

## Mark schemes

1

(a)

Feature	Bacterium	Human immunodeficiency virus (HIV) particle
RNA	✓	✓
Cell wall	✓	
Enzyme molecules	✓	✓
Capsid		✓

1 mark for each correct vertical column

2

- (b) 1. (Complementary) nucleotides/bases pair  
**OR**  
 A to T **and** C to G;  
*Ignore '(DNA polymerase) forms base pairs/nucleotide pairs'*
2. DNA polymerase;
3. Nucleotides join together (to form new strand)/phosphodiester bonds form;  
*Ignore '(DNA polymerase) forms base pairs/nucleotide pairs'*  
*If clearly writing rote answer about DNA replication **2 max** e.g. helicase or separating strands*

3

- (c) 1. DNA double stranded/double helix **and** mRNA single-stranded;  
*Contrast requires both parts of the statement*
2. DNA (very) long **and** RNA short;  
*Accept 'RNA shorter' or 'DNA bigger/longer'*
3. Thymine/T in DNA **and** uracil/U in RNA;
4. Deoxyribose in DNA **and** ribose in RNA;  
*R Deoxyribonucleic/ ribonucleic acid*  
**Ignore** ref. to histones  
**Ignore** ref. to helix and straight chain alone
5. DNA has base pairing **and** mRNA doesn't/ DNA has hydrogen bonding and mRNA doesn't;
6. DNA has introns/non-coding sequences **and** mRNA doesn't;  
**Ignore** ref to splicing

3 max

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2

- (a) 1. In phospholipid, one fatty acid replaced by a phosphate;  
*Ignore references to saturated and unsaturated*  
 Accept  $\text{Pi/PO}_4^{3-}$  /  $\text{P}$   
 Reject P/Phosphorus  
 Accept annotated diagrams

1

- (b) 1. Add ethanol, then add water;  
*Reject ethanal/ethonal*  
*Accept 'Alcohol/named alcohol'*
2. White (emulsion shows lipid);  
*Accept milky – Ignore 'cloudy'*  
*Sequence must be correct*  
*If heated then DQ point 1*  
*Reject precipitate*

2

- (c) Saturated single/no double bonds (between carbons)  
**OR**  
 Unsaturated has (at least one) double bond (between carbons);  
*Accept hydrocarbon chain/R group for 'between carbons' for either*  
*Accept Sat = max number of H atoms bound*  
*'It' refers to saturated*

1

- (d) 1. (Fat substitute) is a different/wrong shape/not complementary;  
**OR**  
 Bond between glycerol/fatty acid and propylene glycol different  
 (to that between glycerol and fatty acid)/no ester bond;
2. Unable to fit/bind to (active site of) lipase/no ES complex formed;  
*If wrong bond name given (e.g. peptide/glycosidic), then penalise once*

2

- (e) It is hydrophilic/is polar/is too large/is too big;  
*Ignore 'Is not lipid soluble'*

1

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3

- (a) 1. From ADP and phosphate;  
*Accept  $P_i/PO_4^{3-} / \textcircled{P}$*   
*Reject P/Phosphorus*  
*Reject use of water in the reaction*

2. By ATP synthase;  
 3. During respiration/photosynthesis;

2 max

- (b) 1. To provide energy for other reactions/named process;  
*Reject 'produce' energy*
2. To add phosphate to other substances **and** make them more reactive/change their shape;

2

- (c) (Can see) 3D image;

1

(d) Crista/cristae;

*Ignore matrix*

1

(e) Value between 20,750 (83mm) and 21,250 (85mm) two marks;;  
Formula given/used but calculation wrong, award 1 mark

$$\text{Magnification} = \frac{\text{image size}}{\text{Object size}}$$

*(Large number divided by 4)*

2

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4

(a)

Transport through a channel protein

Q

1

Transport of small, non-polar molecules

P

1

Transport of glucose with sodium ions

S

1

(b) 1. (Y is) an enzyme/has active site/forms ES complex;

*Accept catalyst*

2. That makes cellulose/attaches substrate to cellulose/joins  $\beta$  glucose;

**OR**

3. Makes cellulose/forms glycosidic bonds;

4. From  $\beta$  glucose;

*Mark in pairs (1&2 or 3&4)*

2

(c) Cell wall forms outside cell-surface membrane/has cellulose on it  
(on the outside);

1

(d) (Tick in box next to) Hydrogen;

1

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- (a) 1. Vaccine/it contains antigen (from HPV);  
*Term 'antigen' may be first mentioned with point 2*
2. Displayed on antigen-presenting cells;  
*Accept named example, e.g. macrophage/phagocyte/B cells*
3. Specific helper T cell (detects antigen and) stimulates specific B cell;  
*Accept 'helper T cell with receptor on surface' for 'specific' and B cells with receptor/antibody on surface that bind to antigen for 'specific'*
4. B cell divides/goes through mitosis/forms clone to give plasma cells;
5. B cell/plasma cell produces antibody;

4 max

- (b) 1. Two (doses) because got more antibody;  
*Accept more effective in producing antibody*
2. With three doses, second dose/dose at 1 month doesn't lead to production of any more antibody (than the two-dose group)/get same/similar response;
3. Three doses would be more expensive/less popular with parents/girls (and serves no purpose);  
*Accept 'less painful'*

2 max

- (c) t-test, because comparing two means;  
*Mark for correct test and explanation correct*  
*Accept 'comparing the mean'*  
*Reject 'to show that the results/means are significant'*

1

- (d) 1. Compare (base sequences of) DNA;
2. Look for mutations/named mutations (that change the base sequence);
3. Compare (base sequences of) (m)RNA;  
*1 and 3 accept triplet/codon sequences for comparisons*  
*Ignore references to 'introns/non-coding DNA'*

2 max

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6

- (a) C

*Auto mark*

1

- (b) 1. No separation of chromatids/chromosomes/centromeres;  
*Accept anaphase prevented*  
*Accept nondisjunction*  
*Reject homologous pairs*
2. Chromatids/chromosomes all go to one pole/end/sides of cell/not pulled to opposite poles;
3. Doubles chromosome number in cell/one daughter cell gets no chromosomes or chromatids;  
*Accept DNA for chromosomes*  
*Accept ploidy*  
*Ignore references to 'genetic information'*  
*Ignore simple descriptions of what normally happens in mitosis*

2 max

- (c) 1. (No, because) at 100 there are still **some** (7%) cancer cells dividing/undergoing mitosis;  
*Accept idea that all division stops only at 1000*
2. So, cancer not destroyed/may continue to grow/spread/form tumours;  
*Must refer to cancer spreading not cells dividing*
3. Best concentration may be between 100 and 1000/need trials between 100 and 1000;
4. This research in culture, don't know effect of KI on people;  
*Reject 'not tested on humans'*  
*Reject 'done in animals'*
5. (Yes, because) above 100 produces little increase in % of cells not dividing/undergoing mitosis/at 100, **most** (93%) cancer cells unable to divide/dead;  
*Must clearly link lack of monopolar mitotic spindles with cell division*
6. Above 100 may be harmful (to body);  
*Accept 'above 100/high concentrations produce harmful side effects/named effects'*
7. Higher concentrations more expensive;
8. (Above 100) will have more effect on (rapidly dividing) cancer cells;  
*Must relate to 100*

4 max

- (d) 1. 10 cm<sup>3</sup> of 10 000 nmol dm<sup>-3</sup>/ (original) solution;
2. 90 cm<sup>3</sup> of water;  
*If ratio correct but make wrong volume e.g. 1 litre, award 1 mark*

2

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- (a) Dipeptidase/s;  
*Accept: membrane bound dipeptidase/s.*

1

- (b) 1. Endopeptidases hydrolyse internal (peptide bonds)  
**OR**  
Exopeptidases remove amino acids/hydrolyse (bonds) at end(s);  
*Accept: break for hydrolyse.*  
*Accept: endopeptidases break (proteins) into shorter chains.*
2. More ends or increase in surface area (for exopeptidases);

2

- (c) 1. No/less ATP produced  
**OR**  
 No active transport;
2. Sodium (ions) not moved (into/out of cell);  
*Accept: sodium (ions) increase in cell.*  
*Accept: sodium (ions) cannot diffuse into cell.*
3. No diffusion gradient for sodium (to move into cell with amino acid)  
**OR**  
No concentration gradient for sodium (to move into cell with amino acid);  
*Accept: converse for all three points.*  
*Note: no active transport of sodium (ions) equals 2 marks.*

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- (a) Stomata per mm<sup>2</sup> or cm<sup>2</sup>  
**OR**  
 Number per mm<sup>2</sup> or cm<sup>2</sup>;  
*Accept: mm<sup>-2</sup> or cm<sup>-2</sup>.*  
*Reject: per μm<sup>2</sup> or μm<sup>-2</sup>.*  
*Reject: the use of a solidus / as being equivalent to per.*  
*Ignore: 'amount'.*

1

- (b) 1. Single/few layer(s) of cells;  
*Accept: more/too many/overlapping.*  
*'Single layer' without reference to cells/tissue should **not** be credited.*
2. So light can pass through;

2

- (c) 1. Distribution may not be uniform  
**OR**  
 So it is a representative sample;  
*Accept: more/fewer stomata in different areas.*  
*Ignore: anomalies/random/bias.*
2. To obtain a (reliable) mean;  
*Accept: 'average'.*

2

- (d) 1. Hairs **so** 'trap' water vapour and water potential gradient decreased;  
 2. Stomata in pits/grooves **so** 'trap' water vapour and water potential gradient decreased;  
 3. Thick (cuticle/waxy) layer **so** increases diffusion distance;  
 4. Waxy layer/cuticle **so** reduces evaporation/transpiration.  
 5. Rolled/folded/curled leaves **so** 'trap' water vapour and water potential gradient decreased;  
 6. Spines/needles **so** reduces surface area to volume ratio;
- 1, 2 and 5. Accept: humid/moist air as 'water vapour' but **not** water/moisture on its own.  
 1, 2 and 5. Accept: diffusion gradient as equivalent to water potential gradient.  
 1, 2 and 5. Accept: less exposed to air as an alternative to water potential gradient.  
 6. Accept: spines/needles **so** 'reduce area'.

2 max

- (e) 1. Water used for support/turgidity;  
 2. Water used in photosynthesis;  
 3. Water used in hydrolysis;  
 4. Water produced during respiration;

2 max

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- (a) (Simple) diffusion;  
 Reject: facilitated diffusion.

1

- (b) 1. Thin/small **so** short diffusion pathway;  
 Reject: thin membrane/wall/cells.  
 2. Flat/long/small/thin **so** large surface area to volume ratio/surface area : volume;  
 Accept: small volume to surface area ratio.

2

- (c) 1. High/50% saturation (with oxygen) below ( $pO_2$  of) 0.2 kPa;  
 Accept: fully saturated **or** above 50% saturation below 0.2kPa.  
 Accept: any number between 0.08 and 0.2 kPa  
 2. (Oxygen) for respiration;

2

- (d) 1. Water potential higher in worm  
**OR**  
 Lower water potential in seawater;  
 Accept: correct reference to water potential gradient if direction of water movement is given.  
 Accept:  $\psi$  for water potential.  
 2. Water leaves by osmosis (and worm dies);  
 Reject: worm/cells burst.

2

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**10**

(a)

White blood cell		✓	✓
Bacteria cell	✓	✓	

2

(b) 2.80 (µm);;

*Answer in range 2.76–2.83 scores 2 marks**If length incorrect but divided by 30 000, allow 1 mark*

2

(c) (i) Circular DNA / smaller/70S ribosomes / no introns / no histones/proteins associated with DNA;

*Ignore reference to plasmids*

1

(ii) 1. Able to respire aerobically;  
2. So make (more) ATP/ release (more) energy;  
*Reject 'producing energy' unqualified*

2

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- (a) 1. Virus can't bind (to receptor)/ can't enter cells;  
2. So can't be replicated/ multiply;  
*Accept can't reproduce*  
3. So, doesn't damage cell(s)/tissues (and cause symptoms);  
*Accept no toxins released*  
**2 max**
- (b) 1. Antigen/glycoprotein on Ebola binds to/stimulates (a specific) B cell;  
*Accept correct reference to stimulation of B cells by T cells*  
2. (Binding causes) replication/cloning of B cell;  
*Accept replication/cloning of plasma cell;*  
3. Plasma cells/B cells release/produce antibodies;  
**2 max**
- (c) 1. Lots of antibodies (against Ebola) in recovered patient;  
2. Transfusion/plasma contains antibodies;  
*Ignore reference to cells*  
3. Antibodies (specific so) will bind with (Ebola) antigen;  
4. (In recipient) virus destroyed/cannot enter cell;  
*Antigen destroyed is insufficient*  
**3 max**
- (d) 1. (High mutation rate leads to) antigens change/antigenic variability;  
*Accept (high mutation rate leads to) changes in base sequence coding for antigen;*  
2. Vaccine contains specific antigen;  
3. Antibodies not complementary to (changed) antigen / won't bind to (changed) antigens;

3

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- (a)
1. Na<sup>+</sup> ions leave epithelial cell and enter blood;  
*Penalise for Na without ions once.*
  2. (Transport out is by) active transport / pump / via carrier protein using ATP;  
*Reject channel protein*
  3. So, Na<sup>+</sup> conc. in cell is lower than in lumen (of gut);  
*Maintains diffusion gradient for Na<sup>+</sup> from lumen/into cells;*
  4. Sodium/Na<sup>+</sup> ions enter by facilitated diffusion;  
*Accept diffusion/from high to low concentration through a symport/cotransport protein*
  5. Glucose absorbed with Na<sup>+</sup> ions against their concentration/diffusion gradient / glucose absorbed down an electrochemical gradient;  
*Accept glucose absorbed with sodium ions by indirect active transport*

5

- (b)
1. Chloride ions water soluble/charged/polar;  
*Penalise chloride molecules only once*  
*Ignore ref to size*  
*Accept not lipid soluble*
  2. Cannot cross (lipid) bilayer (of membrane);
  3. Chloride ions transported by facilitated diffusion OR diffusion involving channel/carrier protein;
  4. Oxygen not charged/non-polar;  
*Accept oxygen lipid soluble*
  5. (Oxygen) soluble in/can diffuse across (lipid) bilayer;

5

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(a)

	Cell B	Cell C	Cell D
homologous chromosomes are present	✓	✓	
a stage of mitosis		✓	

*Mark horizontally*

*1 mark for each correct row*

2

- (b) Mark as pairs, do not mix and match
1. (Chromosomes consist of) two chromatids connected at centromere;  
*Accept: sister chromatids for two chromatids*
  2. (Because) DNA has replicated;
- OR
3. K is on equator of spindle;  
*Ignore: 'middle'*
  4. (because) attached at centromere;  
*Ignore reference to meiosis / bivalents / homologous pairs*
- 2
- (c) 1. Crossing over / exchange of alleles / lengths of DNA / recombination;  
*Accept: description of crossing over eg sections of chromatids break and re-join*  
*Accept: reference to chiasma/ chiasmata*
2. Between (chromatids of) homologous chromosomes;  
*Accept: 'between non-sister chromatids'*  
*Accept: 'bivalent' for homologous*  
*Ignore: genes exchanged*
- 2
- (d) Separation/segregation of pairs/homologous chromosomes;  
*Accept: result of meiosis I / result of division of cell B*  
*Accept: pulled to opposite poles for 'separation'*  
*Ignore ref to chromatids*
- 1
- (e) (DNA) replication taking place/not finished;  
*Accept: they are cells in S phase*
- 1

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- (a) 1. Thin slice/section;  
2. Put on slide in water / solution / stain;  
3. Add cover slip;

*Accept: 'between two slides'*

Max 2

- (b) 200 (µm);;

OR

1. Divide image length by key length eg 64/16 = 4;  
2. Multiply by 50 eg 4 × 50;

*Accept for 2 marks answers in the range of 185-217 (µm)*

*Max 1 mark for responses not within the range*

*Accept: measurements in the ranges 63-65mm and 15-17mm*

2

- (c) 1. Select large number of cells / select cells at random;

*Accept: > 3 for "large number"*

*Accept: many fields of view for 'large number of cells'*

*Accept: all cells in field of view*

2. Count number of chloroplasts;  
3. Divide number of chloroplasts by number of cells;

*Ignore: 'calculate the mean'*

3

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- (a) 1. How to break open cells and remove debris;  
2. Solution is cold / isotonic / buffered;  
3. Second pellet is chloroplast.

3

- (b) 1. **A** stroma;  
2. **B** granum.

*Accept thylakoid*

2

- (c)  $\left( \frac{\text{length of chloroplast}}{\text{length of bar}} \right) \mu\text{m}$

1

- (d) **Two** of the following for **one** mark:  
Mitochondrion / ribosome / endoplasmic reticulum / lysosome / cell-surface membrane.

1 max

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