



BIOLOGY QUESTIONS

MARK SCHEME

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Unit 1:

Cells, Living Processes and Biodiversity

Answers

1.1 Cells

1. (a) Cell membrane;
cytoplasm; [2]
- (b) Any **two** from:
• cellulose cell wall
• chloroplasts
• (large permanent) vacuole [2] [4]
2. (a) (i) X – cell wall;
Y – cytoplasm;
Z – (large permanent) vacuole; [3]
(ii) Cytoplasm/Y; [1]
- (b) (i) Cytoplasm; [1]
(ii) Cell respiration; [1]
- (c) Non-cellulose cell wall;
plasmids; [2] [8]
3. Peel a section of onion epidermal tissue and add to a microscope slide;
add water;
lower a coverslip onto the epidermal tissue;
carefully to avoid air bubbles; [4] [4]
- 4.
- | Unit | Number in one metre | Standard form | Symbol |
|-------------|---------------------|---------------|--------|
| millimetre; | | | mm; |
| | 1 000 000; | 10^{-6} ; | |
- [4]
5. (a) $40 \text{ (mm)} \div 400$;
0.1 mm; [2]
- (b) $70\,000 \text{ (}\mu\text{m)} \div 140$;
500; [2] [4]
6. (a) $20 \text{ (mm)} \div 0.1$;
200; [2]
- (b) $40 \text{ (mm)} \div 200$;
0.2 mm; [2] [4]

7. The ability to see separate parts (of the specimen) as distinct/separate points (when viewed); [1]
8. (a) Embryonic; [2]
adult;
- (b) Stem/shoot or root apices/tips; [1] [3]
9. Any **two** from: [2]
• transfer of viruses/diseases
• formation of tumours
• development of unwanted cell types

10. (a)

Side length / cm	Area / cm ²	Volume / cm ³	Surface area to volume ratio
1			
2			
3	54;		
4		64;	
5			1.2;

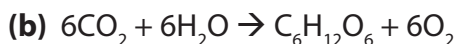
[3]

- (b) As the volume increases the surface area to volume ratio decreases; [1]
- (c) To increase the overall area of (gas) exchange surfaces; [3] [7]
to compensate for the reduced surface area to volume ratio in large multicellular animals;
for the diffusion of respiratory gases/oxygen/carbon dioxide;

1.2 Photosynthesis and Plants

1. Light; chlorophyll; [2] [2]

2. (a) Carbon dioxide and water; → glucose and oxygen; [2]



[one mark for symbols; one mark for balancing] [2] [4]

3. (a) (i) D-C-A-B; [1]
(ii) Removes the chlorophyll; [1]

(b) (Iodine will change from) yellow-brown; to blue-black; [2] [4]

4. (a) (i) Place in a dark area for 48 hours (or other appropriate length of time); [1]
(ii) (Removes starch already present in the leaf) so that starch produced during the investigation can be identified; [1]

(b) (i)

Description of stage	Explanation of stage
	kills leaf and stops reactions;
boil leaf in ethanol;	
	softens the leaf/make the leaf less brittle;

[3]

(ii) Bunsen burner off when boiling in alcohol/use a kettle to supply hot water to heat the ethanol; [1]

(iii) Spread the leaf on a tile and add iodine; if the iodine turns blue-black starch is present; [2] [8]

5. (a) Destarch a potted plant (by leaving in the dark for 48 hours); cover a leaf/part of a leaf with foil; leave the potted plant in light for an appropriate period of time (e.g. 6-24 hours); test the covered leaf/part of leaf and an uncovered leaf/part of leaf for starch; [4]

(b) (i) A leaf which contains parts which does not have chlorophyll; [1]

(ii) (An investigation) to show that chlorophyll is needed for photosynthesis; [1]

(iii) Only the green parts/parts with chlorophyll contain starch/test positive with iodine (or converse); showing that chlorophyll is necessary for photosynthesis; [2] [8]

6. (a) Use a dimmer switch (on the light)/move the light source closer/further away from the pondweed; [1]
- (b) Bubbles will be of different sizes (therefore contain different volumes of oxygen); some bubbles may be missed when counting; [2]
- (c) Any **two** from:
 • use the same pondweed (for the different light intensities)
 • water at the same temperature
 • compare for the same length of time
 • light of same wavelengths [2] [5]
7. (a) Higher rate of photosynthesis at B than A; as a higher light intensity at B; [2]
- (b) (i) $1.5 \div 2.5$;
 = 60%; [2]
 (ii) Higher temperature at C;
 (photosynthesis) reactions occur faster/enzymes have higher activity; [2]
- (c) Higher carbon dioxide levels;
 further increase in temperature (assuming optimum temperature is higher than 25 °C); [2] [8]
8. (a) 13.6 hours/13 hours 36 minutes; [1]
- (b) Dark so no photosynthesis;
 respiration occurring;
 causing an increase in carbon dioxide levels; [3]
- (c) Daylight so both photosynthesis and respiration taking place;
 photosynthesis rate greater than rate of respiration;
 (more carbon dioxide taken in than released by the pondweed) causing a decrease in carbon dioxide levels; [3]
- (d) (i) The light intensity;
 at which the volume of carbon dioxide taken in is the same as the volume given out/the point at which the rates of respiration and photosynthesis are equal; [2]
 (ii) 2; [1] [10]

9. (a) **Similarity** – single row of cells/cells aligned horizontally/cells covered by cuticle on outer edge/
no chloroplasts in (most) cells;
Difference – stomata in lower epidermis; [2]
- (b) (i) **A** – palisade mesophyll;
B – spongy mesophyll; [2]
(ii) More chloroplasts in cells (in A);
cells more tightly packed together/no air spaces (in A); [2]
- (c) **Advantage** – more photosynthesis can take place;
Disadvantage – leaves more likely to be damaged (by wind)/more likely to be an attractive food
source (for herbivores); [2]
- (d) Stomata (create gaps in epidermis);
air spaces (in spongy mesophyll); [2] [10]

10. Indicative content:

1. the waxy cuticle/epidermis is transparent to allow light through;
2. the palisade mesophyll cells are tightly packed together/close to the top of the leaf
3. and contain many chloroplasts
4. in the spongy mesophyll, there are large air spaces
5. for the diffusion of gases (within the leaf)
6. guard cells/stomata
7. allow gases to enter and leave the leaf

Band	Response	Mark
A	Use appropriate, specialist terms to describe and explain how leaves are adapted for photosynthesis using at least 5 of the indicative points. There is good spelling, punctuation and grammar and the form and style are of a high standard.	[5]–[6]
B	Use some appropriate, specialist terms to describe and explain how leaves are adapted for photosynthesis using at least 3 of the points. There is satisfactory spelling, punctuation and grammar and the form and style are of a satisfactory standard.	[3]–[4]
C	There is little use made of specialist terms to describe and explain how leaves are adapted for photosynthesis using at least 1 of the points. Spelling, punctuation, grammar and form and style are of a limited standard.	[1]–[2]
D	Response not worthy of credit.	[0]

1.3 Nutrition and Food Tests

1. (a) (i)

Test	Food type	Colour change if food type present
Biuret;	Protein;	
Iodine;		Yellow-brown to blue-black;
	Fats/lipids;	Colourless to white emulsion;

[6]

(ii) Benedict's;

[1]

(b) (i) Easier to see the colour change/dark chocolate would mask the colour change;

[1]

(ii) To keep both tubes at the same temperature;

[1]

(iii) Reduce the mass of food being tested;

time how long it took each tube to turn brick-red/compare the colours (of the Benedict's solution) at an earlier stage (rather than wait until both had turned brick-red);

[2] [11]

2. (a) Single molecule/unit;

[1]

(b) Contains two sugar/glucose molecules/units;

[1]

(c) (i) Glucose/sugar molecules/units;

[1]

(ii) Compact so can fit into a small space;

coiled/branched so can contain many individual glucose/sugar molecules/units;

[2]

(iii) Starch;

[1] [6]

3. (a) Amino acid;

[1]

(b) Any **two** from:

• enzymes

• antibodies

• other suitable example

[2] [3]

4. (a) A – glycerol;

B – fatty acid;

[2]

(b) (i) $16 \div 19 \times 100$;

84.2%;

[2]

(ii) $15 \times 10 \times 4.2$;

630 J;

[2]

(iii) Y;

as fat has more energy than protein (therefore gives the higher temperature rise);

[2]

(iv) Same mass of food;

held the same distance from the base of the boiling tube (when lit);

[2] [10]

1.4 Enzymes and Digestion

1. Biological catalysts;
protein; [2] [2]
2. (a) Product (molecule); [1]
(b) Lock and key; [1]
(c) Enzyme will only catalyse reactions;
where the substrate molecule(s) is a close fit to the active site of the enzyme; [2]
(d) Salivary amylase normally breaks down larger molecules into smaller molecules (the
enzyme in the diagram is building up smaller molecules into a larger molecule); [1] [5]
3. (a) As enzyme concentration increases the rate of reaction increases;
up to a point before levelling off;
(initial) increase due to more enzymes being available therefore more collisions between
enzymes and substrate;
rate levels off as number of substrate molecules become limiting/the extra enzymes do not
have enough substrates to react with (therefore the reaction doesn't increase further); [4]
- (b) (i) Reduces the rate of reaction at lower enzyme concentrations but has no effect at higher
enzyme concentrations;
inhibitors join to active site of enzyme (therefore preventing substrates gaining access);
at higher concentrations of enzymes, the relative number of enzymes compared to
inhibitors is so high that the inhibitors have little effect; [3]
(ii) An even lower rate of reaction at lower enzyme concentrations (i.e. the graph line
would be below the current inhibitor line);
The effect of the inhibitor will only be lost at higher enzyme concentrations (i.e. the
two inhibitor lines combine at higher enzyme concentrations); [2] [9]
4. (a) (i) 38 °C; [1]
(ii) At 30 °C there is a faster rate of reaction (than at 20 °C);
due to the increased number of collisions (as both enzymes and substrate molecules have
more kinetic energy); [2]
(iii) (45 °C is above the optimum temperature so) enzymes begin to become denatured;
changes to the active site results in a less close fit between enzyme and substrate (so fewer
reactions take place); [2]
- (b) (i) Fat/lipid; [1]
(ii) Glycerol and fatty acids; [1]
(iii) Biological washing powders may cause allergies/lack of understanding of term
'biological'/other suitable answer; [1] [8]

5. (a) Increased rate of reaction around optimum/40 °C;
at lower temperatures/less than 40 °C fewer collisions between enzyme and substrate (due to reduced kinetic energy);
at 50 °C reduced activity due to higher temperature causing changes to the active site;
at 60 °C changes to active site so great there is no activity; [4]
- (b) Enzyme A has a faster rate of reaction at the optimum/40 °C/at all temperatures;
therefore will work faster/needs less powder leading to a reduced cost;
enzyme A will work at higher temperatures/60 °C (unlike enzyme B); [3] [7]
6. (a) Digestion is the breakdown of large, insoluble food molecules into smaller, soluble molecules;
absorption is the transfer of small, soluble food molecules from the gut into the blood system; [2]
- (b) (i) Lacteal; [1]
(ii) Finger-like shape (which increases surface area of the ileum wall);
single layer of cells (between the gut lumen and the capillary network/lacteal);
capillary network and lacteal close to surface; [3]
(iii) Ileum; [1] [7]

1.5 The Respiratory System, Breathing and Respiration

1. Respiratory surfaces;
carbon dioxide/CO₂;
ethanol; [3] [3]
2. (a) (i) X – trachea;
Y – diaphragm; [2]
- (ii) Any **two** from:
• the diaphragm relaxes and returns to its domed shape
• the intercostal muscles relax, and the ribs move down and in
• the volume of the thoracic cavity decreases, increasing pressure [2]
- (b) (i) Carbon dioxide/CO₂; [1]
(ii) Breathing (removes carbon dioxide from the lungs) keeping carbon dioxide concentration in the alveoli low;
causing a diffusion gradient of carbon dioxide between the capillaries and the alveoli; [2]
(iii) Any **two** from:
• only two layers of cells for gases to diffuse across (between the centres of the capillaries and the alveoli)
• these cells are flattened/thin/elongated/very close together
• thus reducing the diffusion distance
• large surface area across which gases can diffuse [2] [9]
3. (a) $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + \text{energy}$ [one mark for symbols and one for balancing] [2]
- (b) (i) Release energy; [1]
(ii) Muscles have a higher energy requirement than skin cells;
thus requiring more mitochondria to release energy; [2]
(iii) Cells have different sizes; [1] [6]
4. (a) 24.5 – 13.5;
11 breaths per minute; [2]
- (b) $11 \div 13.5 \times 100$;
81.5%; [2]
- (c) To take in more oxygen;
for aerobic respiration;
to meet the increased energy needs during exercise; [3]
- (d) (i) 15 – 5.5;
9.5 minutes; [2]
(ii) Lower breathing rate at rest/before exercise started/rises less during exercise
(than student A); [1]
- (e) Depth of breathing increases; [1] [11]

5. (a) Anaerobic respiration;
the oil prevents oxygen diffusing into the glucose solution; [2]
- (b) (i) Counting the bubbles/monitoring the change in colour of the hydrogen indicator; [1]
(ii) Measure rates of respiration at both 20 °C and 30 °C;
description of how experimental temperatures obtained (e.g. use of water bath);
Any **two** from:
• investigation time period the same for both temperatures
• same mass of yeast used
• same percentage of glucose solution [4] [7]

5. (a) A – sensory neurone
B – association neurone; [2]
- (b) Two; [1]
- (c) Receptor; → sensory neurone; → association neurone; → motor neurone; → muscle; [5]
- (d) Short pathway/conscious thought not involved;
faster response; [2] [10]
6. (a) Chemical;
blood; [2]
- (b) (i) Pancreas; [1]
(ii) Rise in blood glucose concentration; [1]
(iii) Any **two** from:
• liver absorbs more glucose (from the blood)
• liver respire this glucose/increased respiration of glucose
• liver converts glucose to glycogen [2] [6]
7. (a) Following the meal, the blood glucose levels in both individuals rise;
the blood glucose level rises further in the individual with diabetes;
and rises outside the normal blood glucose range (for individuals who do not have diabetes);
it takes longer for the blood glucose level to return to normal in the individual with diabetes;
(or converse) [4]
- (b) (i) Type 2; [1]
(ii) Type 1 treated by insulin injections (throughout life);
Type 2 (initially) diet but may eventually require insulin injections; [2]
(iii) 2010 and 2020 numbers = 151 and 289;
 $138 \div 151 \times 100$;
91.4%; [3]
(iv) Numbers of people with each of Type 1 and Type 2 diabetes increase with time;
there are higher numbers of people with Type 2 diabetes (compared to Type 1);
numbers with Type 2 are increasing at a faster rate; [3]
- (c) Any **two** from:
• the treatment is normally for a very long time/for life
• insulin (and other diabetes-related equipment) is expensive/or indication that large amounts are needed
• treatment of long-term effects (e.g. eye disease) is expensive/can be long term [2] [15]

- 8. (a) (i)** A – renal artery;
B – ureter;
C – urethra; [3]
- (ii)** To open or close the top of the urethra;
thus controlling the release of urine from the bladder; [2]
- (b) (i)** Filtering the blood/removing impurities;
osmoregulation/controlling water balance in the blood; [2]
- (ii)** Evaporation of sweat;
water produced in respiration; [2] **[9]**
- 9. (a) (i)** As ADH concentration in the blood increases the volume of urine production decreases (or
converse); [1]
- (ii)** Due to more water being reabsorbed (as a result of the higher ADH levels); [1]
- (b) (i)** 1.75 hours/1 hour 45 minutes; [1]
- (ii)** As a result of exercise, the blood becomes more concentrated (due to loss of water in sweat);
this causes an increase in ADH released (into the blood);
causing the reabsorption of more water back into the blood (in the kidneys);
this causes the blood concentration to return to normal with ADH production falling
back to its normal level; [4] **[7]**
- 10. (a)** Phototropism;
- (b)** More light; [1]
more photosynthesis; [2]
- (c)** Auxin is diverted to the shaded side (in unidirectional light);
causing cells on the shaded side to grow more than those on the brighter side; [2] **[5]**
- 11. (a)** Any **two** from:
- both setups left for the same length of time
 - both subjected to same light intensity
 - seedlings of same type/age used
 - same compost/nutrients in each pot/seedlings given same volume of water [2]
- (b)** Auxin is produced at the tip of the seedling and moves down the shoot;
auxin is diverted to the shaded side of the shoot/diverted away from the light;
causing greater cell elongation on the shaded side;
resulting in the shoot bending in the direction of the light source; [4]
- (c)** (Due to the rotation) all sides of the seedling gain the same intensity/duration of light;
therefore the auxin is distributed evenly in the seedling shoot; [2] **[8]**

6. (a) (i) Blocked by clouds/misses the trees and plants/misses chloroplasts/reflected by cuticle/other suitable answer; [1]
(ii) Trophic levels 1 and 2; [1]
(iii) Large amounts of the trees/plants are not edible (e.g. wood) or accessible (e.g. roots)/other suitable answer; [1]
(iv) $X = 4500 - (2300 + 675)$;
 $4500 - 2975 = 1525$; [2]
(v) Secondary consumers have to chase/catch their prey (unlike primary consumers); using a lot of energy in the process; [2]
- (b) (i) The pyramid of biomass would be a 'true' pyramid/have bars decreasing in length from bottom up;
(although smaller in number), the producers' biomass would be greater than the biomass of the primary consumers; [2]
(ii) Pyramid of biomass gives a more accurate representation of the (amount of) living material at different trophic levels; [1] [10]
7. (a) (i) Enzymes secreted (by the fungi);
extracellular digestion (or by explanation);
products (of digestion) absorbed by the fungi; [3]
(ii) Faster enzyme activity in summer;
due to the higher temperatures; [2]
- (b) (i) Respiration; [1]
(ii) Decomposition slowing down/most of the grass decomposed (so fungal activity decreases); [1]
(iii) Temperature of the compost heap still higher after 30 days (24 °C) than at the start (15 °C); [1]
(iv) Avoid cooling effects at the edge due to evaporation of moisture/wind/other suitable answer; [1] [9]
8. (a) A – combustion;
B – respiration;
C – photosynthesis; [3]
- (b) Fungi;
bacteria; [2]
- (c) Any **two** from:
• increasing photosynthesis by planting more trees
• decreasing combustion by burning fewer fossil fuels/using alternative energy sources
• decreasing rates of respiration by reducing numbers of (large) domestic animals [2] [7]
9. (a) (i) Photosynthesis; [1]
(ii) respiration; [1]
- (b) (i) The plants are growing/getting larger;
therefore more leaves to photosynthesise; [2]
(ii) Combustion; [1]
(iii) (In the life cycle) there is no net gain or loss of carbon dioxide by the willow plants;
reference to data from graph – 25 AU carbon dioxide taken into plants when growing
and 25 produced (following harvesting); [2] [7]

10. Indicative content:

1. (causes of global warming) include the increased combustion of fossil fuels;
2. deforestation;
3. causing a rise in (atmospheric) carbon dioxide;
4. which traps heat within the atmosphere (leading to increased temperatures);
5. causing melting ice caps/rising sea levels/flooding;
6. climate change/extreme weather;
7. loss of habitats/desertification;

Band	Response	Mark
A	Use appropriate, specialist terms to describe and explain global warming, including its causes and effects, using at least 5 of the indicative points. There is good spelling, punctuation and grammar and the form and style are of a high standard.	[5]–[6]
B	Use some appropriate, specialist terms to describe and explain global warming, including its causes and effects using at least 3 of the points. There is satisfactory spelling, punctuation and grammar and the form and style are of a satisfactory standard.	[3]–[4]
C	There is little use made of specialist terms to describe and explain global warming using at least 1 of the points. Spelling, punctuation, grammar and form and style are of a limited standard.	[1]–[2]
D	Response not worthy of credit.	[0]

- 11. (a) (i)** X - ammonium compounds; [1]
- (ii)** A – nitrogen fixation; [3]
 B – nitrification;
 C – denitrification;
- (b) (i)** Denitrifying bacteria; [1]
- (ii)** Denitrifying bacteria are anaerobic; waterlogged conditions provide anaerobic conditions; as soil moisture increases number of denitrifying bacteria increases; [3]
- (iii)** (Nitrifying bacteria) convert ammonium compounds to nitrate; they are aerobic; soils become less aerobic as soil moisture increases; [3]
- (iv)** Waterlogged soils provide anaerobic conditions; nitrifying bacteria are unable to function in waterlogged/anaerobic soils but they provide optimum conditions for denitrifying bacteria; therefore, ammonium compounds cannot be converted to nitrates; (in these conditions) nitrate is converted to nitrogen gas/denitrification (thus decreasing soil fertility); [4] [15]

- 12. (a)** Very wet/waterlogged conditions provide anaerobic conditions; nitrifying bacteria are unable to function in waterlogged/anaerobic soils but they provide optimum conditions for denitrifying bacteria; ammonium compounds cannot be converted to nitrates; nitrates are converted to nitrogen gas; [4]
- (b) (i)** Bog habitats have low nitrate soils/peat; insects are protein-rich; trapped insects are broken down by enzymes and release amino acids; which compensates for the low nitrate levels in the bog; [4]
- (ii)** Outcompeted by other plants ; [1] **[9]**
- 13. (a)**
- | Mineral | Function |
|----------|----------------------------|
| | for chlorophyll formation; |
| calcium; | |
- [2]
- (b) Advantages** – any **two** from:
- easily spread/added to field
 - quantities required easier to calculate
 - easily stored
- Disadvantage** – more likely to leach into waterways (than farmyard manure)/expensive; [3] **[5]**
- 14. (a) (i)** Finger-like extension on surface; [1]
- (ii)** increases surface area (across which substances can be absorbed); [1]
- (b) (i)** Active uptake/transport; [1]
- (ii)** (Root hair cells will be) unable to respire; therefore, unable to release the energy required for active uptake/transport; [2] **[5]**
- 15. (a)** 430 – 100; 330; [2]
- (b)** Aerobic microorganisms decompose/break down the sewage; using oxygen in respiration; [2]
- (c)** All decomposed/diluted in the water/other suitable answer; [1] **[5]**
- 16. (a)** Eutrophication; [1]
- (b)** Aerobic microorganisms decompose the dead algae and plants; using oxygen in respiration; causing death of other aquatic organisms; [3]
- (c)** Do not spread fertiliser close to waterways/do not spread when raining/ground wet/spread only in quantities required/other suitable answer; [1] **[5]**

Unit 2:

Body Systems, Genetics,
Microorganisms and Health

Answers

2.1 Osmosis and Plant Transport

1. (a) The diffusion of water molecules from a dilute solution to a more concentrated solution; through a selectively permeable membrane; [2]
- (b) (i) 20.5; [1]
(ii) $16 \div 176 \times 100$;
9.1; [2]
(iii) The cells are more concentrated than the surrounding (pure) water; water enters the cells (by osmosis); causing the cells to increase in length (up to a maximum); [3]
(iv) The cell wall prevented further increase; [1]
- (c) (i) Decrease in length; up to a minimum value before levelling off; [2]
(ii) The strong sugar solution is more concentrated than the cells; the cells lose water (by osmosis); causing a decrease in length (up to a maximum); [3] [14]
2. (a) Potato cells more concentrated than the (immersing) solution; water entered the cells; by osmosis (causing the cells and cylinders to increase in length); [3]
- (b) 6% sucrose; produced the smallest change in length (in the potato cylinders); due to the difference in concentration between the solution and the cells being the smallest; [3]
- (c) Difficulty in measuring length accurately due to uneven ends; measuring length does not take account of increase in width of the cells/cylinders; [2] [8]
3. Use a balance to determine the mass of each of the Visking tubes; place each in the beaker containing the 10% sugar solution and leave for an appropriate length of time (e.g. 1 hour); remove the Visking tubes from the beaker, dry, and reweigh; the Visking tubing which had the greater percentage decrease in mass contained the 2.5% sugar (as there was a greater difference in concentration between it and the 10% sugar in the beaker therefore it lost more water by osmosis); [4] [4]
4. (a) Transpiration is the evaporation of water from mesophyll cells; followed by diffusion through airspaces and stomata; [2]
- (b) Waterproofed waxy cuticle; ability to close stomata; [2]
- (c) (i) To prevent evaporation through the stalk ends; to ensure that the only water loss was through the main leaf surfaces; [2]
(ii) Greater loss in mass of leaves at 25 °C compared to 15 °C; more evaporation of water at the higher temperature; [2]
(iii) The leaves were (approximately) the same area/age; leaves kept in same light/wind conditions; [2] [10]

5. (a) (i) The greater the leaf surface area the higher the transpiration rate; [1]
(ii) The greater the leaf surface area the more stomata;
through which water can evaporate; [2]
- (b) (i) Transpiration rate increases as wind speed increases before levelling off;
data quoted from graph, e.g. max transpiration rate = 3.8 arbitrary units or levels off at a
wind speed of 33 km per hr;
increased wind speed leads to more evaporation (up to a maximum); [3]
(ii) Decreased rates of transpiration; [1]
(iii) Temperature/light; [1] **[8]**

2.2 The Circulatory System

1. (a) (i) Biconcave shape;
gives a greater surface area across which oxygen can diffuse; [2]
- (ii) Absence of a nucleus;
more room for haemoglobin;
or
contains haemoglobin (rich in iron);
for oxygen transport; [2]
- (b) Fibrinogen;
fibrin;
clot; [3]
- (c) Any **two** from:
• (blood) cells
• food molecules (or by description, e.g. glucose/amino acids)
• carbon dioxide
• hormones
• urea [2] [9]
2. Cell lysis/cell bursts;
water will enter the red blood cells by osmosis;
due to the difference in concentration between the red blood cell and the blood; [3] [3]
3. (a) (i) Allows the artery to expand and recoil;
expands to avoid the pressure getting too high as the blood pulses;
recoils to help maintain pressure between heart beats; [3]
- (ii) Maintains blood pressure; [1]
- (b) (i) Prevents the backflow of blood;
(they are needed as) blood pressure in the veins is very low; [2]
- (ii) Thin walls; [2]
large lumen; [2]
- (c) Exchange of substances between blood and body cells;
capillary cells are one cell thick (so easier for materials to diffuse in or out of capillaries); [2] [10]

- 4. (a)** A – left atrium;
C – right ventricle; [2]
- (b) (i)** B is thicker (than A);
as B pumps blood; [2]
- (ii)** B is thicker (than C);
as it pumps blood further (round the body compared to the lungs); [2]
- (c)** 1 – pulmonary artery;
2 – vena cava; [2]
- (d)** Aorta; [1]
- (e)** Coronary arteries; [1] [10]
- 5. (a)** 82 – 62;
20; [2]
- (b)** 15 minutes; [1]
- (c)** Orla has a higher initial (resting) pulse rate;
her pulse rate rises further/faster during exercise;
it takes longer for her heart rate to return to normal; [3]
- (d)** Strengthens heart muscle/increases cardiac output (at rest); [1]
- (e)** Allows blood to reach the muscles more quickly/more blood reaches the muscles per unit time;
therefore more glucose/oxygen reaches the muscle (per unit time);
for respiration;
to meet the increased energy needs caused by the exercise; [4] [11]

- 5. (a)** Any **two** from:
- sexual organs enlarge
 - development of body and pubic hair
 - voice deepens/body becomes more muscular
 - sexual awareness/drive increases
- [2]
- (b)** Oestrogen; [1] [3]
- 6. (a) (i)** Loss of uterus lining; [1]
- (ii)** Removal of tissue no longer required/ensures that every month a fresh lining is produced; [1]
- (b) (i)** The level of progesterone is low during menstruation/days 0 – 4/5/6/7/8;
rises to reach a peak around 17/18 days;
remains in a plateau before falling (rapidly) after 24/5 days; [3]
- (ii)** Peaks (day 12/13) just before ovulation (day 14); [1]
- (iii)** Maintains build-up of the uterus wall; [1]
- (iv)** The (rapid) fall in levels of oestrogen and progesterone/low levels of oestrogen and progesterone; [1]
- (v)** An egg/ovum will be in the oviduct (on day 15, but not on day 5);
the uterus lining will have been built up (on day 15, but not on day 5); [2] [10]
- 7. (a) (i)** Low sperm count/impotence/other suitable answer; [1]
- (ii)** Failure to produce ova/eggs/blocked oviducts/other suitable answer; [1]
- (b) (i)** To increase ova/egg production; [1]
- (ii)** Collect ova/eggs from the ovaries;
add sperm to the ova/eggs;
in laboratory/specialised conditions; [3]
- (iii)** To increase the chances of successful implantation; [1] [7]

8. (a)

Contraception	Method of action	Advantage	Disadvantage
	barrier which prevents the sperm leaving the male/entering the female;	protects against sexually transmitted infections/ or by example/does not involve chemical/hormonal treatments/ other suitable answer;	not as reliable (as some other methods)/other suitable answer;
chemical/ contraceptive pill/implant;		very reliable;	does not protect against STIs/can cause side effects/ side effects by explanation/other suitable answer;
female sterilisation;		very reliable;	does not protect against STIs/very difficult to reverse;

[9]

(b) (i) (Most male sterilisations in) age range 40–49;

[1]

(ii) 20–29: will not have completed family/unsure of future intentions/other suitable answer;
70+: may have had a vasectomy at an earlier age/no longer sexually active/other suitable answer;

[2]

(iii) Cuts the sperm tubes;
sperm cannot reach urethra/leave the penis;

[2] [14]

2.4 Genome, Chromosomes, DNA and Genetics

1. (a) A – genes; [2]
B – nuclear membrane; [2]
- (b) Cytoplasm; [1]
- (c) This cell has a nucleus/the chromosomes are in a functional pair/no plasmids are visible (or converse); [1] [4]
2. (a) (i) X – phosphate; [2]
Y – (deoxyribose) sugar; [2]
(ii) 1 – cytosine; [2]
2 – thymine; [2]
- (b) Adenine 28; [3]
cytosine 22; [3]
thymine 28; [3]
- (c) (i) All the genetic material in an organism; [1]
(ii) The sequence of DNA bases in any individual is unique/no one else has the same sequence of bases; [1] [9]
3. (a) Thymine; [1]
- (b) 3; [1]
- (c) Amino acids are linked together; [2]
to form protein; [2]
- (d) 126×3 ; [2] [6]
378; [2] [6]
4. (a) Any **two** from: [2]
• enables growth
• replaces worn out cells
• repairs damaged tissue [2]
- (b) (i) (Chromosomes) are the same in the parental and daughter cells/same in each daughter cell; [1]
(ii) (In meiosis) one parental cell produces four daughter cells; [3]
the daughter cells are haploid/contain half the number of chromosomes as the parental cell; [3]
the chromosomes in the daughter cells are not all the same; [3]
(iii) Testes; [1] [7]

5. (a) Allele – particular form of a gene;
 homozygous – both alleles of a gene are the same;
 recessive allele – an allele which can be masked by the dominant allele/the phenotype (of the recessive allele) will only be shown if both alleles are recessive; [3]

- (b) Males have one X chromosomes and one Y chromosome;
 females have two X chromosomes; [2] [5]

6. (a) (i) Pp; [1]
 (ii) Purple flower colour; [1]

- (b) (i)

	P	p
P	PP	Pp
p	Pp	pp

[one mark for Punnett square; one for both sets of gametes; and one for offspring genotypes;] [3]

- (ii) 75%; [1]

- (iii) 50%; [1]

- (c) (i)

	P	p
p	Pp	pp
p	Pp	pp

[one mark for each set of parental gametes;; one mark for offspring genotypes;] [3]

- (ii) Two; [1] [11]

7. (a)

	F	f
F	FF	Ff
f	Ff	ff

[one mark for each set of parental gametes;; one mark for offspring genotypes;] [3]

- (b) Genotype ff circled; [1]

- (c) 25%; [1] [5]

8. (a) Son; [1]

- (b) (i) kk; [1]

- (ii) 5 – Kk; [2]

- 6 – Kk; [2]

- (iii) 1 in 4 chance/25% chance; [1] [5]

9. (a) (i) HH and Hh; [1]
 (ii) hh; [1]
- (b) (i) Sister; [1]
 (ii) 7 – hh; [2]
 8 – Hh;
 (iii) 50% chance of having Huntington's disease;
 50% chance of being a male;
 25%/1 in 4 chance; [3] **[8]**

10. (a) (i) Y; [1]
 (ii) Male; [1]

(b) (i)

	X ^H	X ^h
X ^H	X ^H X ^H	X ^H X ^h
Y	X ^H Y	X ^h Y

[one mark for each set of parental gametes;; one mark for offspring genotypes; and one mark for identifying X^hY as the individual with haemophilia;] [4]

- (ii) A sex-linked condition is one in which there is not an even chance of each of males and females getting the condition/is more likely to be present in a particular sex/males/females; [1] **[7]**

11. (a) 47; [1]

- (b) (i) Some foetal cells are extracted from the amniotic fluid;
 these cells are grown (in specialised conditions in a laboratory);
 the number of chromosomes in these cells are counted; [3]
- (ii) There is a slight/1% risk of miscarriage with the procedure/some parents do not want to be placed in a position of having to decide whether to have an abortion or not/other suitable answer; [1] **[5]**

12. (a)

	H	h
h	Hh	hh
h	Hh	hh

Probability of having Huntington's disease = 50%

[one mark for each set of parental gametes;; one mark for offspring genotypes; and one mark for calculating the 50%/1 in 2 probability;] [4]

- (b) (i) Genetic screening; [1]
 (ii) (If the test is positive), knowing she will develop the condition will affect her quality of life/
 cause anxiety/other suitable answer; [1]
- (c) The insurance companies may decide not to provide insurance (to individuals with genetic conditions)/or it may be much more expensive for these individuals;
 as they are much more likely to die/or become ill; [2] **[8]**

2.5 Variation and Natural Selection

1. (a) (i) Individuals can be placed into distinct/non-overlapping groups; [1]
 (ii) Bar chart; [1]
 (iii) Appropriate axes;
 labels on each axes;
 gaps between bars;
 accurate plotting; [4]
- (b) Tongue rolling/hand dominance/other suitable answer; [1] [7]
2. (a) (i) Weight; height; [2]
 (ii) $202 \div 4$;
 50.5 kg; [2]
- (b) (i) Histogram; [1]
 (ii) 20; [1]
 (iii) 12;
 $12 \div 20 \times 100$;
 60; [3]
 (iv) Continuous;
 no distinct categories/other suitable answer; [2] [11]
3. (a) Bar chart; [1]
- (b) Discontinuous; [1]
- (c) 19 (have 9 petals);
 $19 \div 80 \times 100$;
 23.8% [3] [5]
4. (a) (i) Random changes in the structure of DNA/genes or in chromosome number; [1]
 (ii) Random nature of (genetically different) gametes combining (at fertilisation);
 independent assortment/or by explanation; [2]
- (b) An individual can only grow tall if he/she contains appropriate alleles;
 and will only achieve the potential height if has a good diet; [2] [5]

5. (a) Smoke pollution decreased with time; [1]
- (b) Any **five** from:
- there are two distinct phenotypes – a light and a dark variety
 - initially (year 0) levels of smoke pollution were high, so the dark variety was better adapted/better camouflaged
 - to avoid predation by birds
 - over time the smoke pollution decreased making the light variety better adapted/camouflaged
 - making the dark variety more likely to be predated
 - light variety moths were more likely to reproduce and pass their genes on to the next generation
 - therefore, the numbers of the light variety increased over time as the numbers of the dark variety decreased
 - data from the table used to support trend [5] [6]
6. (a) As level of soil contamination increased, the percentage of plants which are tolerant to heavy metals increased; [1]
- (b) A – percentage of plants tolerant to heavy metals was very low, as tolerance was not an adaptation to survive in this environment;
and due to slower growth, heavy metal tolerant plants were outcompeted by non-tolerant plants as the tolerant plants have a slower growth rate;
B – percentage of plants tolerant to heavy metals was very high, as tolerance was an adaptation to survive in this environment;
non-tolerant plants could not survive in high levels of soil contamination; [4] [5]
7. (a) (i) Appropriate axes;
labels on each axes;
points joined by short straight lines;
accurate plotting; [4]
- (ii) 80 – 130; [1]
- (b) (i) No living members of an (extinct) species remain; [1]
- (ii) Climate change/habitat destruction/hunting/disease/other suitable answer; [1] [7]
8. (a) Change from both wingless and winged forms to wingless forms only; [1]
- (b) Wingless forms are better adapted/favoured due to winged forms being lost over the sea;
wingless forms more likely to pass their genes on to the next generation;
so, proportion of wingless forms increases over time/winged forms die out; [3]
- (c) Fossils provide a historical record of organisms;
showing how (some) species have changed over a long time scale; [2] [6]
9. (a) Selective breeding involves man choosing/selecting desired characteristics in animals/plants;
in natural selection, the environment/nature determines which adaptations are beneficial; [2]
- (b) (Initially) there was variation in volume of milk production in cattle;
cattle which produced high volumes of milk were selected for breeding/cattle which produced low volumes of milk were not used for breeding;
this was repeated over many generations;
over time, all the cattle produced high volumes of milk; [4] [6]

4. (a) If not, the individual who had the vaccination would develop the disease the vaccination is protecting against/would become ill; [1]
- (b) (i) Booster (vaccination); [1]
(ii) Lead to high antibody levels (which remain high for a long time);
lead to production of memory lymphocytes (which can react quickly if infected); [2]
- (c) (i) Older people have weakened immune systems;
likely to become ill if infected;
(or converse for younger people) [2]
(ii) As there is a different strain/type of flu each year; [1]
(iii) The cold does not make people very ill; [1] [8]
5. (a) (i) Cuticle;
cell wall; [2]
(ii) Cuticle is waxy (which prevents microorganisms getting through);
or
cell wall is thick (which acts as a barrier); [1]
- (b) (i) Kill microorganisms; [1]
(ii) Microorganisms are more likely to gain entry at damaged sites; [1] [5]
6. (a) A microorganism that is resistant to many types of antibiotics; [1]
- (b) (i) 2; [1]
(ii) Not enough antibiotic taken (to kill all the bacteria);
antibiotic resistant bacteria starting to multiply; [2]
- (c) (i) Develop new antibiotics/drugs; [1]
(ii) Not overusing antibiotics (thus encouraging resistance in bacteria)/always finishing
courses of antibiotics/increased hygiene/other suitable answer; [1] [6]
7. (a) (i) Narrowing of bronchi/bronchioles;
tar; [2]
(ii) Addictive; [1]
(iii) Reduces the oxygen-carrying capacity of the blood;
as it combines with red blood cells/haemoglobin;
preventing the red blood cells (affected) carrying oxygen; [3]
(iv) Breaks down/damages alveoli;
thus reducing the overall surface area of alveoli/respiratory surface; [2]
- (b) Tar causes bronchitis so less oxygen enters the alveoli;
emphysema reduces the surface area of alveoli;
carbon monoxide reduces the ability of red blood cells to carry oxygen;
(leading to a) reduction in oxygen entering the blood;
(leading to) reduced aerobic respiration (so less energy available); [5]

- (c) (i) (Over time) as the number of individuals using E-cigarettes increased, the number of individuals using traditional cigarettes decreased; [1]
(ii) Graphs are not exact mirror images/the 'kink' in E-cigarette numbers (years 4 – 8) is not matched by a complementary 'kink' in the numbers for traditional cigarettes/other suitable answer; [1]
(iii) No tobacco/tar/there is a lower concentration of (other) chemicals (in E-cigarettes); [1]
(iv) E-cigarettes still cause harm as they contain nicotine/a wide range of chemicals; [1] [17]
8. (a) Cholesterol levels increase with age;
men have higher levels than women; [2]
- (b) (i) Build-up of cholesterol causes arteries to narrow;
(eventually) leading to a blockage; [2]
(ii) Bring blood to the heart (muscle cells); [1]
(iii) Coronary arteries are thinner/have smaller lumens than other arteries; [1]
- (c) (i) Clot/blockage in the coronary arteries;
oxygen/glucose cannot reach the heart muscle cells so they are unable to respire;
heart muscle cells die and cannot contract; [3]
(ii) Any **two** from:
• reduced fat in diet
• avoid smoking
• exercise more
• reduce stress [2]
- (d) A mesh/net type structure which is introduced into an artery;
to hold the artery open;
thus, allowing normal blood flow/preventing narrowing of the artery; [3] [14]
9. (a) (i) UV radiation;
can cause uncontrolled cell division in skin cells; [2]
(ii) More exposure to the sun/more outdoor working; [1]
- (b) Tumour; [1]
- (c) (i) Divide more rapidly/don't grow to full size (before dividing); [1]
(ii) Cancer cells spreading into the blood vessel; [1]
(iii) Has spread to many different places in the body; [1]
- (d) (i) Work/research/new discoveries reviewed/analysed;
by other scientists/experts; [2]
(ii) To check that claims made in research are accurate/based on evidence/other suitable answer; [1] [10]

- 10. (a)** $5472 \div 8 = 684$;
 $684 \div 2 = 342$; [2]
- (b)** Similar genetics/lifestyles; [1]
- (c) (i)** Only men have prostate glands/can get prostate cancer; [1]
(ii) Prostate cancer more likely to affect older men/takes a long time to develop in men; [1]
(iii) Picks up the presence of cancer at an early stage;
when the chance of successful treatment is greater; [2]
(iv) Would struggle with a cancer diagnosis/not wanting to go through treatment/other
suitable answer; [1] **[8]**
- 11. (a)** Observed that bacteria didn't grow close to a fungus (which had contaminated his agar
plates);
due to a chemical/chemicals diffusing from the fungus; [2]
- (b) (i)** Trial and error stage/to see if the drug does what it supposed to do without harming
cells/tissues/other suitable answer; [1]
(ii) Testing on entire organisms/avoids testing on humans at this stage/check for side effects; [1]
- (c) (i)** Testing on human volunteers/patients; [1]
(ii) Determines the optimum dosage/check for side effects (in humans); [1]
- (d)** Benefits are greater than the side effects/problems; [1]
- (e)** Takes a long time to develop a drug/many stages/cost of keeping animals/trials in
hospital/pay volunteers/other suitable answer; [1] **[8]**
- 12. (a)** Bacteria (evenly) spread over the agar surface (in a Petri dish); [1]
- (b)** Larger clear area around B than C but no clear area around A;
antibiotic in disk B was more effective than the antibiotic in disk C;
the antibiotic in disk A had no effect on the bacteria in the Petri dish; [3]
- (c)** Temperature/concentration of antibiotic in each disk/other suitable answer; [1]
- (d) (i)** To avoid contamination (by microorganisms in the air); [1]
(ii) Petri dishes and agar sterilised in advance/sterilise inoculating loops/work close to a lit
Bunsen burner/other suitable answer;
to avoid contamination/to prevent other microorganisms affecting the results; [2]
- (e)** To avoid the growth of (human) pathogens;
which could occur at 35 °C/less likely to occur at 25 °C; [2] **[10]**