than recommending a particular drug.

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35 Rose black spot: loss of working leaf area

- fungal disease
- fungicide

Question 1

How can early loss of leaves reduce growth?

- It reduces photosynthetic tissue and glucose supply
- It gives the plant extra chloroplasts
- It proves the disease is caused by a virus

Available marks: 2.

Worked answer

It reduces photosynthetic tissue and glucose supply

- Removing and destroying affected leaves can reduce infectious material. Appropriate fungicides are another specified control, but school work follows teacher-approved handling and disposal. A control aimed at a fungus is distinct from treating bacterial disease. The effect on growth is explained through leaf function rather than simply saying that spots look unhealthy.

Question 2

A model plant retains 15 of its original 20 functioning leaves. Calculate the percentage retained.

Available marks: 4.

Worked answer

75 %

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

Black spot is fungal, not the same pathogen as TMV. A fallen diseased leaf may still be a source of spread. A correlation between leaf loss and lower growth needs a mechanism and suitable comparison, and remaining leaf number is not a direct measure of glucose production.

36 Malaria: interrupt a vector's role

- disease vector
- protist

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■ Question 1

Which description correctly separates the two organisms?

- The protist causes malaria and a mosquito acts as a vector
- The mosquito is a bacterium producing malaria toxin
- A net kills every protist already inside a host

Available marks: 2.

Worked answer

The protist causes malaria and a mosquito acts as a vector

- Distinguish organism roles carefully. The mosquito is an animal carrier, whereas the disease-causing organism is a protist. A net can reduce opportunities for a mosquito to bite a person; removing suitable breeding conditions can reduce the number of vectors. Neither measure should be described as directly killing every protist already inside an infected person.

■ Question 2

Fictional trap counts fall from 50 to 35. Calculate percentage decrease.

Available marks: 4.

Worked answer

30 %

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

Malaria is not caused by the mosquito itself or by a bacterium. Fewer vectors can reduce transmission opportunities, but a trap result alone does not demonstrate that malaria has been eradicated. Do not infer a safe travel or treatment decision from classroom model data.

37 Barriers and white blood cells

- phagocytosis
- antitoxin

■ Question 1

Which response directly neutralizes a bacterial toxin?

- Antitoxin production
- Oxygen transport by red cells
- Increasing image magnification

Available marks: 2.

Worked answer

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Antitoxin production

- White blood cells defend against pathogens by phagocytosis, producing antibodies and producing antitoxins. In phagocytosis a cell engulfs and digests a pathogen. Antibodies bind to particular antigens associated with a pathogen; antitoxins neutralize toxins. Explain the target before choosing the mechanism: removing a bacterium and neutralizing its toxin are different actions.

■ Question 2

A model traps 42 of 60 incoming particles. Calculate the trapped percentage.

Available marks: 4.

Worked answer

70 %

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

Antibodies and antitoxins are not antibiotics. Red blood cells mainly transport oxygen and do not replace the white-cell roles here. A barrier lowers entry risk but is not an absolute guarantee that no pathogen will ever enter.

38 Vaccination: a faster specific response

- vaccination
- antibody

■ Question 1

What explains the protective later response in this model?

- Rapid production of the correct antibodies
- All pathogens become harmless after any vaccination
- Antibiotics are produced by red blood cells

Available marks: 2.

Worked answer

Rapid production of the correct antibodies

- When many people are immune, a pathogen has fewer opportunities to pass to susceptible hosts. This can reduce spread through the population. Distinguish a vaccinated proportion from guaranteed protection: immunity, exposure and effectiveness vary, and a single percentage does not prove that transmission has stopped.

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■ Question 2

A fictional model assigns immunity to 180 of 240 people. Calculate the percentage.

Available marks: 4.

Worked answer

75 %

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

Vaccination does not mean antibiotics have been placed in the blood. A rapid response must produce the appropriate antibodies, not just any antibodies. The simplified dead/inactive-material description is the specified teaching model rather than a claim that every real vaccine uses the same technology.

39 Antibiotics and symptom relief have different targets

- antibiotic
- painkiller

■ Question 1

Why are drugs against viruses difficult to develop?

- Viruses reproduce inside host cells, which must be protected
- Viruses have cell walls that antibiotics cannot break through
- Viruses reproduce too quickly for any medicine to reach them

Available marks: 2.

Worked answer

Viruses reproduce inside host cells, which must be protected

- Viruses reproduce inside host cells. A drug that interferes with reproduction must avoid unacceptable damage to the host's own cells and tissues, which makes development difficult. This does not imply that no antiviral medicines exist: antiretroviral control of HIV is one example already studied.

■ Question 2

A fictional control has 80 colonies and a stated condition has 20. Calculate percentage reduction.

Available marks: 4.

Worked answer

75 %

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

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Antibiotic effectiveness is not the same as pain relief. A medicine that relieves fever does not demonstrate that it killed the virus. Resistant bacteria survive because of their characteristics; the person is not becoming genetically resistant to an antibiotic.

40 Discovering and testing medicines

- efficacy
- placebo

■ Question 1

What is the main purpose of blinding during a suitable trial?

- Reduce expectation-related bias in measurement
- Make sure that every patient receives the drug
- Measure the side effects that the drug causes

Available marks: 2.

Worked answer

Reduce expectation-related bias in measurement

- Testing investigates toxicity, efficacy and dose. Initial clinical doses are low to check safety. Suitable patient comparisons can include a placebo; blinding helps prevent expectations affecting reported or assessed outcomes. Double-blind trials keep both participants and the relevant researchers unaware of allocation during measurement. Independent peer review examines the methods and evidence before conclusions are accepted.

■ Question 2

A fictional group has 42 improvements among 70 participants. Calculate the percentage.

Available marks: 4.

Worked answer

60 %

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

Natural origin does not guarantee safety. A placebo comparison is not the same as leaving every patient without appropriate care. A larger improvement proportion must be interpreted alongside safety, fair comparison and uncertainty; a classroom calculation is not a medicine recommendation.

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41 Monoclonal antibodies: one clone, one binding target

- hybridoma
- monoclonal antibody

■ Question 1

Why is a lymphocyte fused with a tumour cell?

- Combine antibody production with repeated division
- Remove all antigen specificity
- Turn the antibody into a whole pathogen

Available marks: 2.

Worked answer

Combine antibody production with repeated division

- The hybridoma culture supplies antibodies that can be collected and purified. Explain the purpose of each stage: lymphocyte for a suitable antibody, tumour cell for division, selection for the desired binding specificity and cloning for consistent output. Specificity does not mean the antibody binds to every protein or always cures a disease.

■ Question 2

Two model hybridoma cells complete three division rounds without losses. Calculate cell count.

Available marks: 4.

Worked answer

16 cells

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

A hybridoma is a fused cell, not the antibody itself. Monoclonal describes origin from one clone and a consistent binding target. The tumour-cell component is used for division in the model; it does not mean the purified antibody is a tumour.

42 Antibody specificity in tests, research and treatment

- fluorescent label
- targeted delivery

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■ Question 1

What makes a fluorescent antibody useful for locating a protein?

- Specific binding plus a detectable linked label
- Binding equally to every molecule
- A signal that works without any antibody

Available marks: 2.

Worked answer

Specific binding plus a detectable linked label

- In a supplied cancer-treatment model, antibodies bind an antigen on cancer cells and carry a radioactive substance, a toxic drug or a chemical that stops growth and division. Targeting can reduce effects on other cells, but side effects may still occur. Evaluate usefulness through specificity, measured effects, harm and practical or ethical constraints rather than claiming a guaranteed cure.

■ Question 2

A fictional image has 28 signal-positive cells among 80. Calculate the percentage.

Available marks: 4.

Worked answer

35 %

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

The antibody's binding target and attached payload have different roles. A diagnostic signal is evidence interpreted with controls, not an automatic diagnosis. Targeted delivery can still have unwanted effects, so the benefit must be balanced against measured risks.

43 Plant infection, pests and mineral deficiency

- chlorosis
- mineral deficiency
- magnesium ion

■ Question 1

Which explanation matches nitrate deficiency?

- Less material for amino acids and proteins can restrict growth
- Nitrate is needed to make chlorophyll, so the leaves turn yellow
- Nitrate is needed to make glucose, so photosynthesis stops

Available marks: 2.

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Worked answer

Less material for amino acids and proteins can restrict growth

- Magnesium is needed for chlorophyll production. A shortage can cause chlorosis, or yellowing, which reduces effective light absorption for photosynthesis. Distinguish a pest, a pathogen and a nutrient shortage: an insect is not a mineral deficiency, and adding nitrate does not directly eliminate a virus.

■ Question 2

Model seedling height falls from 15 to 9 cm. Calculate percentage decrease.

Available marks: 4.

Worked answer

40 %

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

Chlorosis describes yellowing rather than proving a single cause. Nitrate supports protein synthesis, while magnesium supports chlorophyll production; swapping these explanations loses the mechanism. Higher-only disease-identification methods are taught separately from this both-tier plant content.

44 Plant diagnosis: symptoms need confirmation

- diagnosis
- test kit

■ Question 1

What makes a monoclonal plant test specific?

- Its antibody binds a particular target antigen
- It detects every cause of yellowing equally
- It does not need a control or instructions

Available marks: 2.

Worked answer

Its antibody binds a particular target antigen

- The specification identifies gardening manuals or websites, laboratory identification of pathogens and test kits containing monoclonal antibodies as methods of identification. A specific antibody binds an appropriate target associated with a pathogen. Interpretation still requires valid controls and attention to the kit's stated target and limitations.

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■ Question 2

A fictional set confirms pathogens in 18 of 30 symptomatic plants. Calculate the percentage.

Available marks: 4.

Worked answer

60 %

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

A symptom list is not a guaranteed diagnosis. A positive target test concerns the target named by that test; it does not identify every possible plant disease. Reliable references and laboratory evidence complement careful observation rather than replace it.

45 Plants defend themselves in several ways

- waxy cuticle
- herbivore

■ Question 1

Which is a specified chemical defence?

- An antibacterial substance produced by the plant
- A thick waxy cuticle covering the leaf
- Thorns and hairs that deter animals

Available marks: 2.

Worked answer

An antibacterial substance produced by the plant

- Mechanical adaptations include thorns and hairs that discourage feeding, leaves that droop or curl when touched, and mimicry that can deter animals. Explain the consequence of each feature: a thorn affects contact or feeding, while an antibacterial substance affects bacteria. No single defence protects a plant against every threat.

■ Question 2

A fictional model has 8 damaged patches among 40. Calculate percentage damaged.

Available marks: 4.

Worked answer

20 %

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

A waxy cuticle is a physical barrier and is not an antibody. Plants do not use the same white-blood-cell mechanisms as animals. A poisonous plant can harm people as well as herbivores, so classroom observation must not involve tasting or extracting its chemicals.

46 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.

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.

47 Respiration, ATP and energy transfers

- respiration
- ATP

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■ 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 respiration releases less energy per glucose than aerobic respiration. In human muscles it produces lactic acid; in yeast it produces ethanol and carbon dioxide. Breathing supplies oxygen but is not itself respiration.

■ 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.

48 Photosynthesis: energy enters through light

- chlorophyll
- endothermic

■ Question 1

What is the role of light in the photosynthesis equation?

- It transfers energy to drive the endothermic reaction
- It is a carbon-containing material reactant
- It prevents plant cells from respiring

Available marks: 2.

Worked answer

It transfers energy to drive the endothermic reaction

- Light supplies energy rather than being a material reactant with a mass in the equation. Carbon dioxide supplies carbon for glucose; water is also required and oxygen

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is released. Photosynthesis and respiration are different processes. Plants respire continuously in living cells, even when no light is available for photosynthesis.

■ Question 2

In the supplied balanced model, 6 carbon dioxide molecules are used per glucose. How many are used for 3 glucose molecules?

Available marks: 4.

Worked answer

18 molecules

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

Photosynthesis takes in energy; it does not release usable energy from glucose in the way respiration does. Chlorophyll and chloroplast are not interchangeable: one is the light-absorbing pigment, the other the cell structure containing it.

49 Measure photosynthesis rate fairly

- photosynthesis rate
- controlled variable

■ Question 1

Why can collecting gas volume improve on counting bubbles?

- Bubble sizes can differ
- Bubbles form at a steady rate
- Light intensity is hard to control

Available marks: 2.

Worked answer

Bubble sizes can differ

- In required practical 6, an aquatic organism such as pondweed supplies an observable oxygen-output estimate. Gas volume divided by time is usually a better measure than bubble count when bubble sizes vary. A graph needs the varied factor on the horizontal axis, rate on the vertical axis and a consistent scale with units. A plateau means the changed factor no longer increases rate under those conditions.

■ Question 2

A model collects 3.6 cm^3 gas in 6 minutes. Calculate the mean output rate.

Available marks: 4.

Worked answer

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0.6 cm^3/min

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

Do not claim that moving a lamp changes only light if it also heats the water. A measured output rate is an estimate under stated conditions. Multi-factor graphs, inverse-square calculations and greenhouse economics belong to the separate Higher Tier lesson.

50 Higher Tier: interacting factors and greenhouse decisions

- limiting factor
- inverse-square relationship

■ Question 1

What does doubling distance do to ideal point-source light intensity?

- Reduces it to one quarter
- Reduces it to one half
- Always doubles photosynthesis rate

Available marks: 2.

Worked answer

Reduces it to one quarter

- For the ideal point-source model, light intensity is proportional to 1/distance^2. Doubling distance makes intensity one quarter, not one half. Real lamp geometry and reflections can depart from this approximation. A greenhouse decision compares added revenue with added lighting, heating or carbon dioxide costs; maximum photosynthesis rate need not give maximum profit.

■ Question 2

Intensity is 144 units at 10 cm. Calculate ideal intensity at 30 cm.

Available marks: 4.

Worked answer

16 relative units

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

Inverse square applies to light intensity in the stated model, not automatically to photosynthesis rate across all conditions. A plateau can reflect another limiting factor. Profit uses both income and cost; comparing income alone is insufficient.

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51 Where the glucose goes

- cellulose
- starch
- nitrate ion

Question 1

Why are nitrate ions needed alongside glucose for plant protein production?

- They supply nitrogen needed to form amino acids
- They are the light energy absorbed by chlorophyll
- They replace every glucose molecule

Available marks: 2.

Worked answer

They supply nitrogen needed to form amino acids

- Storage, structure and energy transfer are separate roles. Starch is insoluble, so it can be stored without behaving like an equivalent amount of dissolved glucose. Cellulose is structural. Nitrate supplies needed nitrogen for amino acids; sunlight alone does not supply every element a growing plant needs.

Question 2

A fictional 80-unit allocation assigns 24 units to storage. Calculate the storage percentage.

Available marks: 4.

Worked answer

30 %

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

Photosynthesis makes glucose rather than directly making every protein. Plants need mineral nutrients as well as light, water and carbon dioxide. A glucose molecule cannot supply nitrogen that it does not contain; nitrate is relevant to amino acids and proteins.

52 Compare three respiration equations

- aerobic respiration
- fermentation

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■ Question 1

Which products match anaerobic respiration in yeast?

- Ethanol and carbon dioxide
- Lactic acid and carbon dioxide
- Ethanol, water and oxygen

Available marks: 2.

Worked answer

Ethanol and carbon dioxide

- Anaerobic respiration in muscle is glucose → lactic acid. Oxidation is incomplete, so much less energy is transferred than in aerobic respiration. In plant and yeast cells, anaerobic respiration is glucose → ethanol + carbon dioxide. Yeast fermentation is economically useful: carbon dioxide helps bread dough rise, and ethanol is used in alcoholic-drink manufacture.

■ Question 2

An approved yeast model produces 20 cm^3 gas in 5 minutes. Calculate mean output rate.

Available marks: 4.

Worked answer

4 cm^3/min

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

Respiration is a chemical process in cells, whereas breathing moves air. Plants also respire. Carbon dioxide is a product of the yeast anaerobic model but is not a product of the muscle equation here. Less energy transfer is not the same as no energy transfer.

53 Exercise increases oxygen delivery demand

- breathing rate
- fatigue

■ Question 1

Why do heart rate and breathing increase during exercise?

- To help deliver more oxygen for increased muscle energy demand
- To make the heart and lungs produce extra glucose for the muscles
- To stop anaerobic respiration so that no lactic acid forms at all

Available marks: 2.

Worked answer

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To help deliver more oxygen for increased muscle energy demand

- During long periods of vigorous activity muscles become fatigued and stop contracting efficiently. Breathing can remain elevated during recovery as extra oxygen is needed. Distinguish rate from volume: breaths per minute and volume per breath are separate quantities, so both can affect the volume of air moved per minute.

■ Question 2

A fictional record has 18 breaths per minute and 0.6 litres per breath. Calculate air volume per minute.

Available marks: 4.

Worked answer

10.8 L/min

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

The heart moves blood and does not generate oxygen. Faster breathing does not mean every oxygen molecule in the air enters the blood. The detailed liver handling of lactic acid and quantitative definition of oxygen debt are Higher Tier content taught separately.

54 Higher Tier: lactic acid and recovery

- oxygen debt
- lactic acid

■ Question 1

Where is transported lactic acid converted back into glucose in the specified model?

- The liver
- The microscope
- The lung air spaces

Available marks: 2.

Worked answer

The liver

- Explain the sequence using location and transport: muscle production, blood movement, liver processing and continued oxygen demand. The examination model supports explaining raised breathing during recovery. It does not imply that all oxygen consumed during exercise was absent or that every recovery process is the same chemical reaction.

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■ Question 2

Two one-minute intervals use 0.80 and 0.50 L oxygen; baseline is 0.20 L per minute. Calculate total extra oxygen.

Available marks: 4.

Worked answer

0.9 L

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

An oxygen debt is a quantity of extra oxygen, not a financial cost or simply the time taken to rest. Blood transports lactic acid; it does not mean the heart converts it into glucose. This finite supplied record estimates only the extra oxygen included in its stated intervals.

55 Metabolism links building and breaking down

- metabolism
- urea

■ Question 1

Which statement correctly describes metabolism?

- It includes both molecule synthesis and breakdown
- It means only food moving through the gut
- It excludes cellular respiration

Available marks: 2.

Worked answer

It includes both molecule synthesis and breakdown

- In plants, glucose and nitrate ions provide materials for amino-acid production. Metabolism also includes respiration and the breakdown of excess proteins to form urea for excretion. Match each molecule to its role rather than treating every metabolic reaction as digestion or every product as an energy store. Urea formation and urea excretion are related but distinct processes.

■ Question 2

In the stated model, each lipid needs three fatty acids. How many fatty-acid molecules are needed for 9 lipid molecules?

Available marks: 4.

Worked answer

27 molecules

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

Metabolism includes synthesis and breakdown, not only reactions that release energy. Proteins are made from amino acids, while lipids use glycerol and fatty acids. Urea is a waste from excess protein breakdown and is not the same substance as glucose or lactic acid.

56 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.

57 Homeostasis: detect a change and respond

- homeostasis
- effector

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■ Question 1

Which component directly brings about a corrective response?

- An effector
- A ruler scale alone
- A stimulus without a responding structure

Available marks: 2.

Worked answer

An effector

- Receptors detect stimuli, or changes. A coordination centre such as the brain, spinal cord or pancreas receives and processes information. Effectors are muscles or glands that produce a response restoring suitable levels. A receptor detects a change; it is not necessarily the structure producing the corrective action.

■ Question 2

A fictional record spans 36.7 to 37.3 °C. Calculate its range.

Available marks: 4.

Worked answer

0.6 °C

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

Homeostasis maintains suitable internal conditions rather than a perfectly constant outside world. Receptor, coordination centre and effector describe roles, not interchangeable labels. Nervous and chemical systems can both contribute; detailed hormone-specific feedback is taught in its own section.

58 A reflex arc: rapid automatic coordination

- sensory neurone
- synapse

■ Question 1

Which sequence is correct for the simplified reflex pathway?

- Receptor → sensory neurone → relay neurone → motor neurone → effector
- Receptor → motor neurone → relay neurone → sensory neurone → effector
- Receptor → sensory neurone → brain → motor neurone → effector

Available marks: 2.

Worked answer

Receptor → sensory neurone → relay neurone → motor neurone → effector

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- A reflex pathway includes a sensory neurone carrying information from a receptor, a relay neurone in the CNS and a motor neurone carrying information to an effector. At a synapse a chemical messenger crosses the small junction between neurones and triggers a new electrical impulse in the next cell. Reflexes are automatic and rapid and do not involve the conscious part of the brain, helping protect the body from harm.

■ Question 2

Supplied model delays are 9, 4 and 13 ms. Calculate their total.

Available marks: 4.

Worked answer

26 ms

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

A reflex does involve the nervous system even though it is not a conscious choice. The sensory neurone leads towards the CNS; the motor neurone leads towards an effector. A synapse is a junction, not a whole sensory cell or a blood vessel.

59 Required practical 7: reaction time and fair comparison

- reaction time
- anticipation

■ Question 1

Why should the releaser avoid giving a countdown?

- It can allow anticipation instead of response to the actual release
- It makes the ruler fall faster, so the measured distance is too short
- It removes the need for repeated trials, because each one is the same

Available marks: 2.

Worked answer

It can allow anticipation instead of response to the actual release

- The chosen factor must change while other relevant conditions stay comparable. Keep the starting ruler position, hand position, catching method and instructions consistent. Avoid advance cues to the release. Repeated trials reduce the influence of random variation; a planned order can reduce practice or fatigue effects. A shorter drop distance generally indicates a quicker catch in the same method.

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■ Question 2

Model catch distances are 16, 20, 18 and 22 cm. Calculate the mean.

Available marks: 4.

Worked answer

19 cm

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

A result is a measurement under particular conditions, not a permanent personal characteristic. Never silently discard the largest value just to improve the mean. A distance-to-time conversion must use the specified model or table rather than relabelling centimetres as milliseconds.

60 Brain regions have different functions

- cerebral cortex
- cerebellum

■ Question 1

Which named region is associated with coordinating movement and balance?

- Cerebellum
- A blood platelet
- The lens of the eye

Available marks: 2.

Worked answer

Cerebellum

- Use a diagram's orientation to locate a region rather than assuming every picture has the same left/right view. The large outer cerebral region, the smaller cerebellum towards the back and the medulla linking to the spinal cord are distinct. A function can involve connections between regions; naming a region does not imply that it acts in isolation.

■ Question 2

A classroom model shares 45 cards equally among three region labels. How many cards are in each group?

Available marks: 4.

Worked answer

15 cards

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

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The medulla and cerebellum are not alternate names for the cerebral cortex. A brain schematic is not to scale and cannot diagnose damage. The separate Higher Tier lesson discusses the evidence and difficulty of mapping brain function; its procedures are not classroom experiments.

61 Higher Tier: evidence about brain function

- MRI scanning
- electrical stimulation

■ Question 1

Why can identifying brain function be difficult?

- Complex interconnected and delicate regions complicate interpretation and intervention
- Every brain region works alone, so damage to one shows its function clearly
- Brain scans give one exact percentage that shows each region's function

Available marks: 2.

Worked answer

Complex interconnected and delicate regions complicate interpretation and intervention

- The brain is complex and delicate. Regions are interconnected, damage may affect more than one pathway and invasive procedures can cause harm. Evaluating a procedure weighs the expected information or treatment benefit against risks, uncertainty and ethical constraints. Agreement between different kinds of evidence can strengthen a conclusion without eliminating every limitation.

■ Question 2

A fictional evidence set reports a response in 21 of 28 cases. Calculate the percentage.

Available marks: 4.

Worked answer

75 %

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

MRI is a technique rather than a single universal readout of every thought. A damaged region may affect connected systems, so a lost function cannot always be localized to one isolated cell group. Higher Tier evaluation must give a specific benefit and risk rather than a generic claim that technology is good.

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62 The eye detects light and controls its entry

- retina
- iris
- optic nerve

■ Question 1

Which structure contains receptors sensitive to light and colour?

- Retina
- Optic nerve alone
- Suspensory ligament

Available marks: 2.

Worked answer

Retina

- In dim light the iris allows a larger pupil, admitting more light; in bright light it reduces the opening. This is different from accommodation, which changes lens shape for focusing. Ciliary muscles and suspensory ligaments control lens shape. Correct diagram labels must distinguish a boundary, an opening, a transparent structure and a nerve.

■ Question 2

A circular-pupil model doubles radius. Calculate its area ratio final/initial.

Available marks: 4.

Worked answer

4

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

The iris controls pupil size; the pupil does not itself contract as a muscle. The optic nerve carries information and does not refract light. Bright/dim adaptation and near/far focusing require different explanations. All eye objectives in this acquired AQA section are both-tier Biology content.

63 Accommodation: near and distant objects

- accommodation
- suspensory ligament

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■ Question 1

Which set of changes focuses on a near object?

- Ciliary muscles contract, ligaments loosen, lens thickens
- Ciliary muscles relax, ligaments tighten, lens thins
- Only the optic nerve becomes thicker

Available marks: 2.

Worked answer

Ciliary muscles contract, ligaments loosen, lens thickens

- The lens does not actively pull itself into shape like a muscle. Explain the mechanical connection: ciliary-muscle action changes tension in the suspensory ligaments, allowing or pulling the elastic lens into the appropriate shape. A change in pupil size alone does not supply the required accommodation explanation.

■ Question 2

A model lens thickness is drawn as 28 mm at magnification 8. Calculate the represented thickness.

Available marks: 4.

Worked answer

3.5 mm

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

Near focusing uses contracted ciliary muscles and loose ligaments, not the reverse. For distance, tightening the ligaments pulls the lens thin. Drawing thickness and actual thickness need a stated scale. This section does not require a clinical eye test or a spectacle prescription.

64 Eye defects: restore focus to the retina

- myopia
- hyperopia

■ Question 1

Which lens corrects the supplied myopia model?

- A diverging lens
- An opaque wall covering the retina
- A lens that makes rays focus even further forward

Available marks: 2.

Worked answer

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A diverging lens

- Interpret the ray diagram using the position of the retina and focus, then the effect of the external lens. The specification also identifies hard and soft contact lenses, laser surgery changing corneal shape and a replacement lens in the eye. These are correction technologies; choosing between them needs individual professional assessment rather than a classroom rule.

■ Question 2

A model displacement is drawn as 18 mm at magnification 6. Calculate the represented displacement.

Available marks: 4.

Worked answer

3 mm

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

Myopia is corrected with a diverging lens, while the supplied hyperopia model uses a converging lens. A retina drawn on the wrong side can reverse an interpretation. Accommodation is the eye changing its own lens shape; a spectacle lens is an external correction.

65 Temperature control: detect hot and cold

- vasodilation
- vasoconstriction

■ Question 1

Which response set matches a too-cold condition?

- Vasoconstriction, stopped sweating and shivering
- Vasodilation, more sweating and the hairs lying flat
- Vasoconstriction, more sweating and a faster breathing rate

Available marks: 2.

Worked answer

Vasoconstriction, stopped sweating and shivering

- When temperature is too low, those blood vessels constrict, called vasoconstriction, sweating stops and skeletal muscles contract repeatedly in shivering. These are co-ordinated responses rather than conscious choices alone. The specification connects hot-condition responses with transfer of energy from skin to the environment; the separate Higher lesson explains each mechanism in a stated context.

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■ Question 2

A fictional temperature record has 37.0, 37.2, 37.4 and 37.0 °C. Calculate the mean.

Available marks: 4.

Worked answer

37.15 °C

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

The thermoregulatory centre is in the brain, not the skin. Skin receptors detect change while sweat glands produce a response. Vasodilation and vasoconstriction have opposite effects on blood delivery near the surface; avoid swapping their names.

66 Higher Tier: explain heating and cooling mechanisms

- evaporation
- shivering

■ Question 1

Why does sweat evaporation help cool the skin?

- Evaporation requires energy transferred from the skin
- Sweat absorbs heat from the air and carries it away from the body
- It stops blood flowing near the skin, so less heat reaches the surface

Available marks: 2.

Worked answer

Evaporation requires energy transferred from the skin

- Vasoconstriction reduces blood flow near the skin surface and therefore reduces energy loss there. Stopping sweating avoids further evaporative cooling. Shivering is repeated skeletal-muscle contraction; increased muscle activity and respiration transfer more energy, helping warm the body. Blood is diverted from surface vessels rather than all circulation stopping.

■ Question 2

A fictional cloth model loses 2.8 g water in 14 min. Calculate mean evaporation mass rate.

Available marks: 4.

Worked answer

0.2 g/min

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

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Shivering does not warm the body mainly by bones rubbing together. Evaporation transfers energy even though the remaining sweat may feel cool. A cloth mass-loss result measures water loss rather than automatically measuring heat energy or a person's core temperature.

67 Endocrine coordination: blood carries the message

- endocrine gland
- target organ

■ Question 1

Which route describes hormonal coordination?

- Gland → blood → target organ
- Hormone → optic lens → air
- Every gland → every cell with the same effect

Available marks: 2.

Worked answer

Gland → blood → target organ

- Locate the pituitary below the brain, thyroid in the neck, adrenal glands above the kidneys and pancreas in the abdomen. Ovaries lie in the pelvis and testes in the scrotum. These positions help identify glands on a body diagram; a gland's position is not the location of every target it affects. The term master gland describes the pituitary's coordinating role, not production of every hormone.

■ Question 2

A supplied model route is 42 cm and transport takes 7 s. Calculate mean transport speed.

Available marks: 4.

Worked answer

6 cm/s

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

The pancreas is a gland, while insulin is a hormone it produces. Blood distribution does not mean all cells respond identically. A hormonal response cannot be assigned a fixed universal speed from one fictional transport calculation.

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68 Insulin and two different diabetes models

- insulin
- glycogen

■ Question 1

Which explanation matches the specified Type 2 model?

- Target cells respond inadequately to insulin
- Every person produces no insulin at all
- The lens cannot accommodate

Available marks: 2.

Worked answer

Target cells respond inadequately to insulin

- In the specified Type 1 diabetes model, the pancreas produces insufficient insulin and insulin injections replace the missing hormone. In Type 2, cells no longer respond adequately to insulin; the specification describes carbohydrate-controlled diet and exercise as management principles and obesity as a risk factor. These are course comparisons, not individualized treatment plans or a claim that every person has the same management needs.

■ Question 2

A fictional concentration falls from 10 to 7.5 units. Calculate percentage decrease.

Available marks: 4.

Worked answer

25 %

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

Insulin and glycogen are different substances. Type 2 does not mean the pancreas necessarily produces no insulin. Obesity is a risk factor rather than proof of an individual diagnosis. Higher-only glucagon/negative-feedback interaction is taught separately.

69 Higher Tier: opposing responses stabilize glucose

- glucagon
- negative feedback

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■ Question 1

Which response fits low blood glucose?

- Glucagon promotes conversion of glycogen to glucose
- Insulin promotes conversion of glycogen to glucose
- The liver secretes glycogen into the blood as a hormone

Available marks: 2.

Worked answer

Glucagon promotes conversion of glycogen to glucose

- Trace two separate pathways: high glucose → insulin → lower glucose, and low glucose → glucagon → higher glucose. Both respond to the regulated variable. Do not say that glucagon and insulin simply cancel each other at all times, or that the system always holds one perfectly unchanging number.

■ Question 2

A fictional concentration rises from 4 to 5 units. Calculate percentage increase.

Available marks: 4.

Worked answer

25 %

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

Glucagon is a hormone, glycogen is a stored carbohydrate and glucose is a sugar. Their similar names do not mean they perform the same role. Negative feedback opposes a change; positive feedback would amplify it. The exact response depends on available stores and the stated model.

70 Kidneys: filtration and selective reabsorption

- filtration
- selective reabsorption

■ Question 1

Why can glucose occur in filtrate but not in the stated final urine?

- It is selectively reabsorbed
- It is too large to be filtered
- It is broken down by the liver

Available marks: 2.

Worked answer

It is selectively reabsorbed

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- Kidneys produce urine by filtering blood and selectively reabsorbing useful substances, including glucose, some ions and water. A substance in the initial filtrate is not automatically a waste product. The final composition depends on what is reabsorbed. Detailed nephron structure and other urinary-system anatomy are not required by this GCSE section.

Question 2

A model filters 32 water units and reabsorbs 25. Calculate units remaining.

Available marks: 4.

Worked answer

7 units

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

Reabsorption moves useful material back into blood; it is not the same as producing it. Urine and initial filtrate are different. The kidneys do not make urea in this model; Higher Tier liver processing and ADH permeability control are taught separately.

71 Higher Tier: ADH and nitrogen waste

- ADH
- deamination

Question 1

Which response fits blood that is too concentrated?

- More ADH and more water reabsorption
- Less tubule permeability with more water loss
- The kidney converts glucose into ammonia

Available marks: 2.

Worked answer

More ADH and more water reabsorption

- When blood is too concentrated, the pituitary releases more ADH. ADH increases the permeability of kidney tubules to water, so more water is reabsorbed into blood. Less water remains in urine. As blood returns towards suitable concentration, the stimulus for ADH release decreases: negative feedback opposes the original disturbance.

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■ Question 2

A model filters 80 water units and reabsorbs 74. Calculate units remaining.

Available marks: 4.

Worked answer

6 units

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

ADH changes permeability rather than directly turning water into glucose. More water reabsorption generally means a smaller water volume in urine in the stated model. Ammonia and urea are different, and the liver–not the kidney–is the specified site of deamination and urea formation.

72 Dialysis and transplant: compare evidence and burdens

- dialysis
- transplant

■ Question 1

What drives net urea movement into dialysis fluid in the stated model?

- Its concentration difference across a permeable membrane
- A membrane that actively reads molecule names
- Every blood cell passing into the fluid

Available marks: 2.

Worked answer

Its concentration difference across a permeable membrane

- Dialysis needs repeated treatment and imposes time and practical burdens. A successful kidney transplant can restore continuing kidney function, but needs a suitable donor, surgery and management of rejection. Compare risks, availability, lifestyle effects and evidence of benefit. Neither route should be presented as suitable for every individual or as a guaranteed cure.

■ Question 2

A fictional waste amount falls from 40 to 10 units. Calculate percentage removed.

Available marks: 4.

Worked answer

75 %

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

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Dialysis is not selective because it recognizes the name of a waste; membrane permeability and concentration differences matter. Cells and large proteins should not cross the stated membrane. A transplant decision includes ethical and practical considerations beyond a single removal percentage.

73 Reproductive hormones: named roles before interactions

- ovulation
- testosterone

■ Question 1

Which hormone stimulates release of the egg in the course model?

- LH
- Insulin
- ADH

Available marks: 2.

Worked answer

LH

- FSH causes an egg to mature in an ovary. LH stimulates its release. Oestrogen and progesterone are involved in maintaining the uterus lining. An egg matures before it is released; ovulation is not fertilization or menstruation. Both-tier teaching requires these roles; the hormone interactions and graph analysis are separately Higher Tier.

■ Question 2

A supplied 30-day model marks an event 15 days after the start. Calculate the elapsed fraction as a percentage.

Available marks: 4.

Worked answer

50 %

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

FSH and LH have different roles. Testosterone is not produced by the ovary in this course model. Variation in real cycle timing means the simplified 28-day representation is used for biological explanation rather than personal forecasting.

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74 Higher Tier: hormones interact across the cycle

- FSH
- progesterone

Question 1

Which change supports lining loss at the end of the stated cycle?

- Falling progesterone support
- Permanent maximum progesterone
- ADH releasing the egg

Available marks: 2.

Worked answer

Falling progesterone support

- Read the supplied curves for the same time interval. Identify a hormone peak, connect it with the specified effect and explain an inhibition or stimulation arrow. Do not describe every increase as negative feedback: stimulation of the LH surge differs from inhibition of FSH. The simplified cycle model does not determine an individual's cycle dates.

Question 2

A fictional hormone value rises from 3 to 12 relative units. Calculate fold increase.

Available marks: 4.

Worked answer

4

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

Hormone concentration and egg number are different quantities. Inhibiting FSH reduces further maturation in the stated model rather than removing every hormone instantly. Menstruation is linked to falling support for the lining, not to the egg being physically washed out of the ovary.

75 Contraception: mechanisms and evidence

- contraception
- barrier method

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■ Question 1

Which explanation matches a barrier method?

- It prevents sperm reaching an egg
- It stops ovulation by releasing hormones
- It prevents a fertilised egg from implanting

Available marks: 2.

Worked answer

It prevents sperm reaching an egg

- Intrauterine methods include hormone-releasing devices and non-hormonal copper devices. The acquired specification mentions prevention of implantation; the NHS reference explains copper's main effect on sperm survival and fertilisation, with a possible additional implantation effect. Distinguish pregnancy prevention from protection against sexually transmitted infections. Evaluate use requirements, reversibility, evidence and values without inventing universal success rates.

■ Question 2

A fictional one-year record has 4 pregnancies among 200 users. Calculate the observed percentage.

Available marks: 4.

Worked answer

2 %

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

A hormonal method does not necessarily protect against infection. A simplified calendar model cannot establish an individual safe interval. Scientific evidence informs effectiveness and risks, but choices also involve values, access and preferences.

76 Higher Tier: fertility hormones and IVF

- IVF
- embryo transfer

■ Question 1

Which sequence fits IVF?

- Egg maturation → collection → laboratory fertilisation → embryo development → transfer
- Embryo development → egg collection → fertilisation in the uterus → transfer
- Egg collection → transfer to the uterus → fertilisation inside the body

Available marks: 2.

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Worked answer

Egg maturation → collection → laboratory fertilisation → embryo development → transfer

- The acquired specification describes transfer of one or two tiny embryos. This is its teaching sequence, not a current clinical recommendation about embryo number. Treatment can be physically and emotionally stressful, success is uncertain and multiple births can carry risks to mother and babies. Evaluate benefits and risks using the stated evidence and perspectives rather than promise a guaranteed baby.

■ Question 2

A fictional dataset has 16 specified successes among 80 cycles. Calculate the rate.

Available marks: 4.

Worked answer

20 %

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

IVF does not place an unfertilised egg directly into the uterus as its final defining step. Fertilisation and implantation are different events. The course model must not be used to prescribe hormone doses or embryo numbers.

77 Higher Tier: thyroxine feedback and adrenaline response

- thyroxine
- adrenaline

■ Question 1

Which hormone is associated with stimulating basal metabolic rate?

- Thyroxine
- The cellulose in a plant wall
- A digestive starch molecule

Available marks: 2.

Worked answer

Thyroxine

- A supplied thyroxine control diagram may show low thyroxine stimulating pituitary signalling to the thyroid, followed by thyroxine release. Raised thyroxine then reduces the stimulating signal. Explain how that opposes the initial fall. Do not assign the same negative-feedback sequence to every adrenaline event merely because both substances are hormones.

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■ Question 2

A fictional metabolic measure rises from 100 to 120 units. Calculate percentage increase.

Available marks: 4.

Worked answer

20 %

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

Adrenal glands and thyroid are different glands. Basal metabolic rate concerns resting metabolic activity rather than only visible movement. Negative feedback reduces a disturbance; an arrow labelled inhibition needs an explanation of what is inhibited and why.

78 Seedling responses: unequal growth makes a bend

- phototropism
- auxin

■ Question 1

Why does the stated shoot bend towards light?

- Greater elongation on the shaded side makes it curve
- All cells cease growing on both sides
- The optic nerve sends a signal to the leaf

Available marks: 2.

Worked answer

Greater elongation on the shaded side makes it curve

- Roots and shoots respond differently. In a horizontal root, more auxin on the lower side inhibits elongation relative to the upper side, so the root bends downwards. In a shoot, greater lower-side elongation bends it upwards. Explain the growth difference rather than claim that gravity pulls all the cells into a new shape.

■ Question 2

A supplied shoot model has growth of 9 mm and 5 mm on opposite sides. Calculate the difference.

Available marks: 4.

Worked answer

4 mm

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

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A tropism is growth in relation to a directional stimulus, not every plant movement. Auxin does not have the same elongation effect in every root and shoot situation. Gibberellin and ethene roles are Higher Tier and are taught separately.

79 Higher Tier: germination and fruit ripening signals

- gibberellin
- ethene

■ Question 1

Which role belongs to gibberellins in this course?

- Initiating seed germination
- Producing human insulin
- Acting as a bacterial antibody

Available marks: 2.

Worked answer

Initiating seed germination

- Distinguish a hormone effect from the conditions needed for the response. A viable seed still needs suitable environmental conditions. A fruit-ripening comparison needs a matched variety, maturity and observation period. A greater observed response in one treatment does not prove that every species or developmental stage behaves identically.

■ Question 2

A fictional condition has 28 germinated seeds among 40. Calculate the percentage.

Available marks: 4.

Worked answer

70 %

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

Ethene and ethanol are different substances. Gibberellins are not auxins and need not have the same growth effects. The specification excludes detailed molecular mechanisms here, so a correct GCSE explanation names the role and interprets the supplied evidence.

80 Higher Tier: controlling plant growth commercially

- rooting powder
- seed dormancy

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■ Question 1

Which use matches ethene?

- Controlling fruit ripening in storage and transport
- Stimulating root growth in plant cuttings
- Killing weeds by making them grow too fast

Available marks: 2.

Worked answer

Controlling fruit ripening in storage and transport

- A weed-killer application can change plant diversity and affect organisms depending on those plants. Evaluate intended crop benefits alongside non-target effects, biodiversity and the stated treatment conditions. A rooting comparison measures root formation, while a fruit-size comparison needs dimensions or mass; neither is automatically evidence for the other hormone uses.

■ Question 2

A fictional trial has 21 rooted cuttings among 28. Calculate the percentage.

Available marks: 4.

Worked answer

75 %

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

Hormones coordinate growth; mineral fertilizers provide nutrients and are a different intervention. A result for cuttings does not prove a fruit-ripening effect. Commercial benefits do not remove the need to evaluate non-target and biodiversity effects.

81 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

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- 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.

82 Sexual and asexual reproduction: what joins?

- gamete
- clone

■ Question 1

Which evidence identifies sexual reproduction?

- Fusion of gametes
- Mitosis in the parent plant
- Offspring forming from runners

Available marks: 2.

Worked answer

Fusion of gametes

- Asexual reproduction uses one parent without fusion of gametes. There is no mixing of information from two parents; mitosis produces genetically identical offspring called clones in the school model. A clone can still grow differently in a different environment. Genetic identity is not a promise of identical height, health or every visible feature.

■ Question 2

A nursery has 18 runner-derived and 12 seed-derived plants. Find the runner-derived percentage.

Available marks: 4.

Worked answer

60 %

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

Pollen is not an egg cell. Mitosis also supports growth after sexual reproduction, so finding mitosis alone does not show how an organism originally formed. The key difference between reproductive routes is gamete fusion and genetic mixing.

83 Meiosis halves; fertilisation restores

- meiosis
- fertilisation

■ Question 1

A model species has 24 chromosomes in ordinary cells. What number should a gamete contain?

- 12
- 24
- 48

Available marks: 2.

Worked answer

12

- Fusion of two gametes restores the normal number of chromosomes in the new cell. The new cell divides by mitosis, increasing the number of cells. As the embryo develops, cells differentiate and become specialised. Copying DNA before division does not mean the final gametes keep two chromosome sets.

■ Question 2

A fictional species has 32 chromosomes in ordinary cells. Find the number in a gamete.

Available marks: 4.

Worked answer

16 chromosomes

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

Meiosis does not make four identical ordinary body cells. Fertilisation is fusion rather than a division. The four-cell outcome is the specification's overall model; detailed gamete development and stage names are outside this objective.

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84 Reproductive advantages depend on conditions

- asexual reproduction
- runner

Question 1

Which is an advantage of sexual reproduction when conditions change?

- Inherited variation may improve survival of some offspring
- All offspring survive because they are identical to a successful parent
- Every offspring is genetically identical, so none is lost to disease

Available marks: 2.

Worked answer

Inherited variation may improve survival of some offspring

- Asexual reproduction needs only one parent, avoids finding a mate and can produce many identical offspring quickly when conditions are favourable. Shared inherited susceptibility can become a disadvantage if conditions change. Malaria parasites reproduce asexually in the human host and sexually in the mosquito. Many fungi use asexual spores but also sexual reproduction. Strawberries can form runners and seeds; daffodils can divide bulbs as well as form seeds.

Question 2

Seven retained parent plants each produce two surviving new plants. Find total plants after the interval.

Available marks: 4.

Worked answer

21 plants

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

Asexual reproduction is not always superior and sexual variation does not guarantee survival. A fungus producing spores is not necessarily using only one reproductive route. Natural selection acts on existing variation rather than organisms choosing a useful change.

85 DNA, genes and the whole genome

- genome
- gene

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■ Question 1

Which description defines the genome?

- The entire genetic material
- The genes for one characteristic
- The genes on one chromosome

Available marks: 2.

Worked answer

The entire genetic material

- Studying the human genome helps researchers search for genes linked to disease, understand inherited disorders and investigate treatments. Comparing inherited DNA patterns also helps trace human migration in the past. A statistical link is not proof that a gene alone determines a person's future health; many characteristics involve several genes and environmental influences.

■ Question 2

A model gene occupies 240 of 1,600 bases in a displayed strand. Find the marked percentage.

Available marks: 4.

Worked answer

15 %

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

A genome is not one chromosome or all the proteins in a cell. DNA is not made of amino acids; proteins are. Genome information can inform research without justifying deterministic predictions or disclosure of personal genetic information.

86 DNA nucleotides and the order of information

- nucleotide
- base sequence

■ Question 1

What distinguishes the four DNA nucleotide kinds in this model?

- The base attached to the sugar
- A completely different protein in each sugar
- Only the length of the chromosome

Available marks: 2.

Worked answer

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The base attached to the sugar

- In the specified simple model, a sequence of three bases codes for a particular amino acid. The order of bases controls the order in which amino acids are assembled into a protein. Moving the same letters into a different order can change the information. Complementary pairing and the simple synthesis mechanism belong to the Higher lesson, so do not demand those details in a common-tier task.

■ Question 2

A fictional sequence contains 36 bases in complete three-base groups. Find the number of groups.

Available marks: 4.

Worked answer

12 groups

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

A nucleotide is not just its base. Sugar and phosphate form the strand framework, while base order carries the sequence information. Three-base grouping here is an explicit classroom model, not a promise that all genomic DNA becomes protein.

87 Higher Tier: sequence, protein shape and gene expression

- protein synthesis
- gene expression

■ Question 1

Which account fits a non-coding regulatory variant?

- It may change whether a gene is expressed
- It must change every amino acid in the protein that the gene codes for
- It has no possible effect, because it lies outside the coding sequence

Available marks: 2.

Worked answer

It may change whether a gene is expressed

- A change in coding DNA can change the amino-acid sequence and therefore folding. An enzyme's active site may no longer fit its substrate, or a structural protein may lose strength. Most mutations do not change the protein, or change it too little to alter its appearance or function. Non-coding DNA can control whether genes are switched on or off; variants there may affect expression without changing the coded amino-acid sequence.

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■ Question 2

Five of 100 variants in a fictional study alter the measured phenotype. Find the percentage.

Available marks: 4.

Worked answer

5 %

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

DNA does not assemble the protein directly inside the nucleus in this account: synthesis takes place on ribosomes. A changed sequence does not automatically create a useful or harmful phenotype. Non-coding means not coding a protein, not having no function.

88 Alleles, genotype and phenotype: read a cross

- allele
- heterozygous
- genotype
- phenotype

■ Question 1

Which statement correctly describes Aa in the supplied model?

- Heterozygous with the dominant phenotype
- Homozygous recessive
- Two entirely different chromosomes and no gene

Available marks: 2.

Worked answer

Heterozygous with the dominant phenotype

- A gamete carries one allele from the pair. A supplied Punnett square combines one allele from each parent. Its four boxes show equally likely combinations when the prompt gives equally likely gametes, not four children who must be born in that exact pattern. The specification names mouse fur colour and human red–green colour blindness as examples of genetic control; use a supplied inheritance key and do not assume both follow an identical autosomal cross. Most phenotype features involve multiple genes, often interacting with the environment, so the simple model has a defined scope.

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■ Question 2

A provided grid has recessive probability 1/4. Find the expected number in 240 model offspring.

Available marks: 4.

Worked answer

60 offspring

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

Dominant does not mean stronger, healthier or more common. Heterozygous does not mean two different genes: it means different alleles at the model gene. Probability for one offspring is not changed by the outcome of an earlier independent birth.

89 Higher Tier: construct a genetic cross from evidence

- Punnett square
- probability

■ Question 1

Under the stated model, what does a recessive offspring of two dominant parents show?

- Both parents carry a recessive allele
- Both parents must be AA
- Dominance means the recessive allele disappeared

Available marks: 2.

Worked answer

Both parents carry a recessive allele

- Each box combines one allele from each parent: AA, Aa, Aa and aa. State genotype and phenotype probabilities separately. The inference depends on the stated model: one gene, complete dominance and no new mutation. Do not apply it unchanged to characteristics controlled by many genes or to a scenario with incomplete dominance.

■ Question 2

An Aa×aa model gives recessive probability 1/2. Find the expected number in 90 offspring.

Available marks: 4.

Worked answer

45 offspring

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

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Writing only a 3:1 ratio earns no explanation of where it came from. Aa×aa does not give 3:1. A recessive outcome is possible again even when the previous offspring was recessive; the model has no memory of earlier births.

90 Inherited disorders and screening judgements

- carrier
- embryo screening

■ Question 1

In the supplied Ff×Ff model, which genotype is a carrier?

- Ff
- FF
- ff

Available marks: 2.

Worked answer

Ff

- For a supplied Ff×Ff grid, the expected outcomes are FF, Ff, Ff and ff. Each offspring has a 1/4 chance of ff, a 1/2 chance of being a carrier and a 3/4 chance of not expressing the disorder in this model. Not expressing the disorder is not the same as not carrying its allele. Use the prompt's explicit allele key; letter choice alone does not define dominance.

■ Question 2

A provided Ff×Ff model predicts affected probability 1/4. Find expected affected count in 360 offspring.

Available marks: 4.

Worked answer

90 offspring

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

Dominant inheritance does not mean every child of an affected parent must be affected. A heterozygous dominant parent and a homozygous recessive parent can produce both phenotypes. Real clinical interpretation may be more complex; classroom conclusions are restricted to the supplied model.

91 Chromosome inheritance in the XX/XY model

- sex chromosome
- chromosome pair

■ Question 1

How many chromosomes are in an ordinary body cell in the specified human model?

- 46
- 23
- 48

Available marks: 2.

Worked answer

46

- Combining X with X gives XX; combining X with Y gives XY. A cross with egg labels X and X and sperm labels X and Y has two XX and two XY boxes. Expected ratio is 1:1 and probability is 1/2 for each outcome. This is the GCSE chromosome-inheritance model, not a complete account of human sex development or gender.

■ Question 2

A model gives XX probability 1/2 in 150 independent fertilisations. Find expected XX outcomes.

Available marks: 4.

Worked answer

75 outcomes

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

An egg in the specified model does not contain both X and Y. The sex-chromosome pair is included in the 23 pairs, not added as a twenty-fourth pair. Equal probability does not alternate outcomes or require the next child to balance previous outcomes.

92 Variation: inherited information and environment

- variation
- mutation

■ Question 1

What can explain different heights among genetically identical plants?

- Different developmental environments
- Every plant must have a different inherited allele
- Clones cannot show any variation

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Available marks: 2.

Worked answer

Different developmental environments

- Mutations occur continuously. Most do not affect the phenotype, some influence it and very few determine a new phenotype in the specification's account. A variant that gives an advantage after an environmental change can become more common through selection. The environment does not intentionally produce exactly the mutation an organism needs.

■ Question 2

Clone heights are 16, 18, 19 and 19 cm. Calculate mean height.

Available marks: 4.

Worked answer

18 cm

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

Variation is not limited to genetic differences. The same genotype can produce different phenotypes in different environments. A mutation can have no measured effect under one set of conditions, so a phenotype observation does not reveal every DNA difference.

93 Natural selection changes a population over generations

- natural selection
- evolution

■ Question 1

What directly increases an advantageous inherited variant over generations?

- Its carriers leave more surviving offspring
- Individuals adapt to survive during their lifetime
- It appears more often by chance mutation

Available marks: 2.

Worked answer

Its carriers leave more surviving offspring

- The theory explains living species evolving from simple early life forms over more than three billion years. Selection acts on an existing population with variation; it does not mean every individual changes during its lifetime. If two populations become sufficiently different that they cannot interbreed to produce fertile offspring, they form separate species in the specified model.

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■ Question 2

A model begins with 50 pale beetles and 40 survive. Find pale survival percentage.

Available marks: 4.

Worked answer

80 %

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

Fitness means reproductive success in the environment, not physical strength alone. Individuals do not choose beneficial inherited changes. A new species requires evidence about interbreeding and fertile offspring, not only a difference in appearance.

94 Selective breeding: repeat selection, retain the risks

- selective breeding
- inbreeding

■ Question 1

Which step must follow breeding the selected parents?

- Select suitable offspring and repeat over generations
- Choose the strongest parents just once
- Insert the desired gene into a plasmid

Available marks: 2.

Worked answer

Select suitable offspring and repeat over generations

- Useful and attractive characteristics are not necessarily the same. Repeatedly breeding closely related individuals can cause inbreeding, making some breeds more prone to disease or inherited defects. A narrow breeding population may reduce variation. Evaluate production benefits alongside health, welfare and resilience rather than treating one selected measurement as the whole organism's value.

■ Question 2

A supplied yield rises from 4.0 to 5.0 kg per plant. Calculate percentage increase.

Available marks: 4.

Worked answer

25 %

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

Selective breeding does not insert a chosen gene directly into a cell. It uses reproduction

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and selection over generations. Choosing every parent from one family can intensify inherited risks; a greater average yield is not proof that all other traits improved.

95 Genetic engineering: trait, evidence and trade-offs

- genetic engineering
- GM crop

■ Question 1

Which is genetic engineering rather than selective breeding?

- Introducing a gene into a recipient organism
- Choosing high-yielding parents over generations
- Selecting the largest offspring repeatedly

Available marks: 2.

Worked answer

Introducing a gene into a recipient organism

- Potential agricultural benefits include improved yield or reduced crop damage. Evaluation also considers effects on wild flowers, insects, gene movement and farming practices. Medical benefits include production of useful substances and research on inherited disorders. The specification records objections and questions about long-term effects; these are issues to evaluate with evidence, not proof that every engineered product has the same risks.

■ Question 2

Comparison yield is 5.0 and engineered-line yield 6.0 tonnes per hectare. Find percentage increase.

Available marks: 4.

Worked answer

20 %

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

Genetic engineering does not necessarily make an organism larger or immune to every disease. Herbicide resistance in a crop is different from insect resistance. Detailed enzymes and vectors are separately Higher-only; common-tier evaluation uses the stated gene transfer and evidence.

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96 Higher Tier: isolate, insert and transfer a gene

- vector
- recipient cell

■ Question 1

What role does the plasmid have in the stated procedure?

- It carries the selected gene into recipient cells
- It is the insulin protein
- It automatically proves every cell expresses the gene

Available marks: 2.

Worked answer

It carries the selected gene into recipient cells

- A plasmid is a small DNA ring, not the human protein product. A vector carries the chosen gene; recipient cells use genetic information to make a product. A virus vector is not a requirement that all engineered organisms become diseased. The general stages are required at Higher Tier, without needing an advanced laboratory protocol or every enzyme name.

■ Question 2

Thirty of 200 recipient cells contain the target gene. Find the transfer percentage.

Available marks: 4.

Worked answer

15 %

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

The vector is not another word for the gene. Isolating a gene alone does not show transfer succeeded. Distinguish introducing information from measuring expression, and do not claim every cell or every later offspring necessarily has the trait without supplied evidence.

97 Cloning routes: identify the genetic source

- tissue culture
- nuclear transfer

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Question 1

Which supplies the nucleus in adult-cell cloning?

- The adult body-cell donor
- The egg-cell donor, whose own nucleus is kept
- The surrogate mother that carries the embryo

Available marks: 2.

Worked answer

The adult body-cell donor

- In adult-cell cloning, remove the nucleus from an unfertilised egg and insert a nucleus from an adult body cell such as skin. An electric shock stimulates division into an embryo. When it forms a ball of cells, transfer it into a female's womb. The specified embryo genetic-information comparison concerns the adult nuclear donor; the host supplies the developmental environment. Detailed mitochondrial inheritance is outside this GCSE account.

Question 2

Forty-five of 60 plant cuttings establish. Find success percentage.

Available marks: 4.

Worked answer

75 %

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

Adult-cell cloning does not fertilise an egg with the donor skin cell. Embryo splitting and adult nuclear transfer start from different material. A genetically identical group does not provide the variation benefits of sexual reproduction.

98 Darwin's explanation and why acceptance took time

- acquired characteristic
- scientific theory

Question 1

Which explains one historical reason for gradual acceptance?

- The inheritance mechanism was not yet understood
- Darwin already knew the complete DNA code
- No evidence was collected before publication

Available marks: 2.

Worked answer

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The inheritance mechanism was not yet understood

- Acceptance was gradual. The ideas challenged widespread beliefs about separate creation, available evidence was initially insufficient to convince many scientists, and the inheritance mechanism was not yet understood. Lamarck's explanation relied mainly on changes acquired during an organism's lifetime being inherited; this is not how inheritance operates in the vast majority of the specified examples. A study of creationism is not required.

■ Question 2

A supplied historical comparison uses dates 1859 and 1909. Find the interval.

Available marks: 4.

Worked answer

50 years

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

Darwin did not know the modern molecular DNA mechanism. Missing that mechanism at publication does not erase later supporting evidence. Do not describe natural selection as organisms deliberately improving themselves or treat a historical controversy as current scientific uncertainty about every aspect of evolution.

99 Wallace and the separation of populations

- speciation
- selection pressure

■ Question 1

What provides the specified final evidence of two species?

- They cannot interbreed to produce fertile offspring
- They live in different habitats and look different from each other
- They have different average sizes and different diets

Available marks: 2.

Worked answer

They cannot interbreed to produce fertile offspring

- A population may become geographically separated. The groups experience different conditions and selection pressures, with inherited variation in each. Different variants leave more offspring, and differences accumulate over generations. If the groups can no longer interbreed to produce fertile offspring, they are separate species under the specified definition.

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■ Question 2

Variant frequency rises from 12% to 42%. Find the increase in percentage points.

Available marks: 4.

Worked answer

30 percentage points

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

Geographical isolation is not proof of a new species. Different appearance alone is insufficient. The key final criterion is failure to produce fertile offspring by interbreeding, and the explanation must connect inherited variation with reproductive success over generations.

100 Mendel's units and later chromosome evidence

- inherited unit
- descendant

■ Question 1

Which evidence later connected Mendel's units with chromosomes?

- Similar behaviour of units and chromosomes during inheritance
- Mendel's own observations of chromosomes under a microscope
- Blending of parental characteristics in each new generation

Available marks: 2.

Worked answer

Similar behaviour of units and chromosomes during inheritance

- Scientists did not yet understand chromosomes and the molecular basis of inheritance, making the importance of his results difficult to recognise. In the late nineteenth century, chromosome behaviour during division was observed. Early in the twentieth century, similarities with Mendel's units supported locating genes on chromosomes. Mid-twentieth-century work established DNA structure and how genes function. Many scientists contributed.

■ Question 2

A model generation has 180 dominant and 60 recessive plants. Find the recessive percentage.

Available marks: 4.

Worked answer

25 %

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

Delayed recognition is not evidence that Mendel had no results. His units are now related to genes; calling them genes retrospectively must not suggest he knew their molecular structure. Inheritance theory developed as independent lines of evidence became connected.

101 Evolutionary evidence: independent lines support an explanation

- fossil record
- inherited variant

■ Question 1

Which is evidence of population evolution under selection?

- An inherited resistant variant becomes more common over generations
- Each bacterium develops resistance after it meets the antibiotic
- An individual organism grows larger during its own lifetime

Available marks: 2.

Worked answer

An inherited resistant variant becomes more common over generations

- Each line answers a different question. A fossil gives evidence of past organisms but usually cannot show their complete DNA. A resistance dataset can show population change over generations but is not a complete history of all life. Agreement between inheritance mechanisms, historical records and observed selection strengthens the explanation.

■ Question 2

A supplied sample has 18 resistant cells among 60. Find resistant frequency.

Available marks: 4.

Worked answer

30 %

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

An incomplete fossil record is not the same as no evidence. A resistant individual surviving does not mean antibiotics gave it an intentional adaptation. Selection and inheritance explain the population change without a goal-directed mechanism.

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102 Fossils, preservation and an incomplete record

- mineral replacement
- trace fossil

■ Question 1

Which is a trace fossil?

- A preserved footprint
- Only a complete living animal
- Any modern drawing of a plant

Available marks: 2.

Worked answer

A preserved footprint

- Many early organisms were soft-bodied and left few traces. Geological processes have destroyed much of the evidence. The record is therefore incomplete, limiting certainty about exactly how life began. Fossils nevertheless reveal how much or little organisms have changed and support reconstructions of evolutionary relationships.

■ Question 2

Two supplied fossils date to 150 and 110 million years before present. Find their age difference.

Available marks: 4.

Worked answer

40 million years

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

A fossil does not need to contain living tissue or a complete skeleton. Older dates before present have larger numerical values. An evolutionary tree is a model of relationships based on evidence, not a ladder ranking organisms as better or worse.

103 Extinction: no surviving individuals

- extinction
- competitor

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■ Question 1

Which observation directly fits extinction?

- No members of the species remain alive anywhere
- No individual was seen in one short survey
- One population moved to another habitat

Available marks: 2.

Worked answer

No members of the species remain alive anywhere

- A small, fragmented population may be vulnerable to loss even when some individuals survive a disturbance. If mortality exceeds successful reproduction for long enough, the number can reach zero. A local disappearance is not global extinction unless the evidence shows no surviving population elsewhere. An unsuccessful survey alone does not establish that conclusion.

■ Question 2

A closed model population starts at 45 with 9 surviving births and 16 deaths. Find the final count.

Available marks: 4.

Worked answer

38 individuals

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

Extinction is not one individual dying or a species moving away from one site. A low population count is a warning, not a claim of zero. Evolutionary adaptation cannot be assumed to rescue every population quickly enough.

104 Antibiotic resistance: selection acts on bacteria

- antibiotic resistance
- strain

■ Question 1

Which explanation accounts for increasing resistance frequency?

- Resistant bacteria survive and reproduce while susceptible ones are removed
- Patients become resistant to the antibiotic after repeated doses
- Bacteria change their DNA on purpose when they meet an antibiotic

Available marks: 2.

Worked answer

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Resistant bacteria survive and reproduce while susceptible ones are removed

- The specification calls for avoiding inappropriate antibiotic prescribing, including use against viral infections, restricting agricultural antibiotic use and completing prescribed treatment. Current NHS information likewise says to follow the healthcare professional's directions. New antibiotic development is slow and expensive. The selection explanation must not say bacteria mutate deliberately because treatment was stopped or that every resistant infection has no treatment.

■ Question 2

Eight resistant and 12 susceptible bacteria remain in a supplied model. Find resistant percentage.

Available marks: 4.

Worked answer

40 %

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

Antibiotics do not treat viral infection. Finishing a prescribed course does not guarantee that every bacterium in every real infection is killed. Mutation supplies variants and selection changes their representation; these processes must not be confused. NHS stewardship reference.

105 Classification, domains and evolutionary trees

- binomial name
- domain

■ Question 1

Which pair forms a binomial name?

- Genus and species
- Kingdom and class
- Phylum and family

Available marks: 2.

Worked answer

Genus and species

- Improved microscopy revealed internal structures and biochemical analysis provided further relationship evidence. Woese's three-domain system separates archaea, bacteria and eukaryota; eukaryota includes protists, fungi, plants and animals. The specification describes archaea using older primitive-bacteria wording and extreme habitats; treat archaea as a separate domain rather than all bacteria or a claim that every archaeon lives in an extreme habitat.

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■ Question 2

A supplied eukaryote sample has 15 plants, 9 fungi and 6 animals. Find the fungal percentage.

Available marks: 4.

Worked answer

30 %

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

A binomial name has two parts, not all seven hierarchy ranks. Archaea and bacteria are separate domains in this system. An evolutionary tree does not say that a living species at one tip must be the direct ancestor of a living species at another tip.

106 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

- 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.

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107 Communities: competition and interdependence

- community
- interdependence

■ Question 1

Which belongs in an ecosystem description in addition to living populations?

- Non-living environmental conditions
- Prey and predator numbers
- Competition between living species

Available marks: 2.

Worked answer

Non-living environmental conditions

- Interdependence means species rely on others for resources or services, including food, shelter, pollination and seed dispersal. Removing one species can affect many others. In a stable community, species and environmental factors are in balance and population sizes remain fairly constant, although short-term fluctuations can occur.

■ Question 2

A supplied community has 30 rabbits, 6 foxes and 84 counted plants. Find the total counted individuals.

Available marks: 4.

Worked answer

120 individuals

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

Competition occurs both within and between species. A larger total number of organisms does not necessarily mean more species. Stability does not require every population count to remain exactly unchanged every day.

108 Abiotic factors: use the context to explain change

- abiotic factor
- limiting factor

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■ Question 1

Which is abiotic?

- Soil pH
- A new predator
- A competing plant

Available marks: 2.

Worked answer

Soil pH

- A change can favour one species while disadvantaging another. More of a factor is not always better: organisms have suitable ranges, and a limiting factor can change. A relationship between population count and temperature is an association unless other changes are considered or controlled.

■ Question 2

A supplied plant count rises from 8 to 14 at two light readings. Find the count increase.

Available marks: 4.

Worked answer

6 plants

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

Oxygen in water is different from carbon dioxide used by plants. Abiotic means non-living, not unimportant. A measured association should be explained cautiously, especially where temperature, moisture and light change together.

109 Biotic factors: changing living relationships

- biotic factor
- pathogen

■ Question 1

Which is a biotic change?

- Arrival of a new predator
- Change in soil pH alone
- Higher wind speed

Available marks: 2.

Worked answer

Arrival of a new predator

- The effect can spread through interdependent populations. Fewer prey may later

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reduce predator numbers; less pollination can reduce seed production. Explain the immediate link before proposing indirect changes. Not every new species outcompetes all existing species, and the effect depends on resources and local conditions.

■ Question 2

A supplied prey count falls from 120 to 90. Calculate percentage decrease.

Available marks: 4.

Worked answer

25 %

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

A pathogen is biotic; temperature is abiotic. Food availability is a living-resource relationship even when a record measures its amount numerically. A fall in a population does not necessarily mean that the species became globally extinct.

110 Adaptations: feature, effect and environmental advantage

- adaptation
- extremophile

■ Question 1

Which explanation connects a structural feature with its benefit?

- Reduced leaf surface can reduce water loss in dry conditions
- The plant is useful because it is a plant
- Every desert organism must have identical features

Available marks: 2.

Worked answer

Reduced leaf surface can reduce water loss in dry conditions

- Some organisms live in extreme temperature, pressure or salt concentrations and are called extremophiles. The specification includes bacteria living near deep-sea vents. Extreme is relative to the usual conditions for many organisms, not a statement that no life can function there. Adaptations do not guarantee survival under every change.

■ Question 2

Model water loss falls from 20 to 15 units. Calculate percentage reduction.

Available marks: 4.

Worked answer

25 %

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

Saying an organism is adapted because it lives there repeats the observation without explaining it. Functional means a biological process, not simply that a shape is useful. An extremophile is not necessarily an organism from every extreme environment.

111 Food chains and predator–prey cycles

- producer
- primary consumer

■ Question 1

In grass → rabbit → fox, what does the arrow from grass to rabbit show?

- Grass is eaten by the rabbit
- Grass hunts the rabbit
- The rabbit produces grass by photosynthesis

Available marks: 2.

Worked answer

Grass is eaten by the rabbit

- In a stable community, prey and predator numbers can rise and fall in cycles. More prey can support more predators after a delay; greater predation can reduce prey, followed by fewer predators when food is scarce. The pattern is a model affected by other food, disease, migration and environmental factors.

■ Question 2

Prey peaks at month 7 and predators at month 10 in a supplied graph. Find the lag.

Available marks: 4.

Worked answer

3 months

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

Plants also respire, but photosynthesis makes them producers in this model. A predator may have predators of its own. Population cycles do not imply that every prey death is due to the named predator or that extinction must follow a trough.

112 Required practical 9: abundance and distribution

- quadrat
- transect

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Question 1

Which method best estimates abundance across a defined habitat?

- Random representative quadrat positions
- Positions chosen where the plants look densest
- Positions spaced along the path for easy access

Available marks: 2.

Worked answer

Random representative quadrat positions

- Required practical 9 measures a common species and investigates a factor affecting its distribution. Measure the factor, such as light intensity, at comparable sampling locations. Random sampling estimates the wider population; a single gradient transect is not automatically representative of the whole habitat. Mean, median and mode describe different properties of the recorded counts.

Question 2

Mean count is 3 plants per 0.25 m^2 quadrat. Estimate the number in a 40 m^2 habitat.

Available marks: 4.

Worked answer

480 plants

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

Do not multiply a quadrat count directly by habitat area without accounting for quadrat area. A transect measures a pattern along a route, not proof of causation. Destroying plants to count them is unnecessary. A written worksheet supports but does not replace field experience.

113 Carbon cycles through living and non-living stores

- carbon cycle
- decomposer

Question 1

Which process returns carbon dioxide from a plant to the air?

- Respiration
- Only feeding by rabbits
- Absorption of mineral ions

Available marks: 2.

Worked answer

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Respiration

- Carbon can remain in organic stores, including fuels formed over long periods. Combustion releases carbon dioxide from carbon-containing fuels or biomass. Materials cycle between biotic and abiotic components and provide building blocks for later organisms. Energy transfers through the system rather than being recycled in the same way.

■ Question 2

A model plant store gains 70 carbon units and loses 24 by feeding and 16 by respiration. Find net increase.

Available marks: 4.

Worked answer

30 carbon units

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

Plants both photosynthesise and respire. Decomposition does not make carbon disappear. Not every arrow goes from one organism to the next trophic level, and the nitrogen cycle is not required by this specification section.

114 Water cycle: evaporation is not disappearance

- precipitation
- condensation

■ Question 1

Which process changes water vapour into liquid droplets?

- Condensation
- Evaporation
- Feeding

Available marks: 2.

Worked answer

Condensation

- Freshwater supply supports plants and animals on land. Organisms take up water and later return it through processes including excretion, respiration and transpiration. The water cycle includes both abiotic stores and biological transfers. A diagram can simplify the system, but not all rainwater immediately travels through the same route.

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■ Question 2

A pond begins with 150 units, gains 30 and loses 18 by evaporation plus 12 by drainage. Find final store.

Available marks: 4.

Worked answer

150 water units

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

Evaporation is liquid changing to vapour; condensation is the reverse. Precipitation is not the same as transpiration. Water can be recycled while its availability at a particular habitat changes, so global cycling does not guarantee local water supply.

115 Required practical 10: conditions and decay rate

- decomposition
- biogas

■ Question 1

Which comparison measures a rate in the defined pH method?

- pH change divided by elapsed time
- Only the final colour without time
- Total milk volume without an endpoint

Available marks: 2.

Worked answer

pH change divided by elapsed time

- Required practical 10 investigates the effect of temperature on fresh-milk decay rate by measuring pH change. Use teacher-approved fresh milk, reagents, controlled water baths and a consistent endpoint. The acquired AQA handbook models faster decay with lipase acting on fresh milk or cream made alkaline using sodium carbonate, with Cresol red changing from purple to yellow. Lipase produces fatty acids; natural microbial decay instead lowers pH through processes including lactic-acid production. These are different mechanisms.

■ Question 2

A supplied pH falls by 1.2 units in 6 min. Find mean magnitude of pH-change rate.

Available marks: 4.

Worked answer

0.2 pH units/min

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

A lower endpoint pH without timing is not a rate. Oxygen is not required for every kind of decomposition; distinguish aerobic compost processes from anaerobic biogas production. A temperature optimum should be inferred from supplied data rather than assumed universal.

116 Higher Tier: environmental change shifts distributions

- distribution
- range boundary

■ Question 1

What additional information best supports a long-term distribution comparison?

- Comparable survey areas, seasons and methods
- Counts from one area in summer and another in winter
- The mass of the largest individual in each area

Available marks: 2.

Worked answer

Comparable survey areas, seasons and methods

- Distribution is where organisms occur; abundance is how many occur. A geographic shift need not mean total population size increased. Evaluate whether records cover comparable seasons, sampling methods and areas. Competing species, dispersal barriers and habitat availability can alter the expected response to an abiotic change.

■ Question 2

A boundary shifts 60 km over 20 years. Calculate its mean shift rate.

Available marks: 4.

Worked answer

3 km/year

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

The same environmental change does not benefit every species. A distribution boundary is not an individual's movement path. A seasonal record and a long-term geographic trend are different comparisons and should not be mixed without explanation.

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117 Biodiversity: count species, explain resilience

- biodiversity
- species richness

Question 1

Which has greater recorded species richness?

- Seven species with 60 individuals
- Four species with 80 individuals
- One species with 1,000 individuals

Available marks: 2.

Worked answer

Seven species with 60 individuals

- A species count is one useful measure, but an incomplete survey misses organisms and does not describe every aspect of diversity. The specification's stability account is a mechanism to explain rather than a guarantee that every diverse ecosystem resists every disturbance. Habitat condition, population sizes and interactions also matter.

Question 2

Equal-effort surveys record 9 species at one site and 14 at another. Find the difference.

Available marks: 4.

Worked answer

5 species

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

A larger population of one species does not necessarily increase biodiversity. A missing species after one survey may reflect detection limits. Stability is supported by several interacting processes, so a species count alone cannot prove the cause of resilience.

118 Waste and pollution: trace the exposure route

- pollution
- runoff

Question 1

Which chain explains one fertiliser-runoff effect?

- More algal growth → decomposition → lower oxygen
- Fertiliser poisons the fish directly
- More algae → more photosynthesis → more oxygen

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Available marks: 2.

Worked answer

More algal growth → decomposition → lower oxygen

- Pollutants can kill plants and animals or change the conditions needed for survival, reducing biodiversity. Fertiliser runoff can stimulate excessive algal growth; subsequent microbial decomposition can reduce dissolved oxygen and affect aquatic animals. This mechanism differs from a toxic substance directly poisoning an organism.

■ Question 2

A model generates 160 kg of waste and recovers 60 kg. Calculate recovery percentage.

Available marks: 4.

Worked answer

37.5 %

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

Pollution categories describe routes, not a rule that one substance affects only one medium. More recycling does not remove every production impact. An oxygen decline in water needs a supported mechanism; it is not proof that all pollution acts identically.

119 Land use and peat: habitat and carbon consequences

- peat
- habitat fragmentation

■ Question 1

Which pair describes two peat-extraction consequences?

- Habitat loss and potential carbon release
- Unlimited new habitat and no stored carbon
- Only a change in flower colour

Available marks: 2.

Worked answer

Habitat loss and potential carbon release

- Peat contains accumulated organic material. Decay or burning releases carbon dioxide into the atmosphere. Keeping peat intact helps retain that carbon store. The specification asks students to weigh cheap available compost and food-production needs against habitat conservation and reduced emissions. Alternative materials also require evidence about cost, performance and environmental impacts.

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Question 2

A model peat habitat falls from 120 to 90 hectares. Find percentage area loss.

Available marks: 4.

Worked answer

25 %

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

Peat is not simply an inexhaustible mineral fertiliser. Habitat loss and carbon release are separate consequences. A percentage area change cannot be converted directly into carbon emissions without a supplied carbon-density and release model.

120 Deforestation: land demand and ecological effects

- deforestation
- biofuel

Question 1

Which evaluation includes both a benefit and a biological cost?

- Crop output compared with habitat loss
- Timber income compared with planting costs
- Fuel used compared with the crop output

Available marks: 2.

Worked answer

Crop output compared with habitat loss

- The result depends on the replacement system, what happens to the wood and the time interval. A claim that every biofuel has no emissions ignores land-use change and production. Evaluate food, income and energy benefits alongside habitat, carbon and other environmental consequences using the supplied evidence.

Question 2

A supplied region has 240 hectares of forest and retains 168. Find the cleared percentage.

Available marks: 4.

Worked answer

30 %

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

Trees do not store carbon only while alive: dead wood and soil can also be stores.

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Carbon dioxide release and reduced future uptake are different terms. A new crop's photosynthesis does not automatically replace all original habitat or carbon storage.

121 Global warming: biological effects and evidence

- greenhouse gas
- scientific consensus

■ Question 1

Which distinction is appropriate?

- Long-term climate trend versus one day's weather
- Every local change has the same cause
- One cold day cancels a 30-year trend

Available marks: 2.

Worked answer

Long-term climate trend versus one day's weather

- Scientific consensus on climate change draws on systematic reviews of many peer-reviewed publications, not one weather observation. Complex local outcomes can be uncertain or incomplete because interacting factors, future emissions and biological responses vary. Uncertainty about a particular population's future does not erase the wider evidence for warming.

■ Question 2

A fictional average rises by 1.5 °C over 30 years. Find the mean annual change.

Available marks: 4.

Worked answer

0.05 °C/year

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

One cold day does not disprove a long-term trend. A shift in a species range is not automatically an increase in biodiversity. A local correlation requires careful attribution, and a fictional classroom graph must not be presented as observed global climate data.

122 Maintaining biodiversity: evaluate a programme

- conservation
- habitat regeneration

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Question 1

Which plan addresses both a species and its living conditions?

- Breeding support plus suitable habitat protection
- Releasing captive-bred animals into any available area
- Protecting the habitat while the population stays too small to breed

Available marks: 2.

Worked answer

Breeding support plus suitable habitat protection

- Each measure has benefits and limitations. Breeding needs genetic diversity and suitable release conditions; habitat restoration takes time; land set aside for biodiversity may compete with production. Human interactions can be positive or negative depending on the action and its context. A justified evaluation weighs evidence and conflicting pressures rather than listing only advantages.

Question 2

Recorded richness rises from 10 to 15 species under equal sampling. Find percentage increase.

Available marks: 4.

Worked answer

50 %

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

A larger release count alone does not show successful conservation. A field margin supports more than decorative plants: it can provide food, shelter and connectivity. Recycling cannot repair every habitat already lost, so different measures address different pressures.

123 Trophic levels and extracellular decomposition

- trophic level
- extracellular digestion

Question 1

Where do decomposer enzymes first act in this account?

- Outside the microorganism
- Inside the plant's cells
- Inside the microorganism

Available marks: 2.

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Worked answer

Outside the microorganism

- Decomposers break down dead plants, animals and waste. They secrete enzymes into their surroundings; enzymes digest large molecules into small soluble products that diffuse into the microorganism. This extracellular digestion lets material from several levels return to the system through microbial activity and material cycling.

■ Question 2

A linear chain has five feeding levels. Find the number of transfers from first to last.

Available marks: 4.

Worked answer

4 transfers

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

Carnivore does not always mean level 3: a carnivore eating another carnivore can be level 4. Enzymes act outside a decomposer before soluble products enter it. The apex label depends on the supplied ecosystem, not a universal claim about the species.

124 Draw a biomass pyramid to a stated scale

- biomass
- scale

■ Question 1

Where should the producer bar be placed?

- At the bottom
- At the top by default
- Outside the pyramid

Available marks: 2.

Worked answer

At the bottom

- The pyramid is a diagram of a defined sample or estimate, not the physical shape of an ecosystem. Equal bar heights allow width to represent relative amount. Biomass and energy are related but are not the same quantity; do not label a kilogram dataset in joules. Organism numbers also require different data.

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■ Question 2

At a scale of 200 kg per centimetre, find the width for 1,000 kg biomass.

Available marks: 4.

Worked answer

5 cm

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

Pyramid width does not represent the height of an organism. More individuals does not always mean greater biomass. Masses from different habitat areas need comparable per-area units before being placed in one pyramid.

125 Biomass transfer: account for losses

- transfer efficiency
- egestion

■ Question 1

Which is egestion rather than excretion?

- Passing unabsorbed food as faeces
- Releasing carbon dioxide from respiration
- Removing urea formed from amino acids

Available marks: 2.

Worked answer

Passing unabsorbed food as faeces

- Not all ingested material is absorbed; some is egested as faeces. Absorbed material can be lost as respiration products, including carbon dioxide and water, or in excretion such as water and urea. Much glucose is used in respiration rather than retained as growth. Biomass available to higher consumers consequently decreases, helping explain smaller supported populations in a stated chain.

■ Question 2

Producer biomass is 500 kg and next-level biomass 60 kg. Calculate transfer efficiency.

Available marks: 4.

Worked answer

12 %

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

Respiration transfers energy and releases material; do not call energy a lost kilogram of

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biomass. Ingested and absorbed are different amounts. A second transfer compounds the reduction rather than adding the percentages from two levels.

126 Food security: production, access and pressures

- food security
- sustainability

■ Question 1

Which additional evidence matters beyond total crop output?

- Population size and access to food
- Number of tractors on farms
- Height of the tallest plant

Available marks: 2.

Worked answer

Population size and access to food

- Sustainable responses need to maintain production without exhausting the conditions that support it. Greater output can help, but inaccessible or unaffordable food does not solve every shortage. A shift towards resource-demanding foods changes how land and feed are used. Use the supplied context instead of assuming one response fits every country.

■ Question 2

A model produces 18,000 food units for 6,000 people. Find production per person.

Available marks: 4.

Worked answer

3 units/person

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

A higher total output does not guarantee higher output per person. Conflict and cost can restrict access without reducing biological yield directly. Avoid using fictional classroom values as real population or famine statistics.

127 Intensive farming: efficiency and welfare

- intensive farming
- animal welfare

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■ Question 1

Which is a relevant limitation of a feed-efficiency comparison?

- It does not by itself measure animal welfare
- It shows the animals grow more quickly
- It reduces the food the animals need

Available marks: 2.

Worked answer

It does not by itself measure animal welfare

- Higher growth or feed efficiency can support production, but limiting movement can raise animal-welfare concerns. Heating and maintaining facilities have costs and environmental impacts. Disease risk and health depend on management. Evaluate benefits, burdens and ethical objections with supplied evidence rather than presenting confinement as automatically desirable.

■ Question 2

A model gains 6 kg from 30 kg feed. Calculate the defined mass-conversion efficiency.

Available marks: 4.

Worked answer

20 %

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

Food mass, biomass gain and energy are different measures. Protein is not a substitute for every other nutrient. A numerically efficient system can still have disadvantages, which a reasoned evaluation should address directly.

128 Sustainable fisheries: allow breeding to continue

- fishing quota
- recruitment

■ Question 1

How can suitable mesh size help conserve a stock?

- Allow smaller fish to escape and potentially breed
- Make sure that every fish which escapes the net survives
- Catch the young fish first so the adults are left to breed

Available marks: 2.

Worked answer

Allow smaller fish to escape and potentially breed

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- Conservation needs evidence about population trends, recruitment and actual removals. A quota alone does not guarantee sustainability if it is too high, ignored or combined with other pressures. Bigger mesh is not a universal solution for every species; bycatch and habitat effects also matter when information is supplied.

■ Question 2

A model stock starts at 800, gains 240 recruits and loses 100 to other deaths plus 180 caught. Find final stock.

Available marks: 4.

Worked answer

760 fish

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

A quota is a limit, not the number automatically caught. A fish escaping capture does not guarantee it survives to breed. Local disappearance and global extinction are different outcomes, and long-term recovery needs repeated evidence.

129 Biotechnology: controlled culture and useful products

- mycoprotein
- purification

■ Question 1

Which condition belongs to the specified Fusarium process?

- Aerobic growth on glucose syrup
- No oxygen and no nutrients
- Only plant photosynthesis

Available marks: 2.

Worked answer

Aerobic growth on glucose syrup

- Genetically modified bacteria can produce human insulin, which is harvested and purified for medical use. GM crops can increase useful output or nutritional value; golden rice is the specified nutritional example. These approaches connect genetic information with practical production but still need evidence about yield, quality, cost and environmental effects.

Question 2

A model harvests 75 kg biomass and retains 60 kg after purification. Find recovery percentage.

Available marks: 4.

Worked answer

80 %

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

Fusarium is a fungus, not a bacterium or a green plant. Mycoprotein production is aerobic in this specification, so do not replace it with an anaerobic brewing account. Golden rice illustrates nutritional modification, not a claim that every GM crop solves all food-security problems.

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