AQA A-LEVEL · 7402

# BIOLOGY



## MARK SCHEME

### 3.2.1 CELL STRUCTURE

| SCORE | PERCENTAGE |
| --- | --- |
| /557 | % |

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## Q1.

(a) D;
G;
F;

**3**

(b) Coronary arteries;

*Accept coronary artery*
*Ignore aorta, arteriole and capillary*
*Reject coronary veins*
*Do not accept coronary by itself*
*Accept phonetic spelling*

**1**

(c) 1. No sketched / hanging / crossing lines / shading;
*Ignore stippling*
2. Must look similar;
3. Matrix **and** crista correctly labelled;
*Ignore any other labels*
4. Correct scale stated (x 62 800);
*Accept other suitable scale given*

**4**

**[8]**

## Q2.

(a) W – (cell surface) membrane
X – cell wall
Y – capsule
Z – flagellum

*Four correct = 2 marks.*
*Three or two correct = 1 mark.*
*Y - Ignore references to slime/mucus*
*Y - Reject capsid*
*Z - accept flagella*

**2**

(b) W - Phospholipids;
X - Murein / glycoprotein;

*X - Accept peptidoglycans.*
*Accept phonetic spellings*

**2**

(c) Binary fission;

*Reject binary fusion*

**1**

(d) $8.64 \times 10^5$;;

*Accept 864 000 however expressed, e.g. 864 × $10^3$*
*Allow one mark for*

*$2^6 = 64$*

***OR***

*$64 / 26 \times (1.35 \times 10^4)$*

**2**

**[7]**

## Q3.

(a) B;

A;

E;

**3**

(b) 1. (Many mitochondria) release energy / ATP **for** movement of vesicles / synthesis of protein / active transport;

*Must include function of organelle **and** use in context of milk production.*

*Ignore reference to lipid / triglyceride*

*Reject reference to mitochondria undergoing anaerobic respiration*

*Reject "produce energy".*

*Reject "energy for respiration"*

2. (Many Golgi) vesicles transport protein / glycoprotein / milk **to** cell membrane / **out of** cell;

*Must include function of organelle **and** use in context of milk production.*

*Ignore reference to lipid / triglyceride*

*Accept exocytosis as transport and release*

*Ignore references to protein synthesis*

**2**

**[5]**

## Q4.

(a) 1. The (individual) chromosomes are visible because they have condensed;

*Both parts of each answer are required – evidence and explanation.*

*For 'they' accept 'chromosomes/chromatin/DNA'*

*Accept 'tightly coiled' or 'short and thick' for condensed but do not accept 'contracted'.*

*Ignore references to nucleus/nucleolus/nuclear membrane.*

2. (Each) chromosome is made up of two chromatids because DNA has replicated;

*Both parts of each answer are required – evidence and explanation.*

*Accept 'sister chromatids' for 'two chromatids'.*

*Ignore references to nucleus/nucleolus/nuclear membrane.*

3. The chromosomes are not arranged in homologous pairs, which they would be

if it was meiosis;

*Both parts of each answer are required – evidence and explanation.*

*Accept not meiosis because bivalents/chiasmata/crossing over not seen.*

*Ignore references to nucleus/nucleolus/nuclear membrane.*

**2 max**

(b) Automarked q – ✔ prophase

**1**

(c) 1. Water moves into the cells/cytoplasm by osmosis;

*Reject water moving into chromosomes/nucleus.*

2. Cell/cytoplasm gets bigger;

*Accept idea of cell/cytoplasm has greater volume/swells/expands.*

*Ignore references to pressure changes, turgidity and chromosomes being more dilute.*

*Ignore references to changing water/fluid contents of the cell.*

*Allow ECF for 'nucleus expands' but not for 'chromosomes expand'.*

**2**

(d) Differences in base sequences

**OR**

Differences in histones/interaction with histones

**OR**

Differences in condensation/(super)coiling;

*Answer must be in context of differences in arrangement of chromosomes not just related to the properties of the stain.*

*Accept spec section 8 ideas e.g. different methylation/acetylation*

*Accept different genes*

*Reject different alleles*

**1**

(e) (Two chromosomes that) carry the same genes;

*Reject 'same alleles'*

*Accept 'same loci' (plural) or 'genes for the same characteristics'*

**1**

(f) (Prokaryotic DNA) is

1. Circular (as opposed to linear);

2. Not associated with proteins/histones ;

3. Only one molecule/piece of DNA
**OR**

present as plasmids;

*Max 1 if prokaryotic DNA only found as plasmids OR if prokaryotic DNA is single stranded.*

*Ignore references to nucleus, exons, introns or length of DNA. Do not credit converse statements.*

*Ignore descriptions of eukaryotic DNA alone.*

**2 max**

**[9]**

## Q5.

(a) 1. Named structures – trachea, bronchi, bronchioles, alveoli;

*Reject mp1 if structures from other physiological systems are named but award mp2 if the correct structures are in the correct order.*

2. Above structures named in correct order
**OR**
Above structures labelled in correct positions on a diagram;

*Reject mp1 if structures from other physiological systems are named but award mp2 if the correct structures are in the correct order.*

3. Breathing in – diaphragm contracts **and** external intercostal muscles contract;

4. (Causes) volume increase and pressure decrease in thoracic cavity (to below atmospheric, resulting in air moving in);

*For thoracic cavity accept 'lungs' or 'thorax'.*

*Reference to 'thoracic cavity' only required once.*

5. Breathing out - Diaphragm relaxes **and** internal intercostal muscles contract;

*Accept diaphragm relaxes **and** (external) intercostal muscles relax **and** lung tissue elastic (so recoils).*

6. (Causes) volume decrease and pressure increase in thoracic cavity (to above atmospheric, resulting in air moving out);

*For thoracic cavity accept 'lungs' or 'thorax'.*

*Reference to 'thoracic cavity' only required once.*

*If idea of thoracic cavity is missing or incorrect, allow ECF for mark point 6.*

**6**

(b) 1. Both contain ester bonds (between glycerol and fatty acid);

*All statements must be clearly comparative or linked by the candidate, not inferred from separate statements.*

*Accept mark points shown on adjacent annotated diagrams.*

2. Both contain glycerol;

3. Fatty acids on both may be saturated or unsaturated;

4. Both are insoluble in water;

5. Both contain C, H and O but phospholipids also contain P;

*Must relate to element.*

6. Triglyceride has three fatty acids and phospholipid has two fatty acids plus phosphate group;

7. Triglycerides are hydrophobic/non-polar and phospholipids have hydrophilic and hydrophobic region;
   *Accept 'non-polar' for hydrophobic and 'polar' for hydrophilic.*

8. Phospholipids form monolayer (on surface)/micelle/bilayer (in water) but triglycerides don't;

**5 max**

(c) 1. Glucose **and** galactose;
   *Ignore α or β for glucose*

2. Joined by condensation (reaction);

3. Joined by glycosidic bond;

4. Added to polypeptide in Golgi (apparatus);;

**4**

**[15]**

## Q6.

(a) Lowercase a in both boxes

**1**

(b) Tick in box next to 'Crossing over';

**1**

(c) 32.73 / 32.7 / 32 / 33;;

Award 1 max for either

409 (409.2) for difference in volume (but incorrect number of mitochondria);

OR

Answer of 262 (261.9) (using diameter, rather than radius);

**2**

(d) 1. Egg (created) has nucleus / DNA / genes of (affected) woman / mother;
   *Accept ref. to zygote / embryo / child for egg*
   *Accept genetic information*
   *Ignore references to alleles*
   *Reject if nucleus from wrong egg / woman*

2. It has mostly / many / lots of normal mitochondria (of unaffected woman)
   **OR**
   There are few faulty mitochondria;
   *Reject ref. to **production** of healthy mitochondria as result of treatment*

**2**

(e) 1. Not enough / little ATP produced;

*One reason asked for, so list rule applies*

*Ignore ref. to no ATP produced*

2. ATP provides **energy** for (enzyme) reactions
**OR**
ATP phosphorylates substrates / enzymes, **so** making them (more) reactive;

*Accept (leads to) lower activation energy for reaction*

*Reject if mention energy produced*

**2 max**

**[8]**

## Q7.

(a) 1. Cell membranes made from phospholipid;

*Note: candidates may make both mark points in once statement*

2. (Detergent) dissolves membranes / phospholipid (bilayer);

*Ignore breaks down*

*Reject hydrolysis*

**2**

(b) 1. Spin (liquid / supernatant) at (very) high speed / high g;

*Need context of high, **not** just 'faster', 'higher' in context of use of bench centrifuge*

*Accept high centrifugal force*

*Award 1 max if ref. to organelle separation*

2. Molecules / CENP-W separates depending on (molecular) mass / size / density;

*Accept weight*

**2**

(c) 1. siRNA binds to / destroys mRNA for CENP-W;

*Reject if siRNA binds to gene / DNA*

*Context is important, siRNA acts on mRNA for CENP-W, **not** tubulin.*

*Ref. to CENP-W required **once** for MP1 and MP2*

2. Prevents translation of CENP-W;

*Context is important, siRNA acts on mRNA for CENP-W, **not** tubulin.*

*Ref. to CENP-W required **once** for MP1 and MP2*

*Accept reduces translation of CENP-W*

3. (After / as) CENP-W reduces **so** does tubulin production;

**3**

**[7]**

## Q8.

(a) Diffusion

*Automarker*

**1**

(b) 1. **Droplets** increase surface areas (for lipase / enzyme action);
2. (So) fast<u>er</u> hydrolysis / digestion (of triglycerides / lipids);
3. **Micelles** carry fatty acids and glycerol / monoglycerides to / through membrane / to (intestinal epithelial) cell;

*1. Context is important*

*1. Reject micelles increase surface area*

*2. Ignore 'breakdown'*

*3. Ignore 'small enough'*

*3. Accept description of membrane*

*3. Reject any movement through membrane proteins*

**3**

(c) 1. <u>Golgi</u> (apparatus);
2. Modifies / processes triglycerides;
3. Combines triglycerides with proteins;
4. Packaged for release / exocytosis
**OR**
Forms vesicles;

*Ignore 'processes and packages' unqualified*

*2. Reject synthesises triglycerides*

*3. Accept 'forms / are lipoproteins'*

**4**

**[8]**

## Q9.

(a) 1. Macerate / homogenise / blend / break tissues / cells (in solution);
2. Centrifuge;
3. At different / increasing speeds until chloroplast fraction obtained;

*1. Accept any suitable method to break tissues / cells / release organelles*

*2. and 3. Allow 'perform differential centrifugation until chloroplasts obtained.' for 2 marks*

**3**

(b)

| Feature | Mitochondrion | Chloroplast |
|---|---|---|
| Double outer membrane | ✔ | ✔ |
| Starch grains | | ✔ |
| Diffusion of oxygen into the organelle | ✔ | |

*1 mark for each correct row*

*Crosses = blank space*

**3**

(c) The site of aerobic respiration (reactions)

**OR**
ATP is made / ADP is phosphorylated;
*Reject 'energy is produced'*

**1**

(d) 1. Training made **no** difference to number (of mitochondria per $\mu m^2$);
2. Training led to an increase in the area (of inner mitochondrial membrane);
*1. Accept **Graph 1** as mean number of mitochondria per $\mu m^2$*
*2. Accept **Graph 2** as area of inner mitochondrial membrane*

**2**

**[9]**

## Q10.

(a) 1. Cellulose is made up of β-glucose (monomers) **and** glycogen is made up of $\alpha$-glucose (monomers);
2. Cellulose molecule has straight chain **and** glycogen is branched;
3. Cellulose molecule has straight chain **and** glycogen is coiled;
4. glycogen has 1,4- and 1,6- glycosidic bonds **and** cellulose has only 1,4-glycosidic bonds;
*Ignore ref. to H bonds / microfibrils*

**2 max**

(b) Any **two** from:
1. Insoluble (in water), so doesn't affect water potential;
2. Branched / coiled / ($\alpha$-)helix, so makes molecule compact;
**OR**
Branched / coiled / ($\alpha$-)helix so can fit many (molecules) in small area;
3. Polymer of ($\alpha$-)glucose so provides glucose for respiration;
4. Branched / more ends for fast breakdown / enzyme action;
5. Large (molecule), so can't cross the cell membrane
*Require feature **and** explanation for 1 mark*
*1. Accept Ψ or WP*
*1. Accept Insoluble so doesn't affect osmosis*
*1. Do **not** allow ref to 'doesn't affect water leaving cells*
*4. Ignore 'surface area'*
*4. Accept 'branched so glucose readily released'*

**2 max**

(c) Iodine/potassium iodide;

**1**

(d) For correct answer of 40 (μm) award 2 marks;
Evidence of division by 500: award 1 mark
*Allow tolerance of 0.5mm i.e. 20±0.5mm*

**2**

(e) 1. Scanning electron (microscope);
2. 3D (image);
*Accept SE(M)*
*2. Ignore any other correct features*

**2**

**[9]**

## Q11.

(a) 1. Low starch, fewer copies;
2. Ranges overlap almost completely;
**OR**
Ranges overlap from 2 − 13 copies;
3. (surprisingly) very few / 2 or 3% have only 2 copies / are diploid;
4. the mode / highest percentage for low starch is 4 copies and for high starch is 6;
5. the range / spread is greater with high starch;

*4. "most people" is not equivalent to mode*

**3 max**

(b) 1. More mRNA / more transcription;
2. More translation / enzyme;
3. So reaction faster;

*The idea of "more" must be stated at least once.*

*2. Accept 'amylase' for enzyme*

*3. "More starch digested" is insufficient*

**3**

(c) 1. Mutation(s) produce extra copies of (*AMY1*) gene;
2. Those with more copies / this adaptation/mutation reproduce / survive better on high starch diet;
2. And pass on multiple copies / this adaptation/mutation (to offspring);

*Ignore ref. to single allele/gene*

**3**

**[9]**

## Q12.

(a) 1. Concentration of mineral ion/named mineral ion in soil;
2. Soil pH;
3. Temperature;
4. Light intensity / wavelength / duration;
5. Distance between seeds / plants;
6. Volume of water given;
7. $CO_2$ concentration;
8. Humidity;

*1 and 2. Allow 'growing solution' for 'soil'.*

*2. pH alone is insufficient.*

*3. Allow 'colour of light'*

*Reject 'amount' for mps 1, 4, 6 and 7.*

*Ignore $O_2$ concentration*

***Three correct = 2 marks***

***Two correct = 1 mark***

***One or none correct = 0 marks***

**2 max**

(b) 1. 2,4-D causes an increase in release of ions from wild oat cells **and** 2,4-D does not affect / has little effect on the release of ions from wheat cells;

2. (For wheat) Difference is less than LSD / 7 **so** <u>difference</u> is not significant;
**OR**
(For wild oats) Difference is more than LSD / 10 **so** <u>difference</u> is significant;
3. Loss of ions from cells (likely to) lead to cell / plant death/damage;
**OR**
Disruption of cell membrane (likely to) lead to cell / plant death / damage;
4. No evidence here about death of plants as a result of this ion loss;
5. No evidence here of other ecological/environmental impact;

*1. Accept reference to 'concentration of ions in water' or 'disruption of the cell membranes' in place of 'release of ions'*

*1. Accept 'difference in release of ions from wild oats is 25 **and** difference in release of ions from wheat is 1'*

*2. Accept '(For wheat) difference is less than LSD **so** greater than 5% probability that <u>difference</u> is due to chance'*

***OR***

*'(For oats) difference is more than LSD **so** less than 5% probability that <u>difference</u> is due to chance'*

*5. Accept 'development of resistance'*

**4 max**

(c) 1. (Maintain temperature) so that the rate of diffusion (of ions out of cells) remains constant
**OR**
(Maintain temperature) so no change in fluidity of phospholipids / kinetic energy of phospholipids;
**OR**
(Maintain temperature) so no change in shape / structure / denaturation of membrane proteins;
2. (Shaking) So all surfaces of the leaf discs are exposed (to water) / so all submerged;
**OR**
To maintain diffusion / concentration gradient (for ions out of leaf discs);

*1. Ignore references to rate of enzyme catalysed reactions*

*2. Accept 'so that leaf discs do not stick together'*

**2**

**[8]**

## Q13.

(a) 1. TEM use electrons **and** optical use light;
2. TEM allows a greater <u>resolution</u>;
3. (So with TEM) smaller <u>organelles</u> / <u>named cell structure</u> can be observed
**OR**
greater detail in <u>organelles</u> / <u>named cell structure</u> can be observed;
4. TEM view only dead / dehydrated specimens **and** optical (can) view live specimens;
5. TEM does not show colour **and** optical (can);
6. TEM requires thinner specimens;
7. TEM requires a <u>more</u> complex/time consuming preparation;
8. TEM focuses using magnets **and** optical uses (glass) lenses;

*3. 'clearer' is not equivalent to 'detail'*

*4. Accept 'Only optical can view live specimens'*

*5. Accept 'Only optical can show colour'*

*7. Accept 'TEM requires a more difficult preparation'*

*Ignore references to artefacts*

**6 max**

(b) 1. **W** has 4 cells / nuclei since it is at the (end of) 2nd division (of meiosis);
2. **Z** has 2 cells/nuclei since it is at the (end of) 1st division (of meiosis);
3. **W** shows haploid cells / cells containing n chromosomes;
4. (Cells in) **W** contain half the (mass of) DNA of (Cells in) **Z**;
**OR**
(between **Z** and **W**) chromatids have separated;
**OR**
In **Z** homologous chromosomes have separated;

*Ignore '**Z** shows diploid cells / contains 2n chromosomes'*

*4. Accept '**W** contains half the amount of DNA of **Z**'*

**4**

(c) 1. Use random sample of seeds (from each population);
2. Use (large enough) sample to be representative of whole population;
3. Indication of what size was measured e.g. mass;
4. Calculate a mean and standard deviation (for each population);
5. Use the (Student's) t-test;
6. Analyse whether there is a significant difference between (the means of) the two populations;

*1. Accept described, suitable method of random sampling.*

*1. Reject description of inappropriate method of random sampling (e.g. random coordinates in the field / use of quadrats)*

*2. Accept 'running mean does not change'*

*2. For representative accept 'reliable, reproducible, repeatable' **OR** a mean close to the true value.*

*5. Accept 'Use 95% confidence limits'*

*6. Reject unqualified references to results being significant*

**5 max**

**[15]**

## Q14.

(a) 1. (Nerve impulse / depolarisation of membrane) causes $Ca^{2+}$ channel (proteins) to open;
2. $Ca^{2+}$ enter by (facilitated) diffusion;
3. Causes (synaptic) vesicles to fuse with (presynaptic) membrane;

*Accept single reference to ions to cover 1 and 2*

*Penalise once for no reference to ions*

*1. Reject carrier proteins*

*3. Reject ref to release of vesicles*

*3. Ignore vesicles bind to membrane (but accept merge with)*

**3**

(b) 1. Myosin head attaches to actin **and** bends / performs powerstroke;

2. (This) pulls mitochondria past / along the actin;
3. Other / next myosin head attaches to actin (and bends / performs powerstroke);

*1. Accept change shape / change angle*

*2. Ignore pulls actin along*

*2. Ignore refs to cytoskeleon*

*Accept plural or singular statements*

**2 max**

(c) 1. (Mitochondria) supply (additional) ATP / energy;
2. To move vesicles / for active transport of ions / for myosin to move past actin
**OR**
Re-synthesis / reabsorption of neurotransmitter / named neurotransmitter;

*1. Reject produces energy*

*2. Ignore ref. to ATP for opening calcium ion channels/making vesicles fuse with membrane*

**2**

**[7]**

## Q15.

(a)

The bacteriophage has a capsid and the bacterium has a cell-surface membrane;



Third box down

*Reject if more than one box with tick. Ignore crossed-out ticks*

*Accept tick to right or left of correct box*

**1**

(b) Correct number of times between
13.0 / 12.96 **and** 13.9 / 13.92 scores 2 marks;
One mark if correct sizes in ranges of
150.7nm to 154.4nm / 0.151µm to 0.154µm
**and** 1953.5nm to 2097.6nm / 1.954µm to 2.098µm;

***Both** lengths required for 1 mark credit*

*Accept refs to 150 / 0.15 and 2000 / 2*

*Ignore number of sig fig*

**2**

(c) The bacteriophage makes no difference to the number of (living) bacteria / there will be no difference in the number of (live) bacteria in treated and untreated mice / there will be no difference in the number of (live) bacteria in A and B;

*Ignore no difference between mice*

**1**

(d) 1. Log scale (on graph) shows big range in number of bacteria
**OR**
Use of suitable data from log scale to give the range in number of bacteria;
2. Some samples too many to count (so dilute) but some countable (so don't dilute)

**OR**

Use of figures from graph relating to ease (or otherwise) of counting Example. 631 000 000 bacteria would be too big to count (without serial dilution), 100 000 bacteria is small enough to count;

*1 and 2* ***Do not*** *accept simple statements of* $log_{10}$ *values from graph*

*Look for answers in standard form*

***Group A***

*Mean between 79 million and 100 million*

*Range 4 million to 631 million*

***Group B***

*Mean between 100 thousand and 126 thousand*

*Range 3.98/4 up to 251 thousand*

**2**

(e) 1. (Bacteriophage) reduces number of bacteria;
2. (In all cases / mice because) ranges don't overlap;
3. But big range of effect/some mice a big reduction/a few mice with big falls in number

**OR**

Doesn't bring bacteria down to 0 in any / works for some (mice) but not for all;

*Do not accept just quotes of* $log_{10}$ *figures direct from graph*

*Ignore refs to significance*

*Range 3.98/4 up to 251 thousand*

*2. Reject ref to SD / SE*

**3**

**[9]**

## Q16.

(a) **B** Golgi (body / apparatus);

**C** Mitochondria / mitochondrion;

**2**

(b) 1. Chloroplasts / plastids

2. Cell wall

3. Cell vacuole

4. Starch grains / amyloplasts;

*Any* ***2*** *for* ***1*** *mark*

**1 max**

(c) 1. Ice-cold – Slows / stops enzyme activity to prevent digestion of organelles / mitochondria;

2. Buffered – Maintains pH so that enzymes / proteins are not denatured;

*Reject reference to cells*

3. Same water potential – Prevents osmosis so no lysis / shrinkage of organelles / mitochondria / **C**;

*Ignore damage*
*For each mark must link reason to relevant property*

3

(d) 1. Break open cells / homogenise / produce homogenate;

2. Remove unbroken cells / larger debris;

2

(e) Nucleus / nuclei;

1

(f) Mitochondria / organelle **C** less dense than nucleus / organelle in first pellet;
*Accept 'lighter' for less dense*

1

**[10]**

## Q17.

(a) × 20 000
*Accept range from 18 000 to 22 000*

1

(b)

| | |
|---|---|
| ✔ | |
| | |
| ✔ | |
| | ✔ |

*1 mark for each correct column*

2

(c) 1. DNA contains thymine **and** RNA contains uracil;

2. DNA contains deoxyribose **and** RNA contains ribose.

2

**[5]**

## Q18.

(a) Electron microscope has higher resolution (than optical microscope).

1

(b) Cytoplasm of red blood cell filled with haemoglobin.

1

(c) 1. Membrane has phospholipid bilayer;

2. Stain binds to phosphate / glycerol;

3. On inside and outside of membrane.
*Accept phospholipid head / protein*

3

(d) 1. Carrier / channel protein;

2. (Protein) specific / complementary to substance;

3. Substance moves down concentration gradient;

*Allow down electrochemical gradient*

*Reject 'along' concentration gradient*

**3**

**[8]**

## Q19.

(a) 1. Antigen / epitope on surface of *N. meninigitidis* / bacterium binds to surface protein / surface receptor on a (specific / single) B cell.

*If answered in context of T cell, allow Antigen binds to (specific / single) T cell*

2. (Activated) B cell divides by mitosis / produces clone;

*If answered in context of T cell, allow (Activated) T cell releases cytokine.*

3. (Division) stimulated by cytokines / by T cells;

*If answered in context of T cell, allow (Cytokine) stimulates production of plasma cells;*

4. B cells / plasma cells release antibodies;

5. (Some) B cells become memory cells;

6. Memory cells produce plasma / antibodies faster

**6**

(b) 1. Mutation

*Allow horizontal gene transfer*

2. Results in Nm cell with allele for resistance to <u>one</u> antibiotic / to named antibiotic

3. (This) cell survives <u>and</u> passes the allele for resistance to offspring;

*2. and 3. If gene for resistance, penalise once*

4. Process repeated with different genes conferring resistance to each of the other (two) antibiotics

*If reference made to 'resistant gene', 2 max for MP2, 3 and 4*

**4**

(c) Any **five** contrasting statements, e.g.

1. Bacterial cell is <u>much</u> smaller than a human cell;

2. Bacterial cell has a cell wall but human cell does not;

3. Bacterial cell lacks a nucleus but human cell has a nucleus;

4. Bacterial cell lacks <u>membrane-bound</u> organelles but human cell has membrane-bound organelles;

*Accept any named membrane-bound organelle*

5. Bacterial ribosomes smaller than human ribosomes / bacteria have 70S ribosomes whereas humans have 80S ribosomes;

6. Bacterial DNA is circular but human DNA is linear;

7. Bacterial DNA is 'naked' whereas human DNA is bound to histones / proteins

*Since contrast is required, both parts of each statement must be present to gain the mark.*

**5 max**

**[15]**

## Q20.

(a) 1. How to break open cells <u>and</u> 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) $\left(\frac{length\ of\ chloroplast}{length\ of\ bar}\right)$ µm

**1**

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

**1 max**

**[7]**

## Q21.

(a) 1. Starch formed from α-glucose but cellulose formed from β-glucose;
2. Position of hydrogen and hydroxyl groups on carbon atom 1 inverted.

**2**

(b) 1. Insoluble;
2. Don't affect water potential;

***OR***

3. Helical;

*Accept form spirals*

4. Compact;

***OR***

5. Large molecule;
6. Cannot leave cell.

**2**

(c) 1. Long and straight chains;
2. Become linked together by many hydrogen bonds to form fibrils;
3. Provide strength (to cell wall).

3

[7]

## Q22.

(a) 1. (If injected into egg), gene gets into all / most of cells of silkworm;
2. So gets into cells that make silk.

2

(b) 1. Not all eggs will successfully take up the plasmid;
2. Silkworms that have taken up gene will glow.

2

(c) Promoter (region / gene).

1

(d) 1. So that protein can be harvested;
2. Fibres in other cells might cause harm.

2

[7]

## Q23.

(a) 1. Add drop of water to (glass) slide;
2. Obtain thin section (of plant tissue) and place on slide / float on drop of water;
3. Stain with / add iodine in potassium iodide.

*3. Allow any appropriate method that avoids trapping air bubbles*

4. Lower cover slip using mounted needle.

4

(b) 1. **W** – chloroplast, photosynthesis;
2. **Z** – nucleus, contains DNA / chromosomes / holds genetic information of cell.

2

(c) 1. High resolution;
2. Can see internal structure of organelles.

2

(d) Length of bar in mm × 1000.

1

[9]

## Q24.

(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 short**er**' or 'DNA bigg**er**/long**er**'*

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**

**[8]**

## Q25.

(a) 1. From ADP and phosphate;

*Accept* $Pi/PO_4^{3-}$ / (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

*Magnification = image size / Object size*

*(Large number divided by 4)*

**2**

**[8]**

## Q26.

(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**

**[7]**

## Q27.

(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**

**[7]**

## Q28.

(a)

| | |
|---|---|
| Protein synthesis | **L;** |
| Modifies protein | **H;** |
| Aerobic respiration | **N;** |

**3**

(b) 1800−2200;

*1.8, 2.0 or 2.2 in working or answer = 1 mark.*

*Ignore units in answer.*

1 mark for an incorrect answer in which student clearly divides measured length by actual length (of scale).

*Accept I / A or I / O for 1 mark but ignore triangle.*

*Accept approx 60mm divided by 30μm for 1 mark*

**2**

**[5]**

## Q29.

(a) 1. Large / dense / heavy cells;
2. Form pellet / move to bottom of tube (when centrifuged);
3. Liquid / supernatant can be removed.

*Must refer to whole cells.*

**3**

(b) Break down cells / cell parts / toxins.

*Idea of 'break down / digestion' needed, not just damage*

**1**

(c) 1. To stop / reduce them being damaged / destroyed / killed;

*Reject (to stop) bacteria being denatured.*

2. By stomach acid.

*Must be in context of stomach.*

**2**

(d) 1. More cell damage when both present / A;

2. Some cell damage when either there on their own / some cell damage in B <u>and</u> C;

*MP1 and MP2 − figures given from the graph are insufficient.*

3. Standard deviation does not overlap for A with B <u>and</u> C <u>so</u>

difference is real;

*MP3 and MP4* ***both*** *aspects needed to gain mark.*

4. Standard deviations do overlap between B and C so no real difference.

*MP3 and MP4 accept reference to significance / chance for 'real difference'*

**3 max**

(e) 1. Enzyme (a protein) is broken down (so no enzyme activity);

*Accept hydrolyse / digested for 'broken down'.*

2. No toxin (as a result of protein-digesting enzyme activity);

*Must be in the correct context.*

3. (So) toxin is protein.

*This must be stated, not inferred from use of 'protein−digesting enzyme'.*

**3**

**[12]**

## Q30.

(a) 1. Bilayer;

*Accept double layer*

*Accept drawing which shows bilayer*

2. Hydrophobic / fatty acid / lipid (tails) to inside;

3. Polar / phosphate group / hydrophilic (head) to outside;

*2. & 3. need labels*

*2. & 3. accept water loving or hating*

**2 max**

(b) (i) 1. (Rough endoplasmic reticulum has) ribosomes;

*accept "contains / stores"*

2. To make protein (which an enzyme is);

*Accept amino acids joined together / (poly)peptide*

*Reject makes amino acids*

*Ignore glycoprotein*

**2**

(ii) (Golgi apparatus) modifies (protein)

**OR**

packages / put into (Golgi) vesicles

**OR**

transport to cell surface / vacuole;

*Accept protein has sugar added*

*Reject protein synthesis*

*Accept lysosome formation*

**1**

**[5]**

## Q31.

(a) *QWC*

1. (Phagocyte engulfs) to form vacuole / vesicle / phagosome;
   *Accept surrounds bacteria with membrane*
2. Lysosome empties contents into vacuole / vesicle / phagosome;
   *Accept joins / fuses*
3. (Releasing) enzymes that digest / hydrolyse bacteria;
   *Ignore breakdown / destroy / lytic enzymes*

**3**

(b) Two suitable structures;;

Examples,

1. Cell wall;
2. Capsule / slime layer;
3. Circular DNA;
   *Reject "circular chromosome"*
4. Naked DNA / DNA without histones;
5. Flagellum;
6. Plasmid;
7. Pilus;
8. 70s / smaller ribosomes;
9. Mesosome;

**2 max**

**[5]**

## Q32.

(a) (i) **(Whole-cell vaccine),**

*Accept converse statements for other vaccine*

*Reject references to the vaccine being alive or the disease reproducing etc*

1. Heat(ing) supposed to kill bacteria;
2. Some might be alive / active / viable;
   *Accept active pathogens present*
3. (If so) bacteria could reproduce;

4. Bacterium makes or contains toxin;

5. Toxin might not be affected / all destroyed by heat;

6. Bacteria or toxins attacking / killing person's cells;

**3 max**

(ii) **(Whole-cell vaccine),**

*Ignore references to more / greater antigens unqualified. It is the variety of antigens that matters*

1. (Contains) many different / greater range of antigens;

2. Each antigen causes its own immune response / production of / has a specific (type of) antibody;

**2**

(b) 1. Only patients who had whooping cough have toxin / antibody / immune response;

*Accept converse e.g. those without antibody had another disease*

2. Toxin is an antigen and is (only) produced by this bacterium;

3. Leading to presence of specific antibody / only 4% had this antibody / 13% did not have antibody;

**3**

(c) 1. There may not be large rises;

2. Might be the result of wrong diagnosis / reference to difference in figures / 13% diagnosed with whooping cough didn't have it;

*Ignore reference to new strains or antigenic variability*

**2**

**[10]**

## Q33.

(a) 1. **A**: phospholipid (layer);

*1. Reject hydrophobic / hydrophilic phospholipid*

2. **B**: pore / channel / pump / carrier / transmembrane / intrinsic / transport protein;

*2. Ignore unqualified reference to protein*

**2**

(b) (i) Condensation (reaction);

**1**

(ii) Organelle named; Function in protein production / secretion;

*Function must be for organelle named*

*Incorrect organelle = 0*

eg

1. Golgi (apparatus);

*1. Accept smooth endoplasmic reticulum*

2. Package / process proteins;

***OR***

3. Rough endoplasmic reticulum / ribosomes;
   *3. Accept alternative correct functions of rough endoplasmic reticulum. ER / RER is insufficient*
   *3. Accept folding polypeptide / protein*

4. Make polypeptide / protein / forming peptide bonds;

***OR***

5. Mitochondria;

6. Release of energy / make ATP;
   *6. Reject produce / make energy*
   *6. Accept produce energy in the form of ATP*

***OR***

7. Vesicles;

8. Secretion / transport of protein;

**2**

**[5]**

## Q34.

(a) (i) Substance that causes an immune response / production of antibodies;
*Ignore foreign / non-self*

**1**

(ii) 1. Not lipid soluble;

2. Too large (to diffuse through the membrane);

3. Antigens do not have the complementary shape / cannot bind to receptor / channel / carrier proteins (in membranes of other epithelial cells);

**2 max**

(b) 1. (Vaccine contains) antigen / attenuated / dead pathogen;
*1. Reject if in context of injection of vaccine*

2. T-cells activate B-cells;

3. B-cells divide / form clone / undergo mitosis;

4. Plasma cells produce antibodies;

5. Memory cells produced meaning more antibodies / antibodies produced faster in secondary response / on reinfection;

**5**

**[8]**

## Q35.

(a) (i) (Aerobic) respiration;

*Accept ATP production / energy release*

*Reject <u>anaerobic</u> respiration*

*Reject energy production*

**1**

(ii) Golgi (apparatus / body);

*Ignore smooth ER*

**1**

(b) ('It' = Optical microscope)

*Ignore reference to magnification*

1. Has low resolution / not high enough resolution;

*Accept converse relating to EM*

2. (Because) wavelength of light not short enough / too long;

*Accept larger wavelength*

*Accept statements that microscopes have a wavelength*

**2**

**[4]**

## Q36.

(a)

| Statement | Starch | Cellulose | Glycogen |
|---|---|---|---|
| Found in plant cells | ✓ | ✓ | |
| Contains glycosidic bonds | ✓ | ✓ | ✓ |
| Contains β-glucose | | ✓ | |

*One mark for each correct row*

**3**

(b) Hydrolysis;

*Accept: if phonetically correct*

*Do not accept: 'hydration'*

**1**

(c) 1. Coiled / helical / spiral;

*Feature = one mark*

*Explanation = one mark*

*Note: these are independent marking points*

*These must be related for <u>both</u> marks but can be in reverse order*

2. (So) compact / tightly packed / can fit (lots) into a small space;

3. Insoluble;

4. (So) no osmotic effect / does not leave cell / does not affect water potential;

*Accept: prevents osmosis*

5. Large molecule / long chain;

6. (So) does not leave cell / contains large number of glucose units;

*4. and 6. Accept: can't cross membranes*

7. Branched chains;

8. (So) easy to remove glucose;

**2 max**

(d) Two marks for correct answer of 479 - 521;

*Accept: measured and actual lengths in different but correct units for 1 mark*

One mark for incorrect answers in which candidate clearly divides measured length by actual length;

*The actual range is 23 - 25mm, If they just divide this by 48 they gain 1 mark*

*Just writing the formula is insufficient, numbers must be used*

**2**

**[8]**

## Q37.

(a) (i) Golgi (apparatus / body);

**1**

(ii) 1. Nucleus;

*Accept: nucleolus / nuclear envelope / nuclear membranes*

2. Mitochondrion;

*Accept cristae / mitochondrial membranes*

3. Endoplasmic reticulum / ER;

*Ignore reference to rough / smooth*

4. Lysosome;

*Reject lysozyme*

**2 max**

(b) (Aerobic) respiration / ATP production / provide energy;

*Accept Krebs cycle / electron transport.*

*Ignore 'produces energy'*

*Reject anaerobic respiration*

*Ignore what energy is used for*

**1**

(c) 1. High / better resolution;

2. Shorter wavelength;

3. To see internal structures / organelles / named organelles;
*Accept ultrastructure*

**2 max**

**[6]**

## Q38.

(a) 1. Mitochondria respire to release energy / produce ATP;
*1. Do not credit make energy*

2. Transport against gradient;
*2. Do not credit active transport as this is given in question.*
*2. Do not accept diffusion against.*

***OR***

3. Infolding of membrane increases area;
*3. Reject microvilli but if mentioned can still accept point 4.*

4. More proteins for active transport;

**2 max**

(b) 1. Ribosomes make proteins / enzymes;
*Ignore references to Golgi or rough ER.*

2. Enzymes are proteins;

***OR***

3. Mitochrondria respire;

4. Release energy / produce ATP;

5. (Energy / ATP) for protein / enzyme synthesis;

**2**

(c) Microvilli increase area / have large area;
*Ignore references to other properties of microvilli.*

**1**

**[5]**

## Q39.

(a) 1. Granum / grana / thylakoid;
*Ignore references to membranes, stacks or discs.*

2. Stroma;
*Allow phonetic spellings.*

**2**

(b) 1. Absorbs / traps / uses light;
*Light dependent reaction = marking point 1.*

2. For photosynthesis;

3. Produces carbohydrates / sugars / lipids / protein;

*Accept any named product of photosynthesis for marking point 3.*

*Reference to light dependent and light independent reactions = two marks*

**2 max**

(c) Correct answer in range of 2.53 - 2.66;

Any length divided by 30000 = 1 mark;

**2**

**[6]**

## Q40.

(a) (i) (Human cells) don't have a cell wall;

*Accept "they" refers to human cells.*

**1**

(ii) (Affects) protein synthesis;

*Allow description e.g. 'amino acids not joined together / translation.*

*Reject: affects transcription.*

**1**

(b) 1. Mutation present / occurs;

*Ignore antibiotic causes mutation.*

2. Resistance gene / allele;

*1. or 2.*

*Reference to immunity disqualifies first credited marking point.*

3. Resistant bacteria (survive and) reproduce;

*Reference to mitosis negates marking point 3.*

**2**

**[4]**

## Q41.

(a) Cell wall;

Starch (store);

Chloroplast;

*Accept: phonetic spelling*

**2 max**

(b) Insoluble;

Reduces / 'stops' water entry / osmosis / does not affect water potential / is osmotically inactive;

*Accept: description for first point e.g. 'does not dissolve'.*

**2**

(c) Light sensitive eyespot / eyespot detects light;

Flagellum enables movement towards light;

Chloroplast / chlorophyll absorbs light / for photosynthesis;

*Do not penalise references to 'many chloroplasts'.*

**3**

**[7]**

## Q42.

(a) (Plasma / cell) membrane;

*Reject: nuclear membrane*

**1**

(b) Nucleus / nuclear envelope / nuclear membrane / nucleolus;

*Accept: membrane-bound organelles only if an example has not been given*

Mitochondrion;

(Smooth / rough) ER;

Lysosome;

Microvillus / brush border;

*Neutral: villi*

Golgi;

Linear / non-circular DNA / chromosome;

*Neutral: DNA strands*

80S / denser / heavier / larger ribosomes;

*Neutral: ribosomes*

**2 max**

(c) (i) Higher resolution / higher (maximum) magnification / higher detail (of image);

***OR***

Allows internal details / structures within (cells) to be seen / cross section to be taken;

*Accept: 'better' instead of 'higher'*

*Neutral: shorter wavelength*

*Reject: longer wavelength*

*Reject: can be used on living specimens*

***Q** Do not accept 'clearer' image*

**1**

(ii) Thin sections do not need to be prepared / shows surface of specimen / can have 3-D images;

*Accept: can be used on thick(er) specimens*

*Reject: can be used on living specimens*

*Neutral: refs. to staining / preparation / artefacts / colour*

**1**

(d) Two marks for correct answer of 0.42 – 0.46;;

One mark for incorrect answers in which candidate clearly divides measured width by magnification;

*Correct answer = 2 marks outright*

*Accept: 0.4 or 0.5 only if working is correct for 2 marks*

*Do not award a mark for 0.4 or 0.5 if there is no working out*

*Ignore rounding up*

**2**

(e) As height increases, the number of deaths decrease / inversely proportional / negative correlation;

Correct reference to increase / decrease at 14-30m;

*Accept: converse statement*

*Must give a trend and not simply give individual points*

*Do not penalise for 'more likely to get cholera'*

**2**

**[9]**

## Q43.

(a) Peptide;

***Q** Do not accept polypeptide*
*Neutral: covalent*

**1**

(b) (F) H J E (K);

*All three boxes correct = 2 marks*
*Two boxes correct = 1 mark*

**2**

(c) (Site of aerobic) respiration;

Release ATP / energy for active transport / transport against the concentration gradient / protein synthesis / exocytosis;

***Q** Reject: anaerobic respiration*

***Q** Reject: produces / makes energy*

*Accept: produces ATP for energy*

*Reject: produces ATP for respiration*

*Neutral: protein secretion*

**2**

(d) (i) Breaks open cells / disrupts cell membrane / releases cell contents / releases organelles / break up cells;

*Reject: breaks down cell wall*

*Neutral: separates the cells*

*Reject: breaks up cells so they can be separated*

*Reject: breaks up / separates organelles*

**1**

(ii) Removes (cell) debris / complete cells / tissue;

*Neutral: to isolate organelle **G** / mitochondria*

*Neutral: removes unwanted substances / impurities*

*Reject: removes organelles / cell walls*

**1**

(iii) Reduces / prevents <u>enzyme</u> activity;

*Reject: ref. to denaturation*

**1**

(iv) Prevents osmosis / no (net) movement of water / water does not enter organelle / water does not leave organelle;

So organelle / named organelle is not damaged / does not burst / does not shrivel;

*Neutral: ref. to water potential*

***Q** Ref. to cells rather than organelles negates the second mark only*

*Reject: ref. to turgid / flaccid for second mark*

*Reject: organelle 'explodes' for second mark*

**2**

**[10]**

## Q44.

Fatty acids used to make phospholipids;
Phospholipids in membranes;
More phospholipids more membranes made;

**2 max**

Fatty acids respired to release energy;
More triglycerides more energy released;
Energy used for cell production / production of named cell component;

*Do not allow credit for 'making' energy*

**2 max**

**[4]**

## Q45.

(a) (i) Mitochondrion;

*Neutral: cristae*

**1**

(ii) (Site of aerobic) respiration / ATP production / energy release;

***Q** Reject: anaerobic respiration*

***Q** Reject: energy produced*

Active transport / transport against the concentration gradient;

*Accept: energy produced in the form of ATP*

**2**

(b) 89 – 91 gains 2 marks;

*Correct answer gains 2 marks outright*

Principle of:

$\frac{\text{correct measured length}}{\text{magnification}}$ gains 1 mark;

*89-91 (mm) / 1000 or 8.9-9.1 (cm) / 1000 gains 1 mark*

**2**

(c) Suitable explanation given e.g.

*Accept: converse arguments*

Reduced surface area; (So) less absorption;

*Neutral: structure **Z** incorrectly named*

(Membrane-bound) enzymes less effective;
(So) proteins / polypeptides not digested;

*Reduced surface area for absorption gains 2 marks*

Cell membranes damaged;
(So) Fewer / less effective carrier / channel proteins;

*Accept: references to diffusion and active transport for 'absorption'*

Carrier / channel proteins damaged;
(So) less absorption;

*Reject: active transport if linked to channel proteins*

**2**

**[7]**

## Q46.

(a) Differentiation / specialisation

**1**

(b) (i) (cellulose) Cell wall;

**1**

(ii) Two marks for correct answer 2350–2500;;

*Accept measured and real lengths in different units for one mark.*

One mark for a measured length divided by real length;

**2**

(iii) Chloroplasts absorb light;

***Q** Do not accept chlorophyll as alternative to chloroplasts*

Or

Large vacuole pushes chloroplasts to edge (of cell);

Or

Thin / permeable (cell) wall to absorb carbon dioxide;

**1 max**

**[5]**

## Q47.

(a) (i) Crista / inner membrane;

1

(ii) Matrix;

1

(b) B;

1

(c) (i) Reduce / prevent enzyme activity;

1

(ii) Prevents osmosis / no (net) movement of water;

So organelle / named organelle does not burst / shrivel;

***Q*** *Allow reference to cell rather than organelle for first mark point only.*

*Regard damage as neutral*

2

(d) (Mitochondria) use aerobic respiration;

Mitochondria produce ATP / release energy required for muscles (to contract);

***Q*** *Do not accept reference to making / producing energy.*

2

**[8]**

## Q48.

(a) Nucleus;

1

(b) Enables organism to remain in area (of food source) / prevent its removal;

***Q*** *'To attach' is not sufficient unless qualified*

1

(c) (i) Correct answer of 222(%);;

Incorrect answer that clearly identifies difference in number of cases as 5800 –1800 or 5.8 – 1.8;

*Correct answer gains two marks*

2

(ii) More water-related activities / more 'organisms' with increased temperature;

***Q*** *Allow any reference to growth or replication of 'organisms'. Do not penalise reference to bacteria.*

***Q*** *Do not allow increase in water consumption.*

1

(d) (i) All have same shape / only binds to *Giardia* / one type of / specific antigen;

1

(ii) Has complementary (shape) / due to (specific) tertiary structure / variable region (of antibody);

***Q*** *Binds / fits not sufficient unless qualified;*

1

(iii) Enzyme / second antibody would remain / is removed by washing;

Enzyme can react with substrate (when no antigen is present);

**2**

**[9]**

## Q49.

(a) (Group of) similar / identical cells / cells with a common origin;

***Q*** *Ignore references to function*

**1**

(b) (i) Add iodine / stain specific for starch to the slide / cells / tissue / add iodine / stain specific for starch and examine under microscope;

Blue-black / blue / black / purple;

*Reject sample*

**2**

(ii) Need a single layer of cells / only a few cells thick / not too many layers / detail obscured by cells underneath;

Light must be able to pass through;

**2**

(c) Both are polymers / made of monomers;

Joined by condensation / molecules can be broken down by hydrolysis;

Both have 1-4 links;

Contain C(arbon), H(ydrogen) and O(xygen) / both made up of glucose;

Both insoluble;

Both contain glycosidic bonds;

*Accept other valid answers.*
*Ignore ref to unbranched.*

**2 max**

**[7]**

## Q50.

Advantages:

1 Small objects can be seen;

2 TEM has high resolution as wavelength of electrons shorter;

*Accept better*

Limitations:

3 Cannot look at living cells as cells must be in a vacuum / must cut section / thin specimen;

4 Preparation may create artefact

5 Does not produce colour image;

**[5]**

## Q51.

(a) (i) no cell wall / only has (plasma) membrane;

**1**

(ii) has capsule / slime layer;

**1**

(b) correct approach which makes use of scalebar; *ignore* reference to units.

**1**

(c) cellulose / starch / amylose / amylopectin;

**1**

(d) (i) <u>water potential</u> lower / more negative in cell;
(water enters by) <u>osmosis</u>;

**2**

(ii) plant cell wall made of a different substance / cellulose / penicillin does not affect cellulose;

**1**

**[7]**

## Q52.

(a) (i) Chloroplast;

**1**

(ii) Photosynthesis;

Uses light (energy);

To produce carbohydrates / starch / glucose / sugars / ATP / reduced NADP;

*Note that candidates cannot be expected to have a detailed knowledge of photosynthesis.*

**max 2**

(b) (i) **A**;

**1**

(ii) **C**;

**1**

(c) (i) Slows enzymes / prevents enzymes being denatured / prevents / stops self-digestion;

*Ignore references to bacteria. Reject enzymes not working*

**1**

(ii) To remove organelle C / nuclei;
Which are larger / more dense;

**2**

**[8]**

## Q53.

(a) Measure diameter of field <u>with</u> ruler; And proportion taken up by the cell; or Measure length with (eyepiece) graticule / eyepiece scale;
Calibrated against stage micrometer / something of known length;

*Reject divide apparent length by magnification*

**2**

(b) Membrane / cytoplasm shrinks / pulls away from cell wall / cell plasmolysed / goes flaccid; Water moves down water potential gradient / to lower / more negative water potential; By osmosis;

**3**

(c) (i) Reaches equilibrium / no further / maximum change in length;

*Reject osmosis takes time*

**1**

(ii) Line / curve of best fit; Extrapolate (and read off) / find where it crosses x-axis;

**2**

(iii) Greater decrease / length smaller; More water removed;
Greater difference in water potential / cell with higher / less negative water potential; Starch is insoluble / has no effect on osmosis

**max 2**

**[10]**

## Q54.

(a) presence of nuclei;

**1**

(b) (i) 1 mark growth clearly calculated from difference between lengths at beginning and end of lesson

2 marks correct answer of 300 µm

**2**

*(Allow for slight measurement errors)*

(ii) <u>divide</u> by time (between measurements);

**1**

(c) blue-black / dark blue / purple / black;
iodine added to slide / specimen / granules;

**2**

**[6]**

## Q55.

(a) removes debris / intact cells / sand;
which would contaminate sediment A / interfere with the results;

**2**

(b) (i) nuclei;

**1**

(ii) ribosomes / endoplasmic reticulum / membrane / Golgi;

**1**

(c) density / size / mass / weight;

1

(d) an electron microscope has a higher resolution;
electrons with shorter wavelength;

2

[7]

## Q56.

(a) Any two from:

| | |
|---|---|
| Loop of DNA; | Non-cellulose cell wall; |
| Plasmid; | Capsule; |
| Flagellum; | Mesosome; |

*Accept small ribosomes*

2

(b) (i) (Granules) turn blue-black / dark blue / black / purple with iodine;

1

(ii) Cellulose / pectin;

1

(c) Use principle:
Feature of starch;
Consequence in terms of storage;
e.g.
Insoluble;
Therefore will not "wash" out of cell / affect water potential / affect osmosis;
OR
Molecule coiled / branched;
Therefore large amount stored in small space / compact
OR
Does not affect water potential;
So no effect on entry of water (into cell);

2

[6]

## Q57.

(a) (i) Mitochondria site of respiration;
Production of ATP / release of energy;
For contraction;

*Do not award credit for making or producing energy.*

3

(ii) Enzymes are proteins;
Proteins synthesised / made on ribosomes;

2

(b) Lysosomes produce / contain enzymes;
Which break down / hydrolyse proteins / substances / cells of tail;

2

(c) 1. Chop up (accept any reference to crude breaking up);
2. Cold;
3. Buffer solution;

4. Isotonic / same water potential;
5. Filter and centrifuge filtrate;
6. Centrifuge supernatant;
7. At higher speed;
8. Chloroplasts in (second) pellet;

**max 6**

**[13]**

## Q58.

(a) (i) Golgi;

**1**

(ii) Exocytosis;

**1**

(b) (i) Joining together of amino acids / synthesis / production of thyroglobulin / makes protein;

*Do not credit synthesis of amino acids*

**1**

(ii) Electron microscope has high / greater resolution;
Because it uses electrons which have smaller wave(length);

**2**

**[5]**

## Q59.

(a) Epithelium of alveolus, capillary wall / epithelium / endothelium, plasma;

**1**

(b) Cell wall;
Capsule;
Flagellum;
Mesosomes;
Plasmid;
Genetic material / DNA / nucleoid;
Ribosomes;

*Accept references to size only if some idea of range is given*

**max 2**

(c) Large (surface) area;
For diffusion;
or
Short distance to centre of cell / to all haemoglobin;
For diffusion;

**2**

(d) (i) Correct answer of approximately 7800 / 8000 = 2 marks
Incorrect answer but clearly derived by
dividing diameter of cell A by 7 = 1 mark

**2**

(ii) Idea of cut through maximum diameter / middle;

**1**

**[8]**

## Q60.

(a) (i) 31 / 31.2;

**1**

(ii) Ratio would be less / smaller;
Cell is thin / has large surface area / (adapted) for diffusion;
*Accept converse. Must relate to concept of ratio.*

**2**

(b) (i) 6;

**1**

(ii) 11;

**1**

(c) Water potential inside vesicle more negative / lower;
Water moves into vesicle by osmosis / diffusion;

**2**

(d) Mitochondria supply energy / ATP;
For active transport / absorption against concentration gradient / synthesis / anabolism / exocytosis / pinocytosis;
*Do not credit references to making, creating or producing energy.*

**2**

(e) 1 Phospholipids forming bilayer / two layers;
2 Details of arrangement with "heads" on the outside;
3 Two types of protein specified;
e.g. passing right through or confined to one layer /
extrinsic or intrinsic /
channel proteins and carrier proteins /
two functional types
4 Reference to other molecule e.g. cholesterol or glycoprotein;
5 Substances move down concentration gradient / from high to low concentration;
*Reject references to across or along a gradient*
6 Water / ions through channel proteins / pores;
7 Small / lipid soluble molecules / examples pass between phospholipids / through phospholipid layer;
8 Carrier proteins involved with facilitated diffusion;
*Ignore references to active transport.*
*Credit information in diagrams.*

**max 6**

**[15]**

## Q61.

(a) <u>On diagram, correctly labelled:</u>

Light-dependent: granum / thylakoid membranes – labelled 'X'
AND
Light-independent: stroma – labelled 'Y';

**1**

(b) <u>Any two from:</u>

(Water) forms $H^+$ / hydrogen ions and electrons / $e^-$ ;

$O_2$ / oxygen formed; [*NOT* 'O', *NOT* '$O^-$']

(Light) excites electrons / raises energy level of electrons / electrons to chlorophyll / to photosystem;

**max 2**

(c) (ATP) Provides energy for GP → TP / provides P for RuP / TP → RuBP;

(Reduced NADP) Provides H / electrons for GP → TP / reduces GP to TP;

**2**

**[5]**

## Q62.

(a) (i) A mitochondrion and B nucleus;
*(need both for one mark)*

**1**

(ii) increased surface area;
for respiration / enzymes;

**2**

(b) *any suitable feature*
e.g. plasmid / capsule / 70S ribosomes / smaller ribosomes / complex cell wall / mesosome / no nucleus;

**1**

(c) use of differential centrifugation / or description;
first / low-spin pellet discarded / spin at low speed to remove cell wall material / cell debris;
supernatant re-spun at higher speed / until pellet with chloroplasts is found;
method of identifying chloroplasts e.g. microscopy;

**3 max**

**[7]**

## Q63.

(a) 16 gains 2 marks;

*(accept 15.5 . 16.5)*

*(principal of calculation i.e.*
$\frac{\text{measured distance (31-33mm / 3.1-3.3cm)}}{\text{Mag}}$ *gains 1 mark)*

**2**

(b) relevant adaptation;
and explanation for second mark; e.g.

*idea of* many chloroplasts / lots of chlorophyll;
to trap or absorb light (energy);

elongated cells;
*idea of* maximum light absorption / light penetration;

chloroplasts move;
to trap or absorb light (energy);

range of pigments;
can absorb a range of wavelengths / colours / for max light absorption;

large S.A. or cell wall feature e.g. thin / permeable;
for (rapid) $CO_2$ absorption;

**2**

**[4]**

## Q64.

(a) (i) **D** plasmid / ribosome(s) / cytoplasm / storage granules;
*(accept any sensible structure)*

**E** (slime / mucous) capsule

*OR*

slime / mucous layer;

**2**

(ii) protection / maintain shape / prevent lysis / strength / support;

**1**

(b) two of the following:
nucleus;

OR

nuclear envelope / mitochondria / chloroplasts / sER / rER /
golgi apparatus / 80s ribosomes

linear <u>DNA</u> / chromosomes / lysosomes / vacuole / vescicles /
<u>cellulose</u> cell wall;

**2 max**

(c) (i) <u>starch</u> digested / broken down;
by amylase / carbohydrase;

**2**

(ii) any sensible suggestion e.g. no secretion of amylase /
functional amylase /
piece of fungus might have died;
*(accept carbohydrase / enzyme for amylase)*
*(reject "no digestion" without qualification)*

**1**

**[8]**

## Q65.

(a) matrix;

**1**

(b) pyruvate;
ADP;
P / inorganic phosphate;

reduced NAD;
oxygen;

**2 max**

(c) larger surface area for electron carrier system / oxidative phosphorylation; provide ATP / energy for contraction;

**2**

**[5]**

## Q66.

(a) (i) homogeniser / blender / pestle and mortar / description e.g. grind with sand;

**1**

(ii) centrifuge / description e.g. spin at high speeds;

**1**

(b) (i) chloroplast;

**1**

**[3]**

## Q67.

(a) X protein synthesis / translation;
Y movement;

**2**

(b) (i) cytoplasm;
ribosomes;
phospholipid membranes / cell membrane / semipermeable membrane;
*(accept folded membrane for two marks)*

**2 max**

(ii) *(it = bacterium)*
cell wall;
capsule;
flagellum;
mesosome;
no nucleus / nuclear membrane / DNA free;
no mitochondria;
*(accept 'no membrane-bound organelles' if neither nucleus nor mitochondria mark scored)*

no microvilli;
no Golgi;
no ER;
70S / smaller ribosomes;

**2 max**

**[6]**

## Q68.

(a) chloroplast, so cell photosynthesises and moves to optimum / best light intensity for photosynthesis;
avoids damage due to bright light;

2

(b) (i) 2700

1

(ii) $\frac{242 \times 7500 \times 900}{60}$ = 27 225 000 / 27 × $10^6$ = *2 marks*

*(allow 1 mark for principle:* $\frac{amino\ acids \times proteins}{time}$ *)*

2

(c) (i) rate slightly slower / not affected in first 20 / 30 minutes / lower peak than control;
then decreases / much lower (than control);

*(allow 1 mark for increase in first 20 / 30 minutes, then decreased, if not compared with control / normal)*

*(disqualify flagellum grows longer)*

2

(ii) 1. actinomycin has no effect (on growth of flagella);
even though mRNA production / transcription prevented;

*(accept references to 'expt 1')*

2. (re)growth little affected by puromycin at first;
protein synthesis inhibited, so likely to be using proteins present;

4

**[11]**

## Q69.

(a) A mitochondria;
B ribosomes (*accept ribosomes and rER*)

2

(b) idea of sections or cuts;
idea of mitochondria orientated differently or in different positions / description of 3D structure of mitochondria, e.g. sausage-shaped;

2

(c) translation / protein / polypeptide synthesis;

1

(d) provide / produce energy or ATP (*reject create energy*);
(*disqualify first mark if* '*for respiration*')
high respiration (rate) (*accept lots*) for active uptake / transport (*accept description*);
absorption of digested food / substances / products / correctly named product

*(only accept monosaccharides, amino acids, dipeptides);*

3

**[8]**

## Q70.

(a) A – granum / thylakoid;
chlorophyll molecules to trap light / light absorbing pigments / light dependent reaction / part of light dependent reaction;

2

B – stroma;
(contains enzymes for) carbon dioxide fixation / light-independent reaction / part of light-independent reaction;
*(allow ribosome role of protein in photosynthesis)*

**2**

(b) (i) C – starch;

**1**

(ii) from glucose in a condensation / polymerisation reaction / many glucose molecules joined together;

**1**

**[6]**

## Q71.

(i) named organelle e.g. nucleus / nuclear envelope; vacuole; chloroplast; RER; mitochondrion; no membrane bound organelles;
*(only award if no organelles named)*
*(reject ribosomes, cell membrane, cell wall)*

ref to large(r) size

**2 max**

(ii) $94/95/96 \times \frac{10}{44/45/46} \frac{(\text{measured distance } \mathbf{Y} - \mathbf{Z})}{\text{lenght of scale bar}}$

20.4 – 21.8
*(correct answer 2 marks)*

**2**

(iii) no cell wall (permanent) / (large) vacuole / chloroplasts / smaller;
*(accept microvilli)*

**1 max**

**[5]**

## Q72.

(a) memory B / T cells do not recognise (new antigens);
antibodies previously produced are not effective
as shape not complementary to new antigen;

**2**

(b) (i) antigen in membrane presented to lymphocytes / produce cytokinins;

**1**

(ii) mitochondria provide (more) ATP / energy;
(more) RER / ribosomes synthesise proteins;
(more) Golgi body secretes / modifies or packages proteins / produces glycoproteins;
(B lymphocytes) produces antibodies;

**4**

**[7]**

## Q73.

(a) (i) microvilli; (*reject brush border*)

1

(ii) increased surface area (for diffusion);

1

(b) (i) $\frac{16 \times (1000)}{0.1}$; principle of $\frac{\text{measuring scale bar}}{\text{dividing by 0.1}}$;

*(15 –17 tolerance)*

160000;

*(correct answer award 2 marks)*

2

(ii) electron microscope has a greater resolving power / objects closer together can be distinguished;
electron (beams) have a shorter wavelength;

2

(c) short diffusion pathway / short pathway to the centre / large SA:V ratio for faster, more diffusion;

1

**[7]**

## Q74.

(a) phospholipids in a double layer / area covered is twice total surface area of red blood cells;
evidence of calculation of number × surface area ($4.74 \times 10^9 \times 99.4\ \mu m^2$ ) /
calculation of area of 1 cell $\frac{0.92}{4.74 \times 10^{-9}}$;
$0.471\ m^2 \approx 0.5 \times 0.92\ m^2$ / $194\ \mu m \approx 2 \times 99.4$;

3

(b) EITHER feature + explanation
red blood cells do not contain organelles / nucleus;
so only surface membrane / no internal membranes in macerate;
OR
red blood cells have simple / regular / spherical shape;
so easy to calculate surface area;
OR
*any two features, e.g.*
simple / regular shape;
all same size;

2

**[5]**

## Q1.

Questions (a) and (b) were designed to assess Assessment Objective 1 and expected recall of basic knowledge. Question (a) allowed students to score well, with just over 50% of them scoring all three marks, and 93.3% scoring at least one mark. Question (b) was less well answered with only 31.6% of students scoring the mark.

Question (c) tested practical drawing skills that students should have acquired, and there is guidance for drawing in the practical handbook. This was poorly answered, with just 2.4% scoring all four marks. Most drawings were sketches, and did not look similar to **Figure 2**, despite the question asking students to draw the mitochondrion shown. The question also asked students to label the matrix and a crista. Very few did, and most did not include a scale of any sort.

## Q2.

Questions (a) and (b) revealed very poor spelling of key terms. 31.7% of students scored two marks on (a) and 16.7% scored two marks on (b). Common errors included W and X being referred to as the inner and outer membranes, and the capsule being labelled as a capsid. In (b), several students gave the functions of the parts, rather than naming the main biological molecule. For X the most common answer was cellulose.

Question (c) was reasonably well answered (57% of students gained the mark); those failing to score most commonly stated just fission, or often mitosis.

Just under half (44.7%) of students scored two marks on (d). A common error was to multiply by 6 or 24, rather than $2^6$.

## Q3.

In (a), statements describing the Golgi apparatus and cell wall were selected correctly by many students. The description of the chloroplast was incorrectly identified most often as a nucleus, and frequently as a mitochondrion. 24.5% of students scored all three marks.

In (b), most students knew mitochondria released energy, but they were often unable to apply their knowledge in the context of this question to explain what use gland cells made of this energy. Statements such as “ATP supplies energy for milk production” (rather than protein production), were frequently given and achieved no mark. Answers involving mitochondria “producing energy” (a misconception reported in previous Examiners’ Reports), and “energy being released for respiration” were examples of students’ poor expression. The function of Golgi vesicles was less well known and their correct function of transporting glycoprotein/milk out of cells was expressed in relatively few answers. Many explanations lacked precision, for example “Golgi vesicles transport milk to its destination”. Exocytosis was accepted as an alternative and was often mentioned in well explained answers, but some students confused it with endocytosis and failed to gain the mark. The idea of breast feeding confused many and caused some to apply their knowledge illogically: “mitochondria provide ATP for the baby” was one, fairly common, inaccurate application of AS level understanding. Nearly 60% of students failed to score on this question.

## Q4.

This question was loosely based on the skills students would have developed when

completing required practical activity 2 – “Preparation of stained squashes of cells from plant root tips; set-up and use of an optical microscope to identify the stages of mitosis in these stained squashes and calculation of a mitotic index”. Students should have observed cells undergoing mitosis surrounded by many cells that were not and, therefore, should have considered why they looked different.

Many incomplete answers were seen to question (a). Students were required to give evidence **and** to explain that piece of evidence, but often only gave half the story. Some students used **Figure 2** rather than **Figure 1** and some tried to explain which stage of mitosis was shown, rather than simply that it was happening. Confusion was demonstrated here and in question (e) between a homologous pair of chromosomes and a pair of chromatids in a single chromosome. Worryingly, 62% of students failed to score on this opening question; only 5.8% gained both marks.

In part (b), 69.3% of students correctly identified that these cells were in prophase.VWithin required practical activity 2, students needed to spread the cells out to gain a clear view; question (c) was based on a similar principle, but using a different method. It required standard knowledge of osmosis, but the novel context threw many students. The majority could state that the water would move into the cells by osmosis, but then often referenced increased pressure, rather than the idea of the volume of the cells increasing. Some complex, incorrect answers were seen in which students attempted to describe changes in polar interactions between the chromosomes and water, and how these would change.

Question (d) tested Assessment Objective 2 (application of knowledge) and there were several parts of the specification from which students could select material to support their answer. 42.2% did this successfully; those who did not often did not describe sufficiently how a feature would be different along the length of the chromosome to result in the striped appearance. For example, mentioning “histones” or “bases” alone was not creditworthy.

In question (e), only 36.9% of students could define the term ‘homologous chromosome’. It is likely that more students could have written about independent segregation or crossing over of homologous chromosomes, but this question revealed that they did not fully understand this biological term. Many students only referred to the origin of the chromosomes as paternal and maternal.VFor question 01.6, most students (83.2%) scored at least one mark, but there were many good answers limited to one out of two by demonstration of fundamental misunderstanding. The most common of these was that only eukaryotic DNA is a double helix and that prokaryotic DNA is single-stranded.

## Q5.

Question (a) demanded recall from section 3.3.2 of the specification; 25.6% of students gained five or six marks. Many, however, omitted any reference to the structure at all and it was surprising that very few students elected to draw a labelled sketch to show the gross structure. Many lengthy answers were seen detailing exchange of gases and the features of the alveolar epithelium, neither of which was required by the wording in the question. Many answers included tracheoles as a part of the human gas exchange system. Inhalation tended to be described in the best detail. Marking points 3 and 5 were often not awarded because of a lack of precision in describing the role of the pair of antagonistic intercostal muscles. Many students conflated the two, and referred to them generically. The relaxation and contraction of the diaphragm and its corresponding shape were frequently confused. For example, students referred to the 'flattened' or 'domed' shape of the diaphragm without stating how that occurred. This question had the highest discrimination index of the paper.

In question (b), although many students could demonstrate knowledge of phospholipids and triglycerides individually, they struggled to complete the required ‘compare and

contrast' command. When this command is used, every marking point requires a comparative statement that must be clearly made by the student: examiners will not infer links between separate statements – in this case, separate descriptions of phospholipids and of triglycerides. Many students did not include glycerol in their structure of the phospholipid. Some students were distracted into discussions of applications for the molecules, and their energetic values.

Question (c) showed that most students had learned the components of lactose and knew that it would be formed in a condensation reaction, although some omitted that this would result in the formation of a glycosidic bond. Fewer students knew that the lactose would be joined to a polypeptide in the Golgi apparatus. Many described that it would be found on the cell-surface membrane, and some tried to describe where on the polypeptide the lactose would be attached, rather than where in the cell as required by the question. Nearly half of the students scored at least two of the four available marks.

## Q6.

In question (a), it was pleasing to find that 83% of students managed to complete the diagram correctly.

In (b), only 68% correctly identified crossing over as the process that produced the alleles in the first polar body. This was a little surprising, given how many correctly answered (a).

The calculation in (c) discriminated well. Two marks were obtained by 30% of students. A further 17% obtained one mark for making some progress with the calculation. This included students who correctly calculated the difference in volume between the nucleus and the polar body, but could not then correctly calculate the number of mitochondria. Others used diameters instead of radii.

Question (d) was marred by the number of students who appeared not to have read the stem carefully enough. As in question 2, the information comes from a published scientific paper. The bullet points in the stem state that the nucleus is removed from a donor egg and this is replaced by the polar body from a woman affected by mitochondrial disease. Only 3% of students obtained both marks by noting that the egg produced by this process would contain a nucleus from the affected woman and very few faulty mitochondria. Very large numbers of students wrote about how the **nucleus from the donated egg** would not contain the genes to make faulty mitochondria and so this would be a cure. This would mean that the child produced would have the DNA of the donor, not the woman affected by mitochondrial disease. There would be little point in carrying out such a complex procedure to achieve this; a donor egg would suffice. Other students correctly spotted that the egg produced would contain the DNA of the affected woman but, having just calculated the number of mitochondria in a polar body, stated that the polar body contained no faulty mitochondria. This accounted for the 21% of students who obtained one mark. Many students thought that mitochondria are contained within nuclei, or that they are synthesised along with proteins at ribosomes, using mRNA from genes in the nucleus.

Question (d) produced an even spread of possible marks. About 40% of students obtained one mark for stating that the faulty mitochondria would produce less ATP. Some 29% obtained a second mark by linking ATP to the energy required for reactions. A few students did recall that ATP is used to phosphorylate substances, to make them more reactive, or helps to lower the activation energy for a reaction. There were pleasingly few references to 'making energy'. Some students drifted into accounts of how ATP is made in mitochondria, which was more than the question required.

## Q7.

Questions (a) and (b) required students to evaluate methods used by scientists (AO3), on the basis of information provided and their own knowledge. In question (a), 38% of students correctly noted that cell membranes have a phospholipid bilayer or are made (mainly) from phospholipid, and then suggested that the detergent would dissolve the phospholipids (in water). Some 30% obtained one mark for the point about phospholipids but then wrote about breaking down the membrane, or even hydrolysing it. Students were expected to use the information given and pick up on the fact that the detergent dissolves lipids (in water). The question discriminated well.

In question (b), it was apparent that most students are not familiar with ultracentrifugation as a method for separating molecules. Nearly 60% did obtain one mark, for stating that CENP-W would separate on the basis of its mass/size/density/weight during centrifugation. Only 7% clearly expressed the idea that separating *molecules* requires centrifugation at very high speeds. Many students wrote apparently rote-learnt answers about cell fractionation and separating organelles; many referred to CENP-W as an organelle. There were some really good answers in which students wrote about removing organelles by spinning at low speeds and then separating molecules in the supernatant by spinning at very high speeds.

Question (c) produced the best discrimination on the paper. It was pleasing to see that many students had at least some understanding of RNA interference. About 17% of students obtained all three marks. They clearly stated that the siRNA binds to mRNA for CENP-W and this prevents the mRNA from being translated. They then linked this to a reduction in CENP-W and a resulting reduction in tubulin production. About 16% obtained two marks, usually for a reduction in translation and the subsequent reduction in CENP-W and then tubulin. Many of these students wrongly thought that siRNA would prevent transcription, with a lack of mRNA leading to reduced translation. Students who failed to score (37%) were very confused about what siRNA binds to and where. They were often unclear, or wrong, with the contexts for CENP-W and tubulin and the reasons for their reductions. A few students gave apparently rote-learnt accounts of how siRNA works, with no references to CENP-W (or tubulin), and failed to score.

## Q8.

There were no problems with question (a); it was well answered.

Question (b) asked for the advantages of lipid droplet **and** micelle formation. Students seemed to group both together ('they' or 'it') and give the same advantages. Many students failed to use the diagram to help them. For mark point two, there were lots of answers referring to making digestion easier; easier digestion does not equate to faster digestion. Only 3.7% of students scored all three marks.

As with (b), students did not use the diagram to help them answer question (c). Most answers just referred to lipids rather than to triglycerides. There were also a lot of generic answers of "packages and processes proteins"; failing to acknowledge that the question is about triglycerides, not proteins. There were several answers stating that the Golgi apparatus produces proteins from lipids or mistaking lysosomes for vesicles. Only 2.9% scored four marks, with over 70% scoring 1 or 2 marks.

## Q9.

Responses to question (a) were mostly good, students having clearly learnt this technique. 82% of students scored two or three marks, with only 5% failing to score. For mark point one there were some simplistic responses such as 'crush a leaf'.

Question (b) tested simple recall of organelle structures and scored well.

Question (c) tested recall of the function of a mitochondrion, and 73% of students scored the mark. Incorrect responses included “the powerhouse of a cell”, “storage of ATP”, “production of energy” and “energy **for** respiration”.

In answers to question (d), most students ignored the standard deviations on the graph, and so did not score mark point one. Many students seemed to think that, as the number decreased slightly, mitochondria are used up during exercise, and that an increase in area of their inner membranes made mitochondria larger overall. Some who did factor in the standard deviations simply stated for mark point two that there was a significant difference, but did not state what that difference was, i.e. an increase in the number of mitochondria. 16% of students scored two marks, and 15% failed to score on this straightforward question.

## Q10.

More than 40% of the students gained both marks on question (a), usually for correctly contrasting the types of glucose ($\alpha$ or β), or by referring to the branched or straight chain of the molecule. Those who failed to score often did not give differences, referring only to one of the molecules.

Question (b) discriminated well. Many students wrote about starch being insoluble and therefore not affecting the water potential, and the branched nature of the molecule making it compact. However, a large number of students did not follow the instruction to both describe **and** explain features of starch that make it a good storage molecule.

In answering question (c), 87% of students correctly identified the correct test.

In answering question (d) most students were able to attempt the calculation but many were unable to convert millimetres to micrometres and therefore gained only 1 mark.

Whilst half of the students scored both marks for question (e), there were many who were unable to identify the correct type of microscope and often their evidence was that the photograph was black and white rather than in 3-D.

## Q11.

Students clearly have difficulty in describing data with almost a quarter gaining no marks at all for question (a), and many of these confusing data for low-starch and high-starch diets. However, most could state that a low-starch diet was linked to fewer copies of the gene and many correctly identified the modal values. There were few references to the overlapping ranges and the higher range in populations with a high-starch diet. Students would benefit from learning to use terms such as mode and range in their answers to similar questions.

In answers to question (b), students seemed less confident in their knowledge of protein synthesis than in their knowledge of enzyme action. Consequently, very few students could explain that, with more copies of the gene, there would be more transcription or more mRNA formed. However, most realised that there would be more enzyme present and then went on to explain the advantage in terms of faster starch digestion.

Often students failed to use the information given to them in question (c) and wrote generic answers about natural selection which failed to gain any marks. Examiners were looking to award marks for points made in the context of multiple copies of the *AMY1* gene. Those students who did this often gave excellent answers referring to mutation resulting in extra copies; they then went on to explain that this mutation resulted in a higher chance of survival and reproduction in populations with a high-starch diet, with the beneficial mutation being passed on to their offspring.

## Q12.

This question was based on required practical activity 4 – an investigation into the effect of a named variable on the permeability of cell-surface membranes. The practical skills assessed here are found in section 8.3 of the specification.

(a) Some good understanding was demonstrated here, but students often failed to gain credit due to poor use of language. “Amount” and “level” are not accepted units; pH and light must be qualified, e.g. ‘soil pH’ and ‘light intensity’, and ‘nutrients’ is not an acceptable alternative to mineral ion concentration at this level.

(b) A very small number of students achieved 4 marks here. The most commonly awarded mark was for identifying that 2,4-D increased the release of ions from wild oats but had very little effect on wheat (mark point 1). There was quite a lot to read and understand in the stem of the question, and some students did not appreciate that disruption of the cell-surface membranes was linked to loss of ions, and so damage to the plant itself. Some students confused these ions from leaves with ions in the soil and consequently suggested greater ion concentration in the water would allow more ion uptake, to be used for growth. The lowest significant difference (LSD) was a novel context, and many students did not read / understand the explanation, and assumed the LSD was a form of standard deviation.

(c) Unfortunately, many students did not fully link the context of this question to the practical they had carried out, and so were not confident in their suggestions here. Many mistakenly thought that the 2,4-D was in the water at this point. Those who did appreciate that the temperature must remain constant, to avoid further changes in membrane permeability (rather than enzyme activity), were often too vague in their responses to gain credit. Better students often appreciated that temperature would affect the rate of diffusion of ions out of the leaf discs. Why the leaf discs were shaken was generally better answered, although those who showed some idea of maintaining the diffusion gradient for ions often gave vague, imprecise answers that could not be given credit.

## Q13.

(a) The command word here was **contrast** and so statements showing clear differences between the use of the two microscopes were required to gain credit. Most students demonstrated sound knowledge of the optical and electron microscopes, but few managed to gain all six marks for relevant contrasting statements. Many suggested that no organelles could be seen with an optical microscope, rather than only larger organelles being visible. Some referred to SEMs and 3D images; neither was relevant here.

(b) There were many good answers here, with over 70% of students scoring 2 marks and over 40% gaining 3 marks. Mark point 4 was the least often awarded. Students often failed to gain mark point 3 because they stated that **W** contained half the genetic material of **Z**, rather than specifying half the DNA. Several students discussed these cells as if they were human cells rather than plant cells, mentioning 23 pairs of chromosomes originally, or 23 chromosomes in cells in **W**. Some students named stages of meiosis in their answer. These were ignored as this is not expected knowledge; we were only looking for the outcomes of 1$^{st}$ and 2$^{nd}$ meiotic divisions.

(c) The full range of 0 – 5 marks was seen in similar proportions here (although slightly fewer with full marks). The main reason for the discrimination was how fully each student used the information from the question stem. The two groups of seeds to be investigated had been collected already, and the investigation that was needed was simply to find out if there was a difference in size of these seeds. Many students

gave extensive answers relating to how to collect the seeds from the environment, and how to measure the pollution – neither of which was relevant to the question. Many students selected an inappropriate statistical test or listed several options, which could not be given credit, even if t-test was amongst the list of possibilities (see note about the 'list rule' in the final paragraph of "General Comments" above).

## Q14.

(a) This was a factual recall question that discriminated well. Examiners expected students to use appropriate A-level terminology, including references to calcium ions, channel proteins and the (facilitated) diffusion of calcium ions in through the (presynaptic) membrane. Weak answers included statements about calcium crossing the membrane.

(b) This question required application of knowledge of how myosin and actin interact. Many students treated it as a factual recall question, not infrequently referring to shortening of the sarcomere. The best answers (about 12% of students) scored both marks by focusing on the information given and noted that, in this circumstance, myosin moves past actin and pulls the mitochondrion along.

(c) Around half of the students obtained one mark for noting that mitochondria produce ATP. Just over 40% got a second mark, usually for relating the use of ATP to some aspect of recycling of neurotransmitter, or the active transport of an appropriate ion. Some students failed to score the point relating to ATP because of references to 'the production of energy', rather than 'the supply of energy'.

## Q15.

(a) Approximately two-thirds of students correctly identified the third statement as the only correct one.

(b) About 30% of students scored both marks for the calculation and 6% obtained one mark for determining the lengths of the virus and bacterium. The main problem for those who did not score appeared to be an inability to convert between one unit of length and another (mm, μm and nm).

(c) Many students struggled to express themselves clearly in this question. Some gave an experimental hypothesis and others gave rather vague statements about bacteriophages having no effect. Examiners were looking for a clear statement relating to this context, something along the lines of 'The bacteriophage makes no difference to the number of (live pathogenic) bacteria in treated and untreated mice.'

(d) / (e) These questions showed that few students seemed to have any real understanding of logarithmic scales. It was intended that students would answer these questions by inspection of the graph in part (c), not by calculating actual numbers from the log values. (However, credit was given when any student used correctly calculated values.) It was hoped that students would recognise that the log scale gave numbers of bacteria per $cm^3$ which differed by orders of magnitude. In question (d), about 20% of students stated that there would be too many bacteria to count in some samples without dilution **and** few enough in other samples to count without dilution. Very few students used the evidence of the logarithmic scale on the graph to support this. Many students suggested that the range of numbers for **B** was greater than for **A**, and that is why dilutions were needed. These answers ignored the log scale and suggested students just looked at the length of the range bars; obviously, the range of **A** is numerically much greater than **B**. Some students treated the numbers on the y-axis as simple numbers and

wrote about the mean of **A** being (about) 8 bacteria per $cm^3$.
In question (e), the misunderstanding of some students about the range bar for **B** ended up helping them. These students often gained the mark for noting a big range of effect of the bacteriophage in individual mice. Many students obtained a mark for noting that the bacteriophage did reduce the number of bacteria. Quite a few also obtained a mark for noting that the ranges of **A** and **B** do not overlap. It was here that a significant minority wrote about SDs not overlapping, even though the stem above the graph clearly states that SDs are **not** shown.

## Q24.

The factual recall question, (a), proved far more challenging than intended. Only 5% of students obtained both marks and 54% failed to score. There was no particular pattern to the wrong answers.

Question (b) discriminated very well, with 15% obtaining three marks and 21% scoring zero. There were good, concise answers that scored three marks for including complementary base pairing and the role of DNA polymerase in joining nucleotides together to form the new DNA strand; often in two or three lines.

Many students failed to read the question carefully and did not answer the question as set. They wrote at length about DNA replication, starting with DNA helicase. These answers were awarded a maximum of two marks, because the question specifically asked how the complementary strand of HIV DNA is made. Many students appeared to believe that DNA actively pulls free nucleotides into place and makes them base pair; some even wrote about condensation reactions. There were students who confused transcription with replication and gave accounts of mRNA production.

Some students appeared to focus on ‘HIV’ and ‘replication’ and gave an extended account of how HIV infects cells, uses reverse transcriptase to make DNA, incorporates its DNA into host DNA, takes over the cell, is replicated by the host cell, infects new cells and leads to AIDS. They often went onto an additional page, or wrote their answer under (c) on the next page, in breach of instructions given on the front of the exam paper. Many of these students may have found themselves short of time for later questions.

In (c), it was pleasing to find that many students did obey the command word to ‘contrast’ and gave full statements about the differences between DNA and RNA. Many students knew enough about the structures of DNA and mRNA to give correct contrasting features and 47% obtained all three marks.

## Q25.

The specification (section 3.1.6) requires students to know that ATP is resynthesised by a condensation reaction involving ADP and phosphate, catalysed by ATP synthase. The examiners did not require reference to ‘a condensation reaction’ but only 26% of students obtained both marks in (a). About 40% obtained one mark for reference to ADP and phosphate. Some failed to score that mark because they wrote about phosphorus. Many wasted time writing about hydrolysis of ATP but often went on to describe the reaction between ADP and phosphate.

The same section of the specification (3.1.6) requires students to know that the hydrolysis of ATP can be coupled to energy-requiring reactions, or the phosphorylation of other compounds (often making them more reactive). In (b), 35% of students obtained one mark for reference to ATP providing energy for a reaction (usually named). Only 3% did this and then made reference to phosphorylation to obtain the second mark.

In (c), about 40% obtained the mark by noting that the image was 3-D. Many simply wrote that the evidence was the black and white nature of the image.

About 56% of students obtained both marks for the calculation in (e). Some (about 30%) had the right idea in terms of what to divide by what but couldn't handle the units and obtained one mark.

## Q26.

(a) Many students were secure in their knowledge of the structural differences between a prokaryotic and a eukaryotic cell. There was, however, a significant number of students who thought that a bacterial cell would have a nucleus or that it lacked a cell wall.

(b) Although there were some students who did not understand how to approach this calculation, almost two thirds gained both marks. Many others gained one mark where they understood that the measurement should be divided by the magnification but could not complete the calculation. Mistakes in converting units caused problems for some students.

(c) (i) Only about one third of students were awarded this mark, usually for referring to circular DNA or smaller ribosomes. Often students failed to gain marks because they did not include sufficient detail in their answers. It was not uncommon for students to state that mitochondria had a cell wall.

(ii) The vast majority of students knew that the mitochondria were involved in ATP production or the release of energy, although many went on to say incorrectly that this was to be used in respiration. It was disappointing that less than half the students stated that the mitochondria carry out aerobic respiration.

## Q27.

(a) Very few students had a good understanding of the term 'temporary mount', used in this question. Some students thought it is a structure inside a leaf. These answers suggest that this kind of practical work is not a common activity. Often, vague references that enabled some to accumulate marks were made to 'rectangular glass pieces' and 'cover slides', although few included keeping the specimen moist or staining it before applying a coverslip.

(b) Accurate measurements and appropriate calculations were performed by the vast majority of students.

(c) Surprisingly, only 5% of students achieved full marks on this question. Again, there was confusion about the meaning of 'temporary mount' which some students regarded to be a type of cell; they suggested counting chloroplasts in many temporary mounts. Many misread the question and so estimated the total number of chloroplasts in a leaf rather than estimate a mean number of chloroplasts in cells. Hardly any students demonstrated an awareness of the need to select cells at random or choose a large number of cells to use in their investigation. For many, the only mark achieved was for making a statement about counting chloroplasts.

## Q28.

(a) It was pleasing to see that most students had a good understanding of the function of organelles with the majority scoring at least two marks. The most common error was in identifying the Golgi apparatus, organelle H.

(b) Although most students knew the simple triangle for relating magnification to image and actual size, only about 40% knew how to apply it correctly to the scale line calculation. Many students found it difficult to work with the scale line, and one of the commonest mistakes was to use the figures to work out the actual size of the cell, rather than the magnification. Sometimes students confused two methods, using the cell proportions along with the scale line proportions. Other common errors occurred when converting units, with many answers being an order of magnitude or so out, in either direction.

## Q29.

(a) Most students tried to answer this question by writing all they knew about the use of the centrifuge in cell fractionation, rather than applying their knowledge of the use of the centrifuge to this example of obtaining a cell free liquid. Mark points 2 and 3 were still available if the cells were homogenised first. Mark point 3 was rarely awarded, as many students simply referred to removing the pellet (rather than the supernatant), or they suggested filtering which would break up the pellet and mix the contents once again.

(b) The vast majority of students could recall the function of lysosomes. Some only stated that lysosomes stored enzymes rather than identifying their active role.

(c) This question was generally well answered, with just a few students showing confusion by suggesting that 'bacteria would be denatured' or that 'neutralising acid would lower the pH'.

(d) Mark points 1 and 2 were commonly awarded but few students could correctly describe the relevance of the standard deviation and the overlap with other strains. Some students tried to explain why the damage was caused to human cells, rather than explain how the data support the conclusion drawn.

(e) Students who fully understood Resource B and the principle of the cell-free liquid answered this question very well. Many students gave answers suggesting the *H. pylori* cells were still present. They were often unable to score mark point 2, as they were suggesting there was no toxin as a result of the cells being unable to produce it; the incorrect context for awarding this mark.

## Q30.

This question was intended to provide an accessible start to the paper. In practice, it discriminated quite highly, with students who scored highly on the paper as a whole tending to get the highest marks.

(a) About two thirds obtained both marks. Quite a few students used the terms hydrophilic and hydrophobic the wrong way round. Others appeared confused about the position of the 'heads' and 'tails' of phospholipids. Some had them the wrong way round in the membrane and others had heads facing out of the cell and tails facing into the cell.

(b) (i) There were many good answers and just over 60% obtained both marks. Some students confused the roles of the rough endoplasmic reticulum and the Golgi apparatus.

(ii) A range of related functions was allowed in part (ii) and just over 70% obtained this mark.

## Q31.

(a) It was pleasing to see many good answers to this part that focused on how bacteria are destroyed by phagocytes. Some students drifted into general accounts of the immune response and others began by writing at length about how phagocytes find bacteria. About 30% obtained all three marks. It was common for students to be vague or wrong about the role of lysosomes. It was not uncommon to see references to lysosomes fusing with bacteria, rather than with the vacuole containing the bacteria. The examiners were looking for references to hydrolytic or digestive enzymes destroying the bacteria, rather than just enzymes breaking down bacteria.

(b) 80% obtained both marks. Those who failed to score usually included features of eukaryotic cells in their answers.

## Q32.

A number of misconceptions about the immune system, immune response and vaccination were commonly expressed by students in different parts of this question. The same, or similar, misconceptions have been seen in previous papers and have been commented upon in the reports.

(a) (i) Many students did not focus on a comparison of a vaccine consisting of whole cells that had been heat treated with one containing only parts of the bacterial cell. The former might not have been killed, or might contain toxins, whereas the latter could not be alive and would not contain toxin. Many students felt that the introduction of whole cells with their many antigens might overwhelm the immune system. These students did not seem to appreciate that our immune systems are exposed to multiple antigens on a daily basis and are not overwhelmed.

(ii) The examiners were looking for the idea that a whole-cell vaccine would contain many different antigens and each would lead to the production of an antibody specific to it. Only about a fifth of students obtained both marks here. Most students simply wrote that there would be more antigens and thus more antibodies. This made it impossible for examiners to know whether or not they understood the ideas of different antigens and different, specific antibodies.

(b) This part produced roughly equal percentages of students obtaining 3, 2, 1 or 0 marks. Many started with the assumption that people with whooping cough would have no antibody against the toxin; because if they had the antibody, they wouldn't get ill. Indeed, many stated that only people who had been vaccinated against whooping cough could have antibody against the toxin. In essence, they did not seem to understand that an immune response occurs naturally when someone becomes infected with a pathogen.

(c) Many appeared to find it difficult to accept that a doctor's diagnosis might be wrong and wrote about vaccines not working and the bacterium mutating. About a quarter of students did spot that the scientists' work suggests there might not be a real rise in whooping cough cases and that this might be linked to mis-diagnosis. Another quarter identified one of these points.

## Q33.

(a) The majority of students gained both of the marks on this question, although some failed to score because they made unqualified references to protein or lipid. Although some students had learnt the term 'integral protein', few qualified this to show they recognised this integral protein spanned the membrane. A few answers

referred to guard cells, microvilli and mitochondria, suggesting that the students had not understood the difference between the molecular structure of a membrane and the gross structure of cells or organelles.

(b) (i) Most students knew this term although some were clearly guessing between condensation and hydrolysis, having written both down and then crossed out one or other of the terms.

(ii) The great majority of students gave mark points 3 and 4, with a few failing to score because they used abbreviations such as ER or RER. These abbreviations were not accepted, since students were asked to name the organelle. The full name endoplasmic reticulum is given in the specification, with no abbreviation offered as an alternative. Where Golgi was given as the organelle, the associated function was not often correctly linked to protein formation. For mark point 6 (release of energy / make ATP), references to producing or making energy were not given credit. Incorrect references to cilia, microvilli, stomach acids and lysosomes suggested that some students did not understand what was meant by the term organelle.

## Q34.

(a) (i) This was done well by many students. Where the mark was not given it was usually because a student stated that the antigen was foreign but did not go on to add that it would cause an immune response.

(ii) Difficulties with this question were linked to poor understanding of the ways in which substances pass through membranes. Weaker answers referred to the antigens not being 'allowed' through, rather than incompatibility between the shape of the antigen and the shape of trans-membrane protein channels.

(b) Many students scored full marks. Rather than microfold cells being the route by which vaccines could enter the body, weaker responses included ideas such as the vaccine being given as treatment for a disease, or people being injected with microfold cells.

## Q35.

(a) (i) This question proved easy for almost all students.

(ii) This question proved easy for almost all students. It was pleasing that they were able to identify the Golgi apparatus from a photomicrograph, rather than an artist's impression.

(b) A large majority of students understood that the light microscope does not have sufficient resolution and scored one mark. About forty percent gained the second mark for some reasonable statement about wavelengths of light or electrons. Some students persisted in thinking, wrongly, that magnification is the issue.

## Q36.

Given that this question was targeted at grade **E**, it is surprising that all parts proved to be good discriminators.

(a) Nearly half of students gained full marks. Students who did not showed a vast range of incorrect answers.

(b) Most students correctly named the type of reaction as 'hydrolysis'. The most

common incorrect response was ‘condensation’.

(c) Just over 60% of students gained full marks. This was usually for relating the insolubility of starch to no osmotic effect, or the coiled shape of starch to being compact. However, some students were prevented from scoring full marks due to giving a definition of ‘compact’. The response ‘compact so can fit a lot into a small space’ was frequently seen.

(d) Nearly half of students scored full marks. A common error seen in weaker responses was to divide the actual length by the measured length. Similarly, the ability to convert between millimetres and micrometres proved to be a good discriminator.

## Q37.

(a) (i) The vast majority of students correctly named organelle Y.

(ii) Most students were able to identify two structures showing the cell was eukaryotic. Those who did not often failed to use the diagram as instructed or confused prokaryotic and eukaryotic cells.

(b) Whilst most students correctly linked the mitochondrion with respiration or ATP production, there was still a sizeable minority with incorrect ideas about energy creation in the mitochondria.

(c) Students generally had a good understanding of why a transmission electron microscope would be needed to see the organelles of the cell. Inevitably there were those who confused transmission with scanning electron microscopy or light microscopy with electron microscopy.

## Q38.

In part (a), most students correctly linked the presence of mitochondria with active transport. Credit was usually awarded for the role of these organelles in releasing energy through the process of respiration. Weak expression occasionally limited the marks awarded. Credit was not awarded, for example, where the student wrote of "making energy" or using energy "for respiration". The frequency with which Golgi appeared both in this part and in part (b) suggested considerable uncertainty as to its role. Students who recognised that enzymes were proteins and that proteins were synthesised on ribosomes gained both marks for part (b). However, many failed to distinguish synthesis and subsequent modification and wrote inappropriately about Golgi. Additionally such comments as "the proteins are now made into enzymes" suggested uncertainty over the relationship between proteins and enzymes. There were many correct answers to part (c) although the role of microvilli was not always appropriately associated with an increase in surface area.

## Q39.

(a) The vast majority of students correctly named structure **X** as the granum or thylakoid. Structure **Y** was often incorrectly labelled as cytoplasm or matrix.

(b) Over 80% of students gained both marks by referring to a chloroplast absorbing light in photosynthesis. A small minority of students incorrectly suggested that the function of a chloroplast is in 'energy production'.

(c) Most students gained one mark for the principle of dividing the measured length by the magnification. However, only two in every five students were able to complete the calculation to provide the correct answer in micrometres.

## Q40.

(a) (i) Over 90% of students correctly explained that vancomycin does not affect human cells as these cells do not contain a cell wall.

(ii) Approximately two thirds of students gained this mark by outlining the role of ribosomes in protein synthesis.

(b) This proved to be an effective discriminator. Most students obtained at least one mark often by referring to vertical gene transmission. Many students then referred to the reproduction of resistant bacteria to gain a second mark. Over a third of students gained maximum marks by explaining that a mutation leads to resistant strains or by stating that a resistant gene or allele is produced. Unfortunately, some weaker students incorrectly referred to bacteria becoming 'immune' or to bacteria reproduction by 'mitosis'.

## Q41.

(a) The vast majority of candidates obtained both marks, usually by naming the cell wall and chloroplast as structures that are present in plant cells but not in animal cells. Very few candidates scored zero.

(b) Most candidates gained one mark for stating that starch is insoluble. However, less than half the candidates were then able to suggest an advantage of this in terms of osmosis or water potential. A common error was to suggest that starch would not move into or out of the cell by osmosis.

(c) Most candidates scored two on this question and over a third of candidates gained all three marks. Generally there was a clear understanding of the roles of the chloroplast and eyespot. A smaller percentage of candidates was able to explain the role of the flagellum. A significant number incorrectly involved the starch store in their answer.

## Q42.

(a) Just over 75% of candidates correctly named A as the membrane. The most common responses seen that did not gain credit were ‘cell wall’ and ‘capsule’.

(b) Many candidates gained two marks for ‘nucleus’, ‘mitochondrion’, ‘Golgi’, ‘smooth/rough ER’ or ‘heavier ribosomes’. Unfortunately, some candidates failed to gain a mark due to a lack of detail. This was usually for failing to qualify ‘ribosomes’ or stating ‘villi’ instead of microvilli. A minority of weaker candidates failed to score through failing to read the question stem with sufficient care. They named structures that were present in a cholera bacterium but absent from an epithelial cell.

(c) A common misconception seen by weaker candidates in both question parts was that a TEM or SEM can be used to view living specimens. Vague references to cost and preparation were not uncommon. A few candidates confused the two types of electron microscope.

(i) Two thirds of candidates were aware that a TEM provides a higher resolution or that it can be used to view the internal structures within cells.

(ii) Just over half of candidates were aware that an SEM allows a 3-D image, thicker sections to be prepared or the surface of a specimen to be viewed. Some candidates stated that an SEM provides colour images. This was not credited. Both types of electron microscope produce black and white images, which can then be enhanced with colour, using computer software.

(d) Just over 40% of candidates scored full marks. Many candidates were aware of the equation used to calculate the actual width of the cholera bacterium. However, the ability to convert millimeters to micrometres proved to be a good discriminator. Where candidates had expressed their answer in standard form, this was usually done poorly. A common error seen by weaker candidates was to multiply the measured length and magnification.

(e) Almost all candidates gained one mark for correctly describing the relationship between height above sea level and the number of deaths from cholera. However, a few then went on to disqualify this mark by referring to this as a 'positive correlation'.

Some weaker candidates referred to the 'sea level increasing' rather than the height above sea level increasing.

## Q43.

(a) Approximately 70% of candidates gained the mark for 'peptide bond'. The most common incorrect responses seen were 'hydrogen bond' and 'glycosidic bond'.

(b) Fewer than half of the candidates gave the correct sequence HJE.

(c) Most candidates gained one mark for describing the role of organelle G in respiration or in producing ATP. Unfortunately, some disqualified this mark through poor expression such as by stating that respiration 'produces energy' or 'produces ATP for respiration'. However, it was encouraging to see that this seemed to be less frequent than in the January paper. Better candidates usually went on to link this role to active transport or protein synthesis. However, some candidates incorrectly referred to organelle G as a ribosome.

(d) (i) Fewer than half of the candidates were aware that the tissue was homogenised to break open cells or to release their contents. A common misconception was that this process alone separates the organelles. Weaker candidates usually gave vague answers or answers that were out of context such as 'to break up the tissue' or 'to separate the cells'. Similarly, a minority seemed to focus on the homo- aspect of homogenised and suggested that this process was used 'to keep the pH the same'.

(ii) Only 35% of candidates were aware that the suspension was filtered to allow cell debris or complete cells to be removed. The most common misconception seen was that filtration separates the organelles. A number of weaker candidates failed to score though repeating information from the question stem in that 'it allows organelle G to be isolated'.

(iii) Just over 60% of candidates were aware that the suspension was kept ice cold to reduce enzyme activity. Candidates who failed to score often had the idea of 'reduced activity' or 'less kinetic energy' but they did not mention enzymes. A minority of weaker candidates incorrectly related the low temperature to preventing denaturation.

(iv) Many candidates gained one mark for the idea that an isotonic solution prevents osmosis. However, it was usually only the better candidates who explained the advantage of this in terms of organelles not bursting or shrinking. Unfortunately, many candidates did have the general idea but referred to cells instead of organelles. Consequently, there were many references to 'preventing cells from bursting' and to 'preventing cells from becoming turgid'.

## Q44.

Some excellent responses were seen. Candidates were able to establish a link between fatty acids and the phospholipid content of the membranes. Many candidates were aware that fatty acids could be respired and the energy released could be used appropriately. Some centres awarded credit when responses indicated that energy was for respiration or when energy was made during respiration. It was rare to see any evidence of the third marking point.

## Q45.

(a) (i) Over 90% of candidates correctly identified organelle **Y** as a mitochondrion.

(ii) This question proved to be a good discriminator. Most candidates gained at least one mark for the function of mitochondria in terms of respiration, energy release or ATP production. Better candidates usually went on to link this to active transport. Unfortunately, some candidates disqualified the first mark through poor expression e.g. 'energy produced' and 'produces ATP for respiration'. Similarly, some answers referred to facilitated diffusion and linked this to a requirement for ATP. A minority of candidates incorrectly referred to structure **Y** as either 'microvilli' or 'ribosome'. This resulted in incorrect answers relating to surface area and protein synthesis respectively.

(b) Most candidates gained one mark for the principle of dividing the measured length by the magnification. However, only the best candidates were able to convert the measured length to micrometres. Candidates who failed to score often divided the magnification by the measured length.

(c) Most candidates scored one mark for mentioning a reduced surface area. The more able usually went on to link this to reduced absorption for full marks. However, some candidates disqualified this mark by referring to less protein being absorbed. Relatively few candidates referred to the cell membrane or membrane proteins.

## Q46.

(a) The vast majority of candidates correctly named the process as differentiation or specialisation. The most common incorrect response was 'mutation'.

(b) (i) Even more candidates correctly named structure **A** as the (cellulose) cell wall. A common incorrect response was 'cell membrane'.

(ii) It was disappointing that over a third of candidates scored zero on this question. Most candidates did gain one mark for the principle of dividing the measured length by the magnification. However, only one in every four candidates was able to complete the calculation to provide the correct answer in micrometres.

(iii) Almost two thirds of candidates failed to obtain the mark for this question. Most candidates mentioned chloroplasts, but only better candidates outlined their role in absorbing light. A significant number of candidates confused chloroplasts with chlorophyll. Very few candidates provided answers relating to the thin cell wall or to chloroplasts being at the periphery of the cell.

## Q47.

(a) (i) Rather disappointingly only approximately half the candidates correctly named part **X** as a crista or as an inner membrane. Common incorrect responses

included ‘fold’ ‘villi’ and ‘microvilli’.

(ii) Even fewer candidates correctly named part **Y** as the matrix. A common incorrect response was ‘cytoplasm’.

(b) The majority of candidates correctly suggested that pellet **B** would contain mitochondria.

(c) (i) Most candidates realised that using an ice-cold solution would reduce or prevent enzyme activity. However, a significant minority of candidates suggested that this denatured enzymes.

(ii) Many candidates started by providing a definition of the term isotonic and then explained that using an isotonic solution prevents net movement of water. However, most of these candidates referred to water movement into or out of ‘cells’ and did not obtain the second mark for explaining that organelles would not burst or shrivel.

(d) Very few candidates obtained both marks for this question. Although many candidates gained a mark for stating that mitochondria produce ATP or release energy, a significant number referred to ‘energy being produced’. Few candidates referred to aerobic respiration or linked exercise to muscles. There were a number misconceptions concerning respiration particularly in relation to ‘energy being used’ in respiration and to mitochondria providing oxygen during respiration.

## Q48.

(a) Over two thirds of the candidates correctly named the nucleus as the structure which confirms that *G. lamblia* is a eukaryotic organism. Ribosome and flagellum were frequent incorrect responses.

(b) Most candidates gained this mark for stating that the sucker enabled *G. lamblia* to remain in the intestines rather than being moved out as substances passed through. However, some candidates suggested the sucker enabled nutrients to be absorbed or somehow prevented digestion of the organism.

(c) (i) Approximately one in five candidates obtained both marks for this calculation. A similar number of candidates did gain one mark for showing some valid working in attempting the calculation.

(ii) The vast majority of candidates did not obtain this mark as they suggested that the number of cases would increase in the summer due to an increase in water consumption. Very few candidates suggested that an increase in temperature could lead to an increase in the number of *G. lamblia* in contaminated water.

(d) (i) Most candidates stated that monoclonal antibodies are the identical with no reference to their shape or the idea that they are specific to a particular antigen.

(ii) Many candidates obtained this mark often by referring to the complementary shapes of the antibody and *Giardia* antigen. Fewer candidates mentioned the tertiary structure or the variable region of antibodies. Most incorrect responses suggested the antibody has an ‘active site’ or the ‘same’ shape as the *Giardia* antigen.

(iii) As expected this proved to be a difficult question. Most candidates had

difficulty understanding the flow chart and gave a variety of incorrect responses. Despite the information provided in the stem of the question many candidates suggested that the *Giardia* antigen would remain on the plate and cause a positive result.
Other misconceptions related to the enzyme reacting with the antigen or with the antibodies. Approximately forty percent of candidates obtained one mark for realising that the second antibody with the attached enzyme would remain on the plate. Far fewer of these candidates went on to explain that the enzyme would react with the substrate to provide a yellow colour.

## Q49.

(a) In defining a tissue, care needs to be taken to produce a definition that excludes organs and other levels of organisation. Thus, it is essential to refer to the cells involved being similar or with a common origin. To say that a tissue consists of cells that carry out a particular function lacks the necessary precision.

(b) In part (a)(i), most candidates appeared to appreciate that iodine solution could be used to locate starch but often failed to note the specific requirement of the question. There was a tendency to describe the test concerned without heeding the need to find out where in the cells the starch was present. On occasions, candidates failed to note that this question was directed towards what a student should do, and there were a number of inappropriate answers involving electron microscopes and ultracentrifugation. Most of the answers to part (b) (ii) identified the need to produce a section through which light could pass but seldom developed the arguments further to embrace the points made in the mark scheme. Some of the less able candidates confused optical and electron microscopes.

(c) Although most candidates produced sound answers to part (c), some occasionally went far beyond the two differences required in the question. They should be aware that this approach is not without its drawbacks. Examiners cannot be expected to select correct answers from a mixture of correct and incorrect responses. In order to be fair to all, once the required number of responses has been exceeded, correct answers are disqualified by those that are clearly wrong. ***Guidance for Teachers Marking ISAs*** on the AQA Website has useful information about the application and interpretation of mark schemes.

## Q50.

The examiners were at something of a loss to explain why so many candidates chose to write about the advantages and limitations of using a transmission electron microscope rather than a scanning electron microscope. Those who selected the right instruments usually commented about the greater resolution of an electron microscope but occasionally attributed this to the **lower** wavelength of the instrument itself. Limitations, however, were somewhat less convincingly discussed and there were many vague references to size, cost and portability and an obsession among the least able with the fact that electron microscopes were unsuitable for school use.

## Q51.

(a) Knowledge of cell structure was sound and most candidates provided evidence supporting the identity of cell B. Those who failed to gain credit often incorrectly identified the surrounding layer as a wall. Although most were also able to recognise the significance of the third cell layer possessed by cell C, terminology raised problems for some of the less able candidates. Although some of these offered acceptable alternatives to capsule, others suggested that there was an extra cell wall or even an extra membrane. Examiners were of the impression that some

candidates attempted to recall similar questions from past papers and there were numerous references to nuclei and membrane-bound organelles, features that were not visible in the diagrams.

(b) Few candidates attempted to make use of a scale bar in calculating magnification, many falling back on uncertain memory of the relationship between the size of the object, the size of the image and magnification. The simplest correct approach was to divide the actual length of the scale bar, in micrometres, by 0.5. Candidates who adopted this method experienced few difficulties in gaining the mark. Others recognised that they should involve the scale bar in some way but were uncertain of to how to progress. The most frequent approach was to divide the size of the cell by the length of the scale bar without appreciating that this technique would give rise to different “magnifications” depending on whether the length or breadth of the cell were measured.

(c) While most candidates named an appropriate polysaccharide, there were many references to “chlorophyll” and “chloroplast”.

(d) Despite the emphasis in the specification on the link between osmosis and water potential, many candidates fail to use the term in explaining osmotic phenomena. Such was the case here. Those who adopted the required approach frequently gained maximum credit for part (i) although there were possibly more instances than in the past of negative values presenting difficulties. There were many excellent answers to part (ii), but some less able candidates were clearly unable to link the lack of action of penicillin on plant cell walls to some aspect of their structure. Many such candidates appeared distracted by the content of later modules and sought responses based on aspects of immunology.

## Q52.

(a) Although most candidates were able to identify organelle **B** as a chloroplast, some were undoubtedly influenced by the reference to the inner membranes being arranged in stacks and identified it as Golgi. There were also occasional references to cell walls. Those who named the organelle correctly usually offered appropriate descriptions of photosynthesis, although there was evidence of some confusion with respiration.

(b) It was likely that the considerable number of candidates who selected **D** for part (b) (i) were again unduly influenced by a single phrase in the description and selected this organelle because it was described as being smaller. However, part (b)(ii) was correctly answered by almost all.

(c) It was apparent from part (c)(i) that although many candidates were familiar with the requirement for a cold, buffered, isotonic solution in preparing tissue for centrifugation, rather fewer understood the reasons for the procedure. Although there were many who wrote convincingly of minimising enzyme activity or preventing autolysis, there were numerous references to ice regulating pH or preventing osmosis. Even among those who realised that enzymes were involved, many failed to gain marks by ignoring the context of the question and describing the role of enzymes in “protecting’ cells from damage. Part (c)(ii) was generally answered well but many answers underlined the importance of reading the question carefully. This question related to liver. The initial centrifugation in this case removed the nuclei; it could not remove chloroplasts and cell walls.

## Q53.

(a) It was apparent from the answers that few candidates were conversant with section

10.1 of the specification which refers to the requirement for practical microscopy including the estimation of size. Most simply measured the image without explaining how, and then used a formula to relate magnification and observed length to real length.

(b) The answers were generally sound and many of the better candidates correctly related the water potential gradient to osmotic movement from the cell and plasmolysis. There was, however, evidence of less certainty about this topic than has been shown in the past, in particular with the direction of water movement. Candidates are free to discuss values of water potential either in terms of higher and lower values or as being less negative or more negative, respectively. They would be well advised, however, to stay with the same approach throughout. Combining both tends to lead to contradiction and an inevitable failure to gain credit.

(c) There were few references in part (i) either to achieving equilibrium or to allowing a maximum change in length. Most candidates referred somewhat imprecisely to osmosis taking a long time or being slow. Candidates should be familiar from their practical work with the use of graphs as analytical tools. There was, however, a frequent misconception in part (ii) that the sucrose concentration equating with no change in length was where the curve levelled out, suggesting that many candidates failed to examine the data with sufficient care before attempting the question. What was required here was the drawing of a curve of best fit and extrapolating this to obtain the required value. Candidates found part (iii) difficult especially when they abandoned osmosis in favour of diffusion or hydolysis of starch. However, most candidates were able to gain some credit for recognising that starch was insoluble even if they subsequently failed to link sufficient steps in the reasoning to produce a coherent explanation.

## Q54.

This question targeted grade E and most candidates revealed a sound knowledge of the principles and skills tested here.

(a) The presence of a nucleus was usually correctly identified as being a eukaryotic feature, although there were occasional inappropriate references to cell walls.

(b) (i) The majority of candidates measured hypha length to an acceptable level of accuracy although errors of a centimetre or more were surprisingly frequent. Most completed the necessary subtraction to arrive at a value for growth but problems were frequently encountered with the use of the scale bar and conversion to micrometres.

(ii) Candidates were expected to provide a method of calculation but a significant number, although identifying the key variables of growth and time, could not supply the necessary idea of growth divided by time.

(c) It was expected that candidates would draw on their knowledge of the biochemical test for starch in their responses. While most were successful, many answers made no attempt to link this to the context of the question and wrote generally about “doing the iodine test” on “the food” or on “the solution”. There was occasional confusion with Benedict’s test and the biuret reaction. Some referred incorrectly to the reagent as potassium iodide and a few were rather more concerned about representing their findings than testing for starch.

## Q55.

(a) Maximum credit was rarely awarded to answers. Although candidates appeared

familiar with the need for initial filtration, few had a clear idea as to what was being removed, with many being of the opinion that it was either “broken organelles”, plasma membranes or individual molecules.

(b) Most candidates answered correctly but some negated their answers by subsequently referring to chloroplasts and cell walls.

(c) Apart from the few candidates who were of the opinion that centrifugation can only be used to separate membrane-bound organelles, answers were good.

(d) Most candidates correctly involved the concept of resolution in their responses, but frequently linked this to the wavelength of the electron microscope rather than of the beam of electrons used.

## Q56.

(a) The wording of the question made it clear that candidates were required to give features found in prokaryotic cells. Many of those who failed to gain credit for this very straightforward question ignored this instruction, and listed features of a eukaryotic cell which would not be found. Such answers failed to gain credit.

(b) Among those candidates who clearly knew which test should be used, some identified the reagent as ‘potassium iodide’ while others limited their responses to ‘iodine test’. Credit was withheld in both these cases, in the first instance for the use of an incorrect reagent and in the second, for an inadequate answer. The instruction ‘Describe’ should have indicated that rather more was required. The most frequent error in part (ii) was to identify the polysaccharide concerned as protein, although there were also numerous references to glycogen.

(c) Most candidates were able to give both a relevant aspect of starch molecules and a consequence of the feature described, and thus gained maximum credit. Those who failed to do so, either did not add significantly to information provided in the question with answers such as ‘It is insoluble, so can be stored’ or concentrated on aspects of glucose which were linked to its function as a respiratory substrate, clearly an inappropriate approach to this question.

## Q57.

(a) Superficial answers along the lines that ‘muscles have many mitochondria because we use our muscles in everyday life’ failed to gain credit but, even where candidates had some understanding of the function of these organelles, errors crept into the accounts they gave. There were still many thermodynamically incorrect statements about ‘making’ energy and a significant number were reluctant to associate mitochondria with respiration, or having done so, expressed their ideas incorrectly in terms of the ATP produced by mitochondria being used for respiration or to ‘allow the muscle to respire’. Many candidates were clearly of the opinion that rough endoplasmic reticulum synthesises protein so did not refer to ribosomes in their answers to part (ii). Others were somewhat equivocal about the status of enzymes and proteins.

(b) There was considerable confusion between lymphocytes and phagocytes with many candidates describing reabsorption of the tail in terms of it being engulfed by lysosomes. Most, however, realised that lysosomes contained enzymes, although there were some who were of the opinion that they were enzymes. There was less clarity about the function of these enzymes. Their digestive role was seldom recognised and most responses concluded with a vague statement about ‘destroying’ the tail.

(c) Responses to this part of the question were frequently marred by misuse of terminology. Homogenate and supernatant, fractionation and centrifugation were often confused. Where possible, examiners ignored such incorrect usage, but where this obscured the underlying meaning, marks were withheld. Most candidates clearly appreciated the significance of adding a cold, isotonic buffer although this was generally added at a rather late stage in the procedure. From this point on, many accounts became less convincing. Homogenisation as a process which breaks open cells was perhaps not understood, with many answers giving the impression that whole leaves, or small pieces of leaf were centrifuged; few referred to filtering before centrifugation, while others appeared to lose track of precisely what they were centrifuging, supernatant or pellet.

## Q58.

(a) A well answered question with the majority of candidates gaining full credit. Diffusion and endocytosis occasionally appeared in the answers to part (ii).

(b) In part (i), candidates who adopted the approach of identifying the organelle and then relating this to the context of the question generally described the role of the ribosomes in the synthesis of thyroglobulin. Others started from the end point of thyroglobulin secretion and met with rather less success by emphasising vesicle formation, and protein packaging and modification. Some candidates were clearly uncertain as to the meaning of the word synthesise and there were frequent references to amino acids being “synthesised” and RNA being “synthesised into” proteins. The answers to part (ii) revealed that many candidates understand the concept of resolution and could account for the higher resolving power of an electron microscope.

## Q59.

(a) Only the best candidates interpreted the diagram correctly and, having done this, were able to describe the pathway in appropriate biological language. There were rather too many references to walls and membranes to be sure of understanding. In addition, there was some interpretation of the question as requiring a reference to the mechanism involved. This resulted in some lengthy explanations of the process of diffusion.

(b) Common correct answers were the possession of a capsule and a cell wall, but there was a disappointing number of incorrect responses. These tended to arise either because the candidate sought to compare a prokaryotic cell with an unspecified eukaryotic cell, or because references were made to features such as nuclei and mitochondria which were absent from prokaryotic cells. Many of the responses made in this question clearly highlighted the perils of failing to read the question carefully.

(c) Candidates who explained the advantage of a disc shape in terms of increased surface area encountered few problems in equating this property to diffusion. Others were less successful, either because they were unable to explain the flattened shape of the cell in terms of a short diffusion pathway, or because they constructed inappropriate arguments based on the amount of haemoglobin present or the flexibility of the cells.

(d) Despite the frequency of such calculations in Unit tests, candidates met with only limited success in part (i). This part of the question gave rise to two problems which created particular difficulties. Candidates had to select the right measurement to represent the diameter and they had to convert this measurement to micrometres. Both tasks presented major hurdles to those of more limited ability. Further

difficulties arose from a failure to calculate magnification from the data provided. Part (ii), however, was generally answered well, although there were those who sought to offer explanations based on resolution or the orientation of the specimen, perhaps relying on uncertain memories of previous mark schemes.

## Q60.

(a) Although, in part (i), most candidates showed sufficient familiarity with the concept of a ratio to be able to calculate the answer correctly, part (ii) presented more difficulties. The few candidates who analysed the question with sufficient care and began their answers with wording along the lines of "The height to breadth ratio of an epithelial cell . . " were usually able to obtain credit. The main problems which arose elsewhere were either a failure to make any reference to a ratio, or to answer in terms of the milk-producing cell. These approaches, coupled with confused explanation, severely limited the marks that could be awarded in many cases.

(b) Most candidates recognised that a molecule of galactose would contain six oxygen atoms. Predictably, the most frequent incorrect answer in part (ii) was 12 and this appeared with considerable frequency.

(c) This question required candidates to apply their knowledge of water potential to unfamiliar material. Most demonstrated that they understood the principles involved but gave the impression, yet again, of relying on their knowledge of seemingly similar, but very different, questions which had been set in the past. Those who related their answers to the vesicles usually gained full credit. Unfortunately many lost their way by attempting to describe water movement into the cell or, in some cases, the membrane.

(d) Those candidates who avoided the obvious pitfall of describing mitochondria as "making" energy and referred to releasing energy or producing ATP were able to gain at least one mark. They were not always successful in gaining the second, however. Some of these less convincing answers were based on bland statements about the ATP or energy being "needed" by the cells. Others treated energy as a specific substance required by the baby.

(e) There were some outstanding answers to this question and candidates from some centres demonstrated not only a good understanding of membrane structure but were able to relate this clearly to diffusion. Less able candidates showed that they understood the structure of a plasma membrane in terms of the phospholipid bilayer but were less certain of the role of proteins in diffusion, often failing to link them with facilitated diffusion.

## Q61.

(a) Most correctly identified the site of the light-dependent reaction as being in the granum and the light-independent reaction in the stroma of the chloroplast. A substantial minority did, however, reverse these, with some labelling the starch grain, an oil droplet or even the chloroplast envelope as one of the sites.

(b) Most knew what was meant by the photolysis of water, but many failed to gain marks through imprecision – 'hydrogen', 'H', '$H_2$' could not be regarded as synonymous with *hydrogen ions*; other imprecise symbols included 'e' for electrons and 'O' or '$O^{-}$' for molecular oxygen. While candidates are generally at liberty to use chemical symbols in their answers, it is their responsibility to ensure that these are correct. Thus, '$H_2O \rightarrow H^+ + e^- + O_2$' was quite acceptable for 2 marks, even without being correctly balanced. Some candidates also knew that light excited electrons or that they were transferred to a photosystem.

(c) Precise answers were required in this section giving the specific roles of ATP and reduced NADP in particular reactions. Answers such as ‘ATP is used to change GP to TP’ were regarded as imprecise, whereas ATP providing energy to drive this conversion, and reduced NADP supplying hydrogens for it, were acceptable.

## Q62.

The question was accessible to the majority of candidates and many obtained full marks.

(a) (i) This was generally answered well, although some candidates thought that **B** was a nucleolus.

(ii) Most candidates gained a mark for saying ‘increased surface area’ and many also knew the link to respiration.

(b) This was answered well by the majority of candidates, although some misinterpretted the question and gave a feature of a eukaryotic cell instead. Some candidates gave flagellum, but did not qualify this with ‘bacterial’.

(c) Generally, candidates achieved 3 marks in most cases. However, a significant number wasted time by describing how a homogenate is produced. Weak terminology let down other candidates.

## Q63.

(a) In part (a), most candidates scored one mark for the principle of the calculation, but many then failed to convert their answer correctly to micrometers.

(b) Most candidates managed to score one mark, mostly by mentioning many chloroplasts, but fewer candidates gained the second mark, with many giving vague answers, such as ‘where photosynthesis occurs’. A significant number of candidates thought wrongly that mitochondria were the site of photosynthesis.

## Q64.

(a) There was evidence of some confusion concerning the drawing of the plasmid in this question. In order not to disadvantage the candidates, any reasonable structure was accepted. The most common answers were ribosomes and plasmid for **D**. Not many candidates knew capsule for **E**. Common incorrect answers were ‘cell wall’ and ‘membrane’.

(b) Most candidates could give a function for the cell wall, but some gave vague statements such as ‘keeping the structure’.

(c) Many candidates realised that starch had been digested, but few could name amylase as the specific enzyme. Many gave a credible explanation for the piece of fungus not having a clear area; the most common answer was that the fungus had died or was unable to secrete an enzyme to digest the starch. Answers stating the starch had not been digested were not accepted.

## Q65.

This question was generally well answered, the majority of candidates gaining at least two

marks.

(a) The majority of candidates correctly gave the matrix as the site of the Krebs cycle.

(b) Most candidates gained one mark for naming pyruvate, oxygen or reduced NAD. ATP and glucose were the most frequent incorrect responses. Better candidates had little difficulty in obtaining both marks.

(c) Many candidates gained a mark for linking ATP production to the electron carrier system but few provided further details such as the large surface area provided by the many cristae.

## Q66.

(a) This was generally well answered. Most candidates understood the techniques and many gained both marks, although the spelling of 'centrifugation' was frequently poor. Incorrect answers included references to use of different solvents or enzymes to break open the cells.

(b) Most candidates correctly identified the organelle as a chloroplast. Mitochondrion was the most frequent incorrect answer, with Golgi apparatus, endoplasmic reticulum or nucleus occasionally being given.

## Q67.

(a) This question was answered very well indeed, with even weaker candidates gaining high marks.

Some identified the structures when the question required a function.

(b) (i) Most candidates gained several marks for this synoptic question. There was more confusion with the similarities than the differences. Some weaker candidates referred to both cells having DNA, which was too general for credit.

(ii) Most candidates gained full marks for this question. A minority of candidates mentioned plasmids as a difference. The question stem required differences for the bacterium shown in the diagram, which had no visible plasmids.

## Q68.

(a) Although more demanding than the others, it was pleasing to find that many candidates performed well on this question, and that a considerable number gained at least 6 or 7 marks. In particular, an encouraging number managed to get to grips with part (c).

Surprisingly, this was rather poorly answered by many candidates. Often this was because they failed to use the diagram, and, for example, quite often the presence of the chloroplast was not related to photosynthesis. Very few suggested that the movements might position the cells in the optimum light intensity for photosynthesis. The commonest suggestion was that moving away from very bright light would avoid damage, more often to the eyespot than the chlorophyll. Some equated bright light with heat and suggested it would denature enzymes. Others were sidetracked into accounts of avoiding predators or referred to physiological processes that could not be seen in the diagram. Quite a few suggested that bright light was avoided so that the cells would not make too much starch or sugar and burst.

(b) (i) This proved more discriminating than expected, and only the better candidates

simply multiplied the 900 amino acids by three.

(ii) There was a good proportion of correct answers, and many more made a sufficiently sensible attempt to gain a mark for the principle. Some gave a figure for two flagella, rather than for each flagellum, and others made errors with the number of zeros or the indices.

(c) (i) A good proportion of candidates gained both marks for this part, but quite a large number failed to compare the results for puromycin with those for the control. The latter group simply described the curve for puromycin. Some weaker candidates misinterpreted the graph and stated that the flagella stopped growing longer after 20 minutes.

(ii) This question was targeted at the more able candidates and the examiners were looking for a precise explanation of the evidence. It was, however, pleasing to note that large numbers of candidates were able to make the links between transcription and mRNA production and between translation and protein synthesis. Better candidates did point out that actinomycin D had no significant effect on regrowth of the flagella and that therefore the cells must be using existing mRNA. Fewer specified that the rate of regrowth declined after about 20 minutes in the presence of puromycin, so only some of the regrowth could be attributed to proteins already present in the cells.

## Q69.

(a) Very few candidates failed to gain at least one mark. **A** was almost invariably correctly identified as mitochondria but **B** was more frequently incorrectly labelled. The most common mistake was to label it endoplasmic reticulum, without reference to ribosomes. Some candidates apparently failed to appreciate that the guideline did not point to a ribosome.

(b) This question was generally not well answered with a significant number of candidates gaining no marks. Only the better candidates suggested that the different shapes were a result of sections taken of mitochondria in different positions. There were poorly expressed references to organelles being seen from different angles. Weaker candidates often gave explanations in terms of the mitochondria being specialised for different functions.

(c) Most candidates gained a mark. The most common mistake was to suggest the function was transport, even after correctly naming the organelle.

(d) Only the better candidates achieved full marks, with the majority gaining two. Very few linked the high numbers of mitochondria with a high rate of respiration. The most common omission was a failure to link an adaptation with the function of these cells in absorption.

## Q70.

(a) This was answered well by the majority of candidates, with many scoring full marks. Part (i) was answered better than (ii), as a significant number identified **B** as the cytoplasm, even though they correctly gave its role in photosynthesis.

(b) Many candidates identified the main substance in **C** as starch. Although some candidates mentioned glucose as the substrate, only a minority explained how starch was formed from the glucose. There was a wide range of incorrect answers including chlorophyll, water and protein.

## Q71.

Cell structure was generally well understood, although some candidates assumed that cell walls are a feature of eukaryotic cells and are absent from prokaryotes. The calculation was attempted by the majority of candidates, most of whom measured the scale bar and gained at least one mark.

## Q72.

This question produced a wide range of marks and proved to be an effective discriminator.

(a) Answers to this question were rather disappointing, often lacking the precise details expected at Advanced level. Although some candidates referred to 'memory cells', many did not specify that these are T or B cells (lymphocytes). Better candidates did mention antibodies but they often failed to explain that antibodies previously produced were ineffective or that it takes time to produce new effective antibodies following infection by a new strain of the influenza virus.

(b) In part (c)(i), although many candidates appreciated that macrophages engulf pathogens, few candidates precisely described that the antigen is then displayed on the macrophage cell membrane. An alternative mark point credited was the role of macrophages in producing cytokinins which stimulate B lymphocytes. Part (c)(ii) was generally well answered with most candidates obtaining at least two marks. Many candidates explained that the mitochondria provide ATP and that the RER or ribosomes are involved in protein synthesis. Although some candidates then linked protein synthesis to antibody production, only the best candidates provided a correct function of the Golgi body in terms of packaging and/or secreting proteins or glycoproteins.

## Q73.

(a) Only the weakest candidates failed to score here. Some candidates gave villi or failed to gain the mark by giving the examiner the choice of microvilli /villi.

(b) Many candidates failed to measure the scale bar and most did not know that there are 1000μm in a mm. Answers were often out by a factor of 10. Most candidates gained the resolution mark but then failed to relate this to the shorter wavelength of the electrons' beam. Some answers linked detail only to increased magnification.

(c) This part was not well answered, only the better candidates recognising the link between width and short diffusion pathway. Many referred to SA:V ratio but then failed to relate this to diffusion. A common error was to assume the mitochondria would be able to move around the cell more easily, and weaker candidates often opted for the simple idea that more would fit into a cell.

## Q74.

(a) A majority of candidates did not attempt to calculate the total surface area of the red blood cells. Most of those who made the attempt had difficulty with units or with standard form, consequently only a handful successfully completed the calculation and were able to make the correct deduction from the data.

(b) Most candidates obtained at least one of the two marks, but relatively few could relate the feature they described to measurement of membrane surface area.