

Mark schemes

**Q1.**

(a)

	statement is true for		
	mitosis only	meiosis only	both mitosis and meiosis
all cells produced are genetically identical	✓		
in humans, at the end of cell division each cell contains 23 chromosomes		✓	
involves DNA replication			✓

3 correct = 2 marks

2 correct = 1 mark

0 or 1 correct = 0 marks

2

(b) any **two** from:

*ignore references to one parent only*

- many offspring produced
- takes less time  
*allow asexual is faster*
- (more) energy efficient
- genetically identical offspring  
*allow offspring are clones*
- successful traits propagated / maintained / passed on (due to offspring being genetically identical)
- no transfer of gametes or seed dispersal  
*allow no vulnerable embryo stage*  
*allow no need for animals*
- not wasteful of flowers / pollen / seeds
- colonisation of local area  
*must imply local area*

2

(c) genetic variation (in offspring)

1

(so) better adapted survive

*allow reference to natural selection or survival of the fittest*

1

(and) colonise new areas by seed dispersal  
**or**  
can escape adverse event in original area (by living in new area)  
*must imply new area*

1

many offspring **so** higher probability some will survive

1

*allow bluebell example described (max 3 if not bluebell)*

[8]

## Q2.

(a) **C**

1

(b) cytoplasm **and** cell membrane dividing  
*accept cytokinesis for 1 mark*

1

to form two identical daughter cells

1

(c) stage 4

1

only one cell seen in this stage

1

(d)  $(4 / 36) \times 16 \times 60$

1

107 / 106.7

1

110 (minutes)

*allow 110 (minutes) with no working shown for 3 marks*

1

(e) binary fission

*do **not** accept mitosis*

1

(f) shortage of nutrients / oxygen

1

so cells die

**or**

death rate = rate of cell division

1

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## Q3.

(a) vena cava

1

(b) 0.5 mm = 0.05 cm

1

$$\text{time} = \frac{10.00 - 0.05}{0.4}$$

*allow alternative correct substitution*

1

24.875

1

25 (s)

*an answer of 25 (s) scores 4 marks*

*allow 24 for 3 marks (no conversion of mm to cm)*

*allow 23.8 / 23.75 for 2 marks (no conversion of mm to cm and incorrect sf)*

1

(c) (blood) travels through (the) pulmonary vein

1

(blood) enters left atrium

1

(blood) enters (the) left ventricle

1

(blood) leaves the heart via / through (the) aorta

*allow blood travels through arterioles*

*allow blood (travels round the body and) reaches the cells / tissues via / in capillaries*

1

*ignore ref to valves / systole / diastole throughout*

(d) **Level 3 (5-6 marks):**

Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.

**Level 2 (3-4 marks):**

Relevant points (reasons/causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.

**Level 1 (1-2 marks):**

Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.

No relevant content (0 marks)

### **Indicative content**

**S = structural F = functional**

- (S) both have a large surface area
- (S) villi have many microvilli
- (S) alveolar walls are not flat / are folded
- (F) to maximise diffusion (of gases) / absorption of (food) molecules
- (S) both have many capillaries / good blood supply / capillaries near the surface
- (F) to maintain concentration / diffusion gradient
- (S) both have thin walls / walls that are one cell thick / one cell thick surface
- (F) to provide a short diffusion distance (for molecules to travel)
- (S) villi have many mitochondria

- (F) to provide energy for active transport (of food molecules)
- (S) cells of the villi have microvilli / more projections
- (F) to further increase the surface area / increase the number of proteins in the membrane / to allow more active transport to take place

[15]

#### Q4.

##### Level 3 (5–6 marks):

A detailed and coherent explanation is provided with most of the relevant content, which demonstrates a comprehensive understanding of the human circulatory system. The response makes logical links between content points.

##### Level 2 (3–4 marks):

The response is mostly relevant and with some logical explanation. Gives a broad understanding of the human circulatory system. The response makes some logical links between the content points.

##### Level 1 (1–2 marks):

Simple descriptions are made of the roles of some of the following: heart function, gas exchange, named blood vessels, named blood cells. The response demonstrates limited logical linking of points.

##### 0 marks:

No relevant content.

##### Indicative content

- dual / double circulatory system which means that it has higher blood pressure and a greater flow of blood to the tissues
- heart made of specialised (cardiac) muscle cells which have long protein filaments that can slide past each other to shorten the cell to bring about contraction for pumping blood
- heart pumps blood to lungs in pulmonary artery so that oxygen can diffuse into blood from air in alveoli
- blood returns to heart via pulmonary vein where muscles pump blood to the body via aorta
- oxygen carried by specialised cells / RBCs which contain haemoglobin to bind oxygen and have no nucleus so there is more space available to carry oxygen
- arteries carry oxygenated blood to tissues where capillaries deliver oxygen to cells for respiration and energy release
- thin walls allow for easy diffusion to cells
- large surface area of capillaries to maximise exchange
- waste products removed eg CO<sub>2</sub> diffuse from cells into the blood plasma
- blood goes back to the heart in veins which have valves to prevent backflow
- cardiac output can vary according to demand / is affected by adrenaline

accept annotated diagrams

[6]

#### Q5.

- (a) (i) doesn't have valves  
*allow veins have valves*

has a thicker wall **or** thicker layer of muscle  
*allow has a smaller lumen*  
*ignore references to elastic (in walls)*

- (ii) any **two** from:
- (artery has) more oxygen
  - (artery has) more glucose  
*allow (artery has) more amino acids / fatty acids*
  - (artery has) less carbon dioxide
  - (artery has) less lactic acid  
*ignore urea*  
*ignore reference to pressure*  
*accept converse for veins if veins is clearly stated*

2

- (b) any **two** from:
- no rejection  
*allow no tissue matching required*
  - abundant supply
  - low risk of infection  
*allow named example ie HIV, CJD*
  - longer shelf life  
*allow less space needed for storage*  
*ignore side effects*

2

[6]

**Q6.**

- (a) (i) diaphragm  
*accept phonetic spelling*
- (ii) (because) the volume (inside the jar) increases  
*maximum **two** marks if no reference to correct part of model*
- (causing) the pressure to decrease
- (and) air enters the balloon  
*allow oxygen*
- (b) (i) (so it moves by) diffusion  
*do **not** allow osmosis or active transport*
- from a high concentration (of oxygen) to a low concentration  
*allow down its / oxygen concentration gradient from the air*  
***or** to the blood*
- or**  
(because) there is a high(er) concentration (of oxygen) in the air **or** there is a low(er) concentration of oxygen in the blood  
*ignore reference to amount of oxygen*
- (ii) many gill filaments  
*must be in the correct pairs to gain 2 marks*

1

1

1

1

1

1

1

(give a) large surface / area  
*do not allow surface area to volume ratio*  
**or**  
 thin  
 (so) short diffusion pathway  
**or**  
 good blood supply  
 (to) maintain the concentration gradient  
**or**  
 water continually flows over them / continually ventilated  
 (to) maintain the concentration gradient

1

[8]

**Q7.**

(a) (i) guard (cells)  
*allow phonetic spelling*

1

(ii) any **one** from:  
*ignore reference to cells*

- allow carbon dioxide to enter  
*allow control loss / evaporation of water or control transpiration rate*
- allow oxygen to leave.  
*allow 'gaseous exchange'*

1

(b) (i) 200  
*correct answer gains 2 marks with or without working*  
*allow 1 mark for  $0.1 \times 0.1 = 0.01$  (mm<sup>2</sup>)*

2

(ii) more / a lot of / increased water loss  
*allow plant more likely to wilt (in hot / dry conditions)*

1

(c) (i) 0.12

1

(ii) the lower surface has most stomata

1

stomata are now covered / blocked (by grease)

1

so water cannot escape / evaporate from the stomata

*ignore waterproof*

*to gain credit stomata must be mentioned at least once*

1

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**Q8.**

(a) solution in soil is more dilute (than in root cells)  
*concentration of water higher in the soil (than in root cells)*

1

so water moves from the dilute to the more concentrated region  
*so water moves down (its) concentration gradient **or** water moves from a high concentration of water to a lower concentration*

1

concentration of ions in soil less (than that in root cells)

1

so energy needed to move ions

**or**

ions are moved against concentration gradient  
*the direction of the concentration gradient must be expressed clearly*  
*accept correct reference to water potential or to concentrations of water*

1

(b) any **three** from:

- movement of water from roots / root hairs (up stem)
- via xylem
- to the leaves
- (water) evaporates
- via stomata

3

(c) (i) 0.67/0.7

*accept 0.66, 0.666666... or  $\frac{2}{3}$  or 0.6*  
*correct answer gains **2** marks with or without working*

*if answer incorrect allow evidence of  $\frac{100}{150}$  for **1** mark*  
*do **not** accept 0.6 or 0.70*

2

(ii) during the first 30 minutes

any **one** from:

- it was warmer
- it was windier
- it was less humid
- there was more water (vapour) in the leaves

1

so there was more evaporation

*ignore 'water loss'*

or

stomata open during first 30 minutes or closed after 30 minutes (1)

so faster (rate of) evaporation in first 30 min or reducing (rate of) evaporation after 30 min (1)

1

[11]

**Q9.**

- (a) (mouthpiece) has pierced / entered the phloem  
or  
(the aphid) has been feeding from the phloem

1

- (b) yellow leaves due to lack of chlorophyll

*ignore 'chloroplasts'*

*ignore magnesium is needed to make chlorophyll*

1

(therefore) less / no light absorbed (by chlorophyll)

1

(therefore) lower rate of / no photosynthesis

*do not allow 'energy is produced by photosynthesis'*

1

(therefore) plant makes less / no sugar / glucose

1

(therefore) plant converts less / no sugar / glucose into protein (for growth, so growth is stunted)

*allow less glucose / sugar converted into cellulose (cell wall)*

*allow less energy for protein synthesis*

1

- (c) inject the protein / it into a mouse

1

combine lymphocytes with tumour / cancer cells to make hybridoma (cells)

*ignore white blood cells*

*allow T or B lymphocytes*

*ignore tumour unqualified*

1

find a hybridoma which makes a monoclonal antibody specific to PVY

1

(the scientist) clones (the hybridoma) to produce many cells (to make the antibody)

*do not allow cloning of original stem cells*

*allow many rounds of cloning / mitosis*

1

[10]

**Q10.**



- (a) 86  
*allow this answer only*  
*do **not** accept 85.7*  
*if no answer given, check for answer in the table* 1
- (b) as salt concentration increases, percentage of open stomata (in field of view) decreases (above 0.1 mol / dm<sup>3</sup>)  
**or**  
 allow percentage of open stomata stays the same between 0.0 and 0.1 (mol / dm<sup>3</sup>) then decreases as salt concentration increases)  
*ignore references to number of open stomata*  
*allow converse*  
*allow idea that mean concentration (of salt) in guard cells is between 0.3 and 0.4 mol per dm<sup>3</sup>* 1
- (c) use concentrations between 0.3 (mol / dm<sup>3</sup>) and 0.4 (mol / dm<sup>3</sup>)  
**or**  
 draw a graph of the data and read off the value at 50% (open stomata)  
*allow a list of appropriate concentrations i.e. 0.32 mol / dm<sup>3</sup>, 0.34 (mol / dm<sup>3</sup>), 0.36 (mol / dm<sup>3</sup>) etc.* 1
- (d)  $(\pi \times 0.1875^2) = 0.11$  (mm<sup>2</sup>)  
*an answer of 36 scores 3 marks* 1
- $\frac{4}{0.11}$  1
- 36 (per mm<sup>2</sup>)  
*allow 36.22 / 36.23 **or** 36.2*  
*if answer is incorrect allow for 2 marks for sight of number of open stomata = 9 per mm<sup>2</sup> (diameter used instead of radius)*  
*if no other marks awarded allow for 1 mark any **one** from:*
- *sight of area = 0.44(mm<sup>2</sup>) (diameter used instead of radius)*
  - *sight of number of open stomata = 9.1 / 9.05 / 9.06 per mm<sup>2</sup> (diameter used instead of radius and no rounding)*
- 1
- (e) (potassium) ions increase the concentration of the solution (inside guard cells)  
**or**  
 (potassium) ions make cell more concentrated / less dilute  
*allow (potassium) ions decrease concentration of water / water potential (of guard cells)* 1
- water moves into the (guard) cell by osmosis 1
- cell swells unevenly (so stoma opens) 1
- as inner wall is less flexible than outer wall **or** thick part of the wall is less flexible than the thin part (of the wall)

**Q11.**

- (a) (i) dead / inactive / weakened  
*allow antigen / protein*  
*ignore ref to other components*  
*ignore small amount* 1
- pathogen / bacterium / virus / microorganism  
*ignore germs / disease* 1
- (ii) *antigen / antibiotic instead of antibody = max 2*
- white blood cells produce / release antibodies  
*accept lymphocytes / leucocytes / memory cells produce antibodies*  
*do **not** accept phagocytes* 1
- antibodies produced quickly 1
- (these) antibodies destroy the pathogen  
*allow kill*  
*do **not** accept antibodies engulf pathogens* 1
- (b) (i) (live) bacteria still in body  
*ignore numbers* 1
- would reproduce  
*ignore mutation / growth* 1
- (ii) antibiotics / treatment ineffective **or** resistant pathogens survive  
*accept resistant out compete non-resistant* 1
- these reproduce 1
- population of resistant pathogens increases  
*allow (resistant pathogens reproduce) rapidly* 1

**Q12.**

- (a) (i) any **one** from:
- (produce) toxins / poisons
  - (cause) damage to cells  
*kill / destroy cells*

- allow kills white blood cells* 1
- (ii) produce antitoxins 1
- engulf / ingest / digest pathogens / viruses / bacteria / microorganisms  
*accept phagocytosis or description*  
*ignore eat / consume / absorb for engulf*  
*ignore references to memory cells* 1
- (b) (i) dead / inactive / weakened 1  
*accept idea of antigen / protein*
- (measles) pathogen / virus  
*ignore bacteria* 1
- (ii) (after infection) 1  
*accept converse if clearly referring to before vaccination*
- rise begins sooner / less lag time  
 steeper / faster rise (in number) 1
- longer lasting **or** doesn't drop so quickly  
*idea of staying high for longer*  
*ignore reference to higher starting point* 1
- (iii) antibodies are specific or needs different antibodies 1  
*accept antigens are different **or** white blood cells do not recognise virus*
- (c) reduces spread of infection / less likely to get an epidemic 1  
*accept idea of eradicating measles*

[10]

### Q13.

- (a) any **two** from:
- regular hand washing
  - or**
  - use hand sanitiser / alcohol gel
  - cover nose / mouth when coughing / sneezing  
*allow wear a face mask*
  - put used tissues (straight) in the bin
  - don't kiss uninfected people  
*allow isolate patient from others*
  - or**
  - don't share cutlery / cups / drinks with uninfected people
  - clean / disinfect / sterilise surfaces regularly

*ignore responses referring to infected people*

2

(b) any **three** from:

- stimulate (mouse) lymphocytes to produce antibody  
*for marking points 1 and 2 lymphocyte must be used at least once*
- combine (mouse) lymphocyte with tumour cell  
**or**  
(create a) hybridoma
- clone (hybridoma) cell
- (hybridoma) divides rapidly **and** produces the antibody

3

(c) any **two** from:

- (monoclonal) antibody binds to virus **or** antibody binds to antigen on surface of virus
- (monoclonal) antibody is complementary (in shape) / specific to antigen (on surface of virus)
- white blood cells / phagocytes kill / engulf the virus(es)

2

(d) as a control

**or**  
to see / compare the effects of the treatment (vs. no treatment)

1

(e)  $(4.8 + 10.4) \div 2 \div 100 \times 1500$

**or**  
 $(4.8 \div 100 \times 750) + (10.4 \div 100 \times 750)$

1

114

*an answer of 114 scores 2 marks  
allow 228 for 1 mark*

1

(f) **(supports the conclusion because)**

over double the number / % of patients (in the trial) were hospitalised with the placebo (compared to MAB)

1

**(does not support the conclusion because)**

no information on patients not hospitalised / still unwell at home

**or**

other factors may have affected those admitted to hospital

*allow correct named factor e.g. age / gender / other illness*

**or**

don't know if it was a double blind trial

1

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## Q14.

(a) (i) viruses live inside cells

1

viruses inaccessible to antibiotic

*allow drug / antibiotic (if used)*

*would (have to) kill cell*

- (ii) any **two** from eg
- non-resistant strains killed (by antibiotics)
  - so less competition
  - overuse of antibiotics / antibiotics prescribed for mild infections  
*if no marks gained allow one mark for 'people do not finish course of antibiotics'*

2

- (b) (stimulate) antibody production  
*ignore antitoxin*

1

(by) white cells

1

rapidly produce antibody on re-infection  
*ignore antibodies remain in blood*

1

[7]

### Q15.

- (a) phosphate

*allow  $PO_4^{3-}$*

1

*do **not** allow P*

- (b) A / adenine and T / thymine  
**and**  
C / cytosine and G / guanine

*do **not** allow U / uracil*

1

- (c) (mutation) changes from C to T DNA code  
**or**  
there is a change in the three bases / triplet from CAG to TAG

1

(mutation) changes the amino acid

1

(this could) change the protein

1

(so it) forms a different shape / changed active site  
*accept different tertiary structure*

1

(therefore) the enzyme no longer fits the substrate / carbohydrate

1

- (d) mother / woman's gametes correct: A a

1

father / man's gametes correct: a a

1

correct derivation of offspring  
*ecf* 1

identification of child with syndrome H or genotype aa 1

0.5  
*ecf*  
*allow 50% / 1 / 2 / 1 in 2 / 1:1*  
*do not accept 1:2* 1

[12]

**Q16.**

(a) testis / testes  
*allow testicle(s)* 1

(b) (i) **B** = 13.2  
**C** = 6.6  
**E** = 3.3  
*all 3 correct = 2 marks*  
*2 or 1 correct = 1 mark*  
*If no marks awarded allow ecf for C and E based on answer to B*  
*ie C = ½ B and E = ½ C for one mark* 2

(ii) 6.6  
*allow twice answer for cell E in part bi* 1

(iii) mitosis  
*correct spelling only* 1

(c) (i) any **two** from:  
• cells that are able to divide  
• undifferentiated cells / not specialised  
• can become other types of cells / tissues **or** become specialised /differentiated  
*allow pluripotent* 2

(ii) 4-day embryo is a (potential) human life  
**or**  
destroying/damaging (potential) human life  
*allow cord would have been discarded anyway*  
*ignore reference to miscarriage*  
*allow cannot give consent* 1

(iii) perfect tissue match **or** hard to find suitable donors

*allow same/matching antigens*  
*allow no danger of rejection*  
*allow no need to take immunosuppressant drugs (for life)*  
*ignore genetically identical **or** same DNA*

1

- (iv) stem cells have same faulty gene / allele / DNA / chromosomes  
*allow genetically identical*  
*ignore cells have the same genetic disorder*

1

[10]

**Q17.**

- (a) • caused by a recessive\* gene / allele  
*(allow non / not dominant)*
- both parents heterozygous / carry the gene / allele  
*for 1 mark each*

offspring needs two recessive genes to have / inherit disease  
*for 2 marks*

**or**

- $Nn \times Nn$
- $NN \quad Nn \quad Nn \quad nn$   
*for 1 mark each*

$nn$  identified as having the disease\*  
*for 2 marks*

4

- (b) any reference to DNA  
*gains 1 mark*

**but**  
different genes means difference in DNA  
*gains 2 marks*

*idea of*  
different codes / instructions for making proteins

**or**  
different (order of) amino acids (in proteins)  
*for 1 mark*

3

[7]

**Q18.**

- (a) gene / allele

1

- (b) (in / on) ribosome(s)

1

- (c) any **three** from:
- amino acids make up a protein
  - (protein is) particular combination / sequence (of amino acids)
  - bases form a code
  - the bases work in threes or description  
*accept bases work in triplet*
  - (code / three bases) for one amino acid  
*accept eg (bases) WXZ for amino acid J for 2 marks*
- 3
- (d) (i) different / wrong amino acid (coded for) **or** different / wrong shape  
*ignore reference to amino acid 'made'*  
*ignore change unqualified*  
*ignore different protein*
- 1
- (ii) different / example of different eye colour  
*allow protein may / would not be made / function (normally)*
- 1
- [7]

### Q19.

- (a) 860
- correct answer gains 2 marks*  
*if answer incorrect evidence of  $(6100 - 1800) \div 5$*   
*or  $4300 \div 5$*   
*or  $(900 + 600 + 1000 + 700 + 1100) \div 5$  gains 1 mark*  
*allow ecf from 1 incorrect graph reading*
- 2
- (b) *ignore references to oxygen / sulfur dioxide / nitrogen oxides / acid rain*  
*ignore global warming*

#### Effects of deforestation

deforestation increases the amount of carbon dioxide in the atmosphere  
*award this point only if linked to deforestation*

1

any **two** from:

- due to less photosynthesis **or** less carbon dioxide taken in  
**or** carbon dioxide not locked up in (forest) trees
- due to burning of forest / from machinery
- due to activity of microorganisms / decay

2

#### Effects of growing palm for fuel

carbon dioxide released when palm oil used as fuel



(eventually) CO<sub>2</sub> intake and output might balance out **or** burning palm oil carbon neutral

*accept less carbon dioxide than from burning fossil fuels*