St Mary's Science Department

A level Biology

Independent Work Book

Cell Structure and Division

Name: _____

Class: _____

Teacher : _____

Q1.

(a) Name the process by which bacterial cells divide.

_____

(1)

A microbiologist investigated the ability of different plant oils to kill the bacterium *Listeria monocytogenes*. She cultured the bacteria on agar plates. She obtained the bacteria from a broth culture.

(b) Describe **two** aseptic techniques she would have used when transferring a sample of broth culture on to an agar plate.
Explain why each was important.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)

The microbiologist tested five different plant oils at two different temperatures and determined the minimum concentration of plant oil that killed the *L. monocytogenes*.

The table below shows her results.

Plant oil	**Minimum concentration of plant oil that killed *Listeria monocytogenes* / percentage**	
	4 °C	**35 °C**
Bay	0.10	0.04
Cinnamon	0.08	0.08
Clove	0.05	0.05
Nutmeg	>1.00	0.05
Thyme	0.02	0.03

(c) Which plant oil is least effective at killing *L. monocytogenes* at 35 °C?

_____

(1)

L. monocytogenes is a pathogen of great concern to the food industry, especially in foods stored in refrigeration conditions (4 °C) where, unlike most food-borne pathogens, it is able to multiply. It has been suggested that plant oils, together with refrigeration may help to reduce the growth of *L. monocytogenes*.

(d) What conclusions can be drawn about the effectiveness of using plant oils with refrigeration to reduce food-borne infections caused by *L. monocytogenes*?

_____

_____

_____

_____

(3)

(e) Plant oils are hydrophobic and can cross the cell-surface membrane of the bacterium. The low temperature of 4 °C can slow the rate of entry of plant oils into the cells.

Suggest how the low temperature slows the rate of entry.

_____

_____

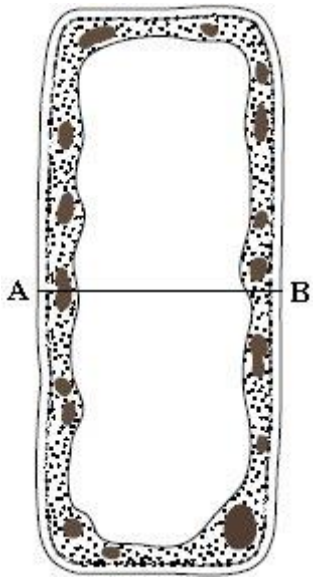
_____

(1)

(Total 10 marks)

Q2.

The figure shows a section through a palisade cell in a leaf as seen with a light microscope. The palisade has been magnified × 2000.



x 2000

(a) Calculate the actual width of the cell, measured from **A** to **B**, in µm. Show your working.

Answer _____ µm

(2)

(b) Palisade cells are the main site of photosynthesis. Explain **one** way in which a palisade cell is adapted for photosynthesis.

_____

_____

_____

_____

(2)

(Total 4 marks)

Q3.

(a) Describe how you would use cell fractionation techniques to obtain a sample of chloroplasts from leaf tissue. Do **not** include in your answer information about any solutions.

(3)

(b) The table shows features of a mitochondrion and a chloroplast. Complete the table with ticks where a feature is present.

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

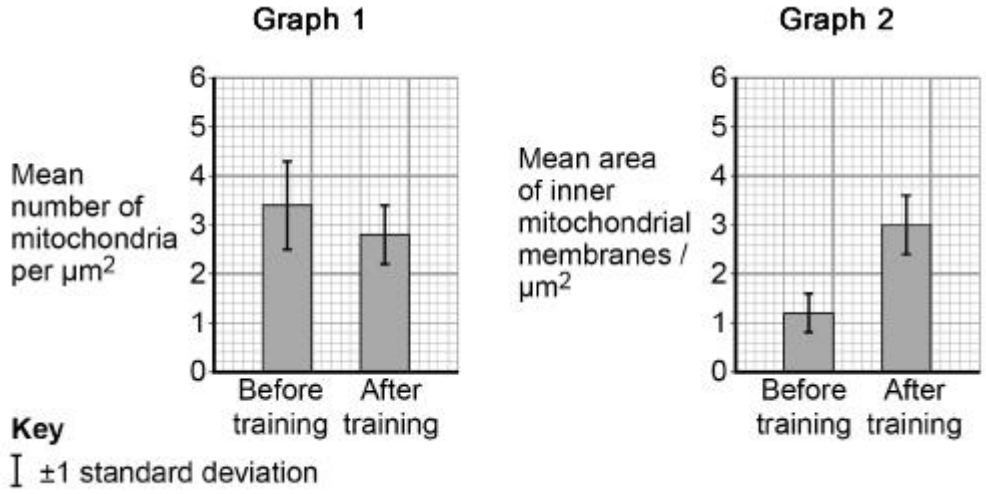
(3)

(c) Give the function of a mitochondrion.

(1)

(d) Scientists investigated the effect of an exercise programme on the number and size of mitochondria in skeletal muscle. They took samples of muscle from a large number of volunteers before and after the exercise programme. From each sample, they cut thin sections and used these to determine the mean number of mitochondria per μm^2 and the mean area of inner mitochondrial membranes.

Their results are shown in **Graph 1** and **Graph 2**.



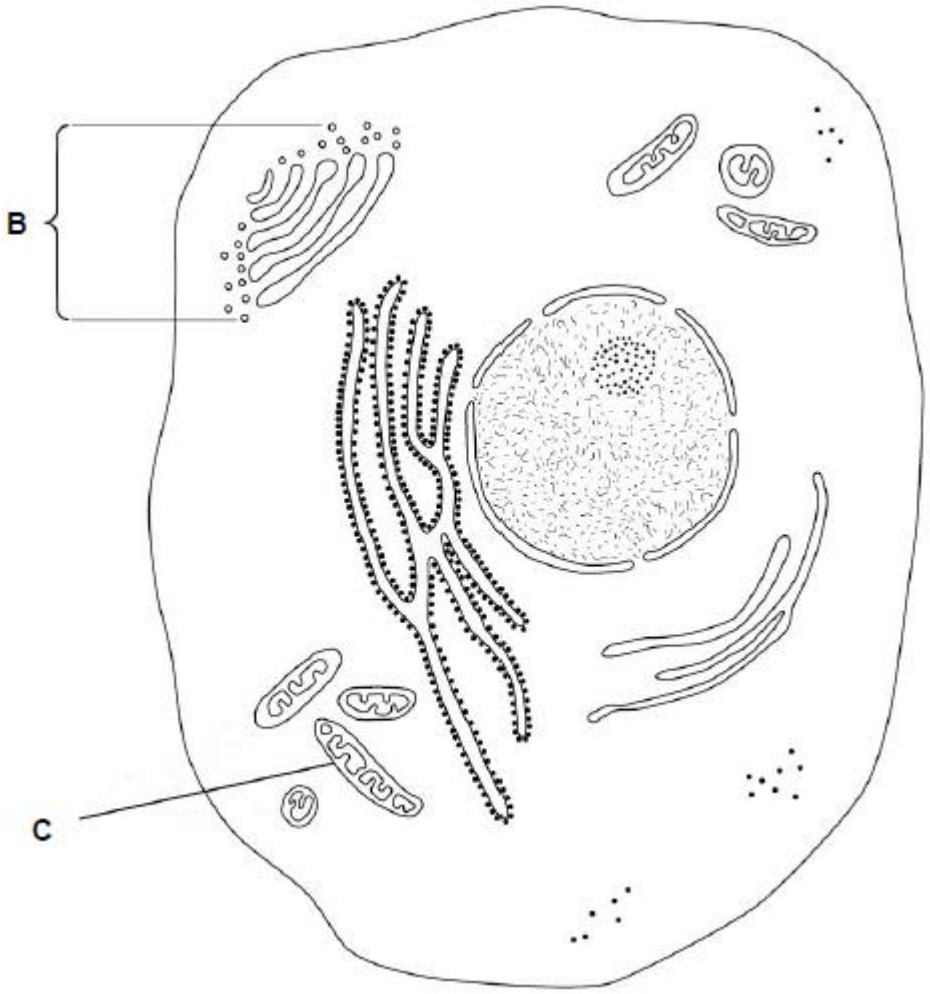
What do the data in **Graph 1** and **Graph 2** suggest about the effect of the exercise programme on mitochondria?

(2)

(Total 9 marks)

Q4.

Below is a diagram of an animal cell.



(a) Name the organelles labelled:

B _____

C _____

(2)

(b) Name **two** structures present in plant cells that are **not** present in animal cells.

1. _____

2. _____

(1)

A biologist prepared a sample of organelles labelled **C** from liver. He used the following method.

1. Added to the liver tissues an ice-cold, buffered solution with the same water potential as the liver tissue.
2. Mixed the liver and solution in a blender.
3. Filtered the mixture from the blender.
4. Spun the filtered liquid in a centrifuge at a low speed. A pellet appeared in the bottom of the centrifuge tube.

5. Poured off the liquid above the pellet into a second centrifuge tube and spun this at a higher speed to obtain the sample of organelles labelled **C**.

(c) Explain why the solution the biologist used was ice-cold, buffered and the same water potential as the liver tissue (step 1).

Ice-cold_____

_____

Buffered_____

_____

Same water potential_____

_____

(3)

(d) Explain why the biologist used a blender and then filtered the mixture (steps 2 and 3).

_____

_____

_____

_____

_____

(2)

(e) Name the organelle that made up most of the first pellet after centrifuging at a low speed (step 4).

_____

(1)

(f) The second centrifuge tube was spun at a higher speed to obtain the sample of organelles labelled **C** in the diagram (step 5).

Suggest why.

_____

_____

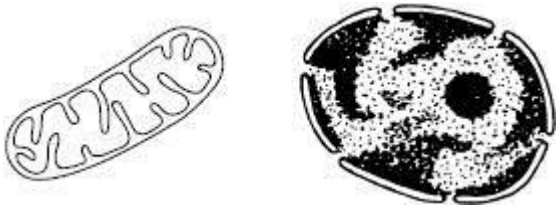
_____

(1)

(Total 10 marks)

Q5.

(a) The diagram shows two organelles found in a eukaryotic cell.



A **B**

(i) Name the organelles.

A _____

B _____

(1)

(ii) Explain how the inner membrane is adapted to its function in organelle **A**.

_____

_____

_____

_____

(2)

(b) Give **one** feature of a prokaryotic cell that is not found in a eukaryotic cell.

_____

(1)

(c) Describe how a sample consisting only of chloroplasts could be obtained from homogenised plant tissue.

_____

_____

_____

_____

_____

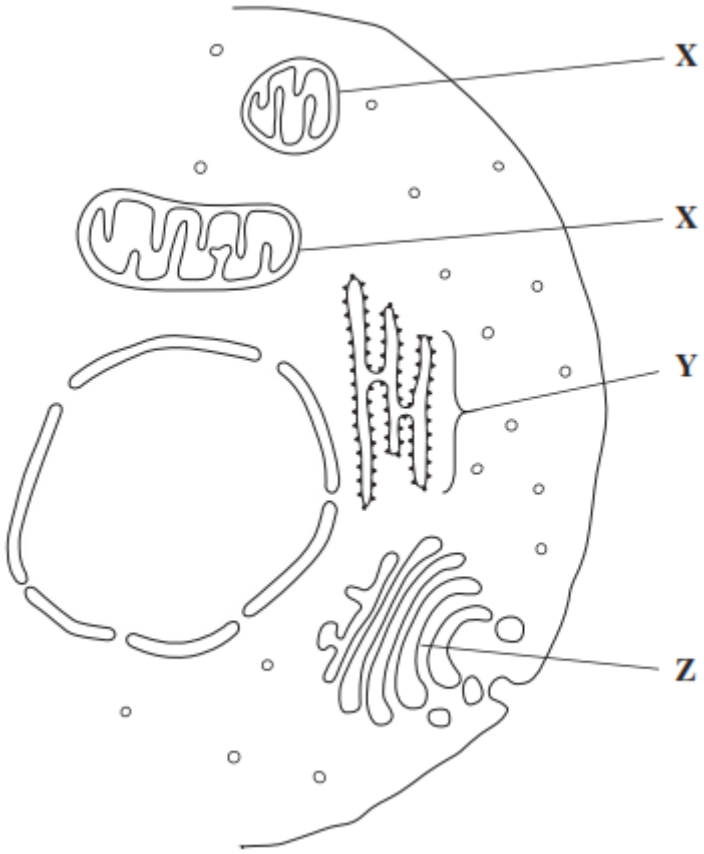
_____

(3)

(Total 7 marks)

Q6.

The drawing shows part of a human cell.



(a) Name organelles

X _____

Y _____

(2)

(b) (i) The organelles labelled **X** all have very similar shapes in this cell.
Explain why they appear to have different shapes in this drawing.

_____

_____

(Extra space) _____

_____

(1)

(ii) Large numbers of organelles **X** and **Z** are found in mucus-secreting cells. Explain why.

_____

_____

_____

_____

(Extra space) _____

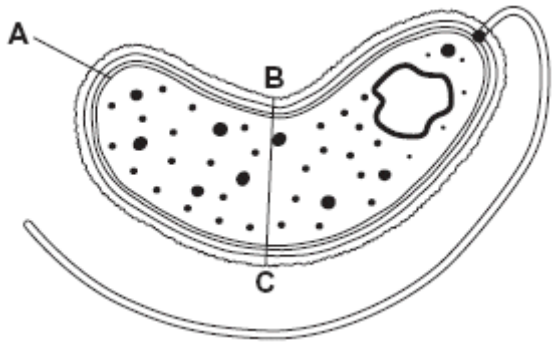
_____

(2)

(Total 5 marks)

Q7.

The diagram shows a cholera bacterium. It has been magnified 50 000 times.



(a) Name **A**.

_____

(1)

(b) Name **two** structures present in an epithelial cell from the small intestine that are **not** present in a cholera bacterium.

1. _____

2. _____

(2)

(c) Cholera bacteria can be viewed using a transmission electron microscope (TEM) or a scanning electron microscope (SEM).

(i) Give **one** advantage of using a TEM rather than a SEM.

_____

_____

(1)

(ii) Give **one** advantage of using a SEM rather than a TEM.

_____

_____

_____

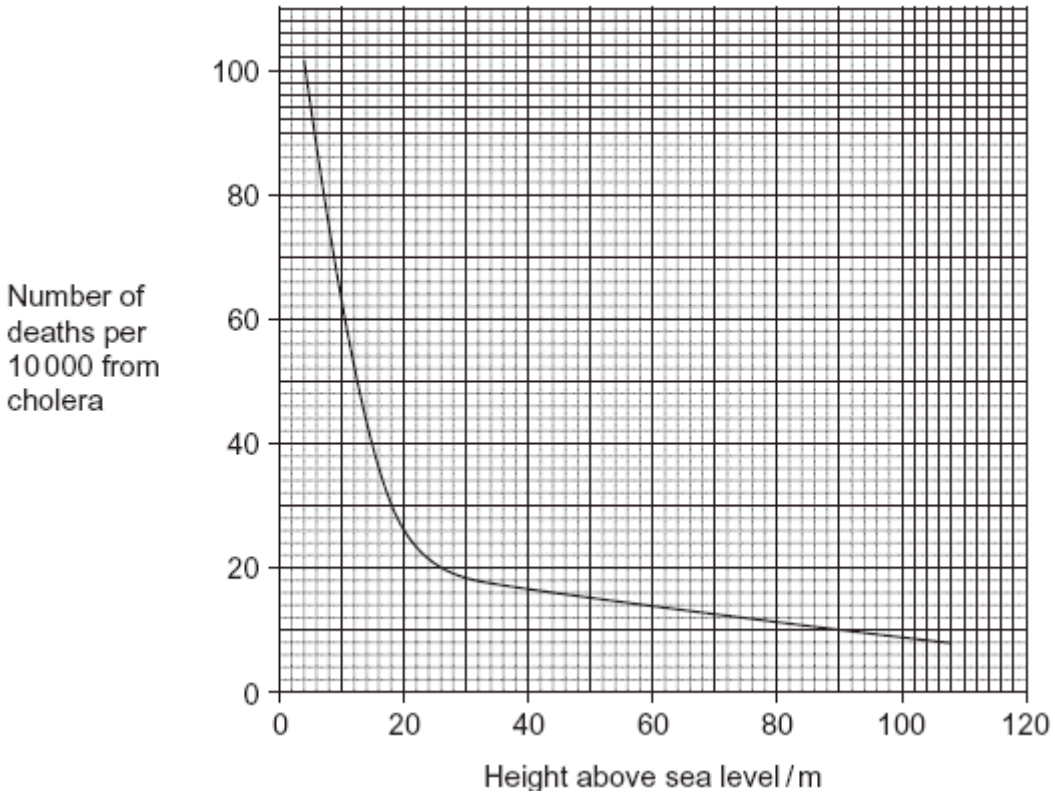
(1)

(d) Calculate the actual width of the cholera bacterium between points **B** and **C**.
Give your answer in micrometres and show your working.

_____ µm

(2)

(e) An outbreak of cholera occurred in London in 1849. The graph shows the relationship between the number of deaths from cholera and the height at which people lived above sea level.



Describe the relationship between the number of deaths from cholera and the height at which people lived above sea level.

_____

_____

_____

_____

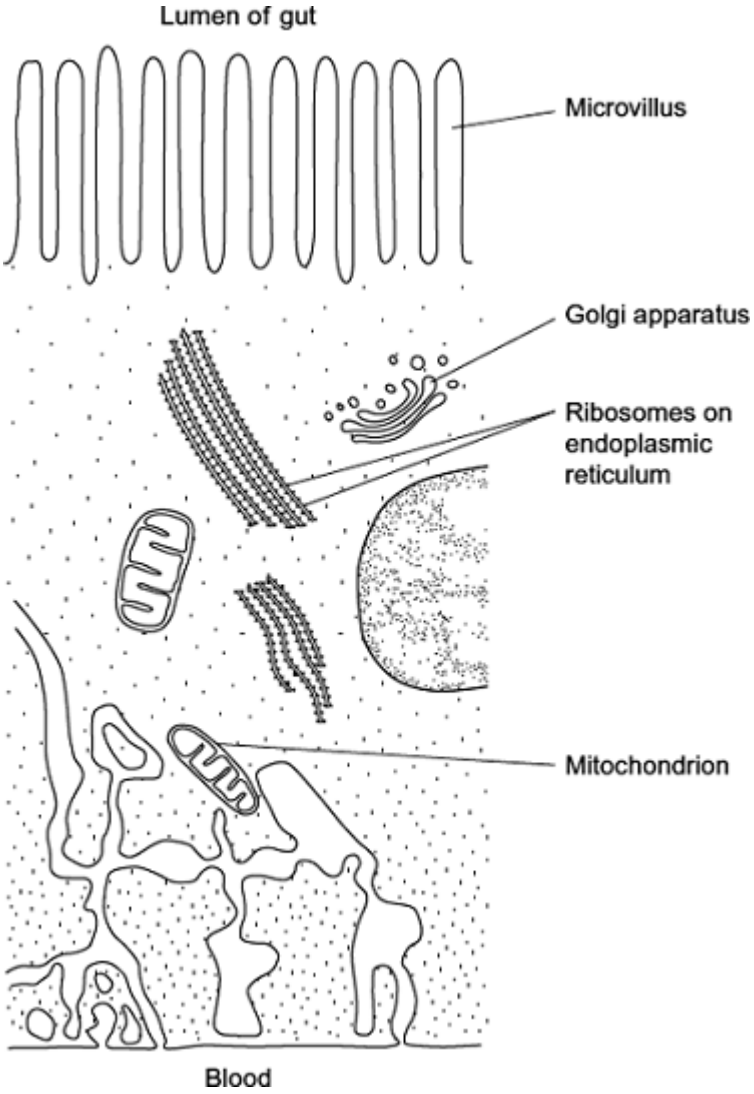
_____

(2)

(Total 9 marks)

Q8.

The diagram shows part of an epithelial cell from an insect's gut.



This cell is adapted for the three functions listed below. Use the diagram to explain how this cell is adapted for each of these functions.

Use a **different** feature in the diagram for each of your answers.

(a) the active transport of substances from the cell into the blood

_____

_____

_____

_____

_____

_____

(2)

(b) the synthesis of enzymes

_____

_____

_____

_____

_____

(2)

(c) rapid diffusion of substances from the lumen of the gut into the cytoplasm

_____

_____

_____

(1)

(Total 5 marks)

Q9.

(a) Small samples of plant tissue were placed in a cold, isotonic solution and then treated to break open the cells to release the organelles. The different organelles were then separated. Describe a technique that could be used to

(i) break open the cells;

_____

_____

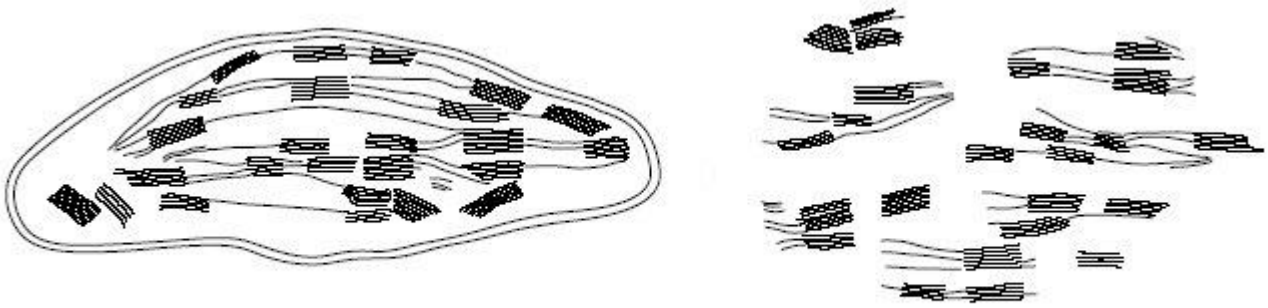
(ii) separate the organelles.

_____

_____

(2)

(b) One group of organelles was placed in a hypotonic solution. The diagram shows one of these organelles seen under an electron microscope before and after it was placed in the hypotonic solution.



Before

After

Name the organelle.

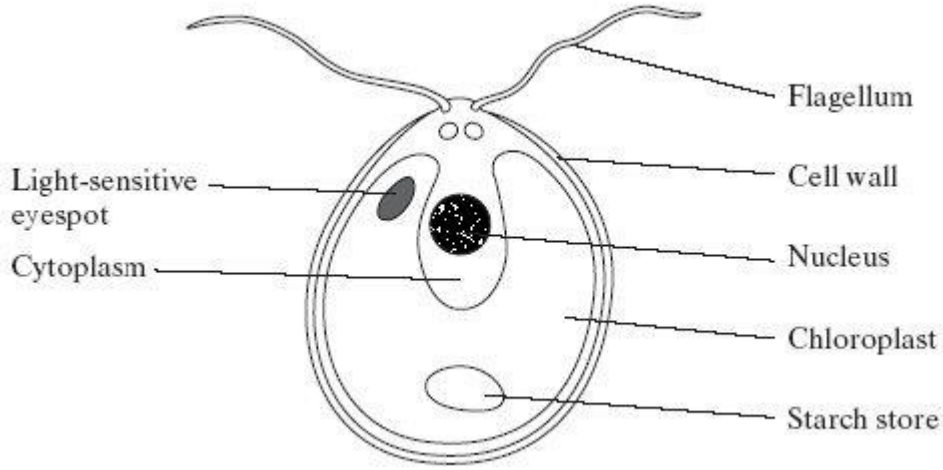
_____

(1)

(Total 3 marks)

Q10.

The diagram shows a single-celled organism called *Chlamydomonas*.



(a) *Chlamydomonas* lives in fresh-water ponds. It uses its flagella to swim towards light of moderate intensity but away from very bright light. Using information in the diagram, explain the advantage of this behaviour.

_____

_____

_____

_____

(2)

(b) A *Chlamydomonas* cell has two flagella. These flagella contain a single sort of protein. A flagellum consists of a bundle of 242 filaments. Each filament consists of 7500 protein molecules. Each protein molecule contains 900 amino acid units.

(i) What would be the minimum number of nucleotides in the coding region of the mRNA used to synthesise this protein?

_____

(1)

(ii) In an investigation, a culture of *Chlamydomonas* was treated in a way that caused them to lose their flagella without any other damage to the cells. The flagella grew back to their original length in 60 minutes.

How many amino acid molecules would be incorporated into each growing flagellum per minute? Show your working.

Answer _____

(2)

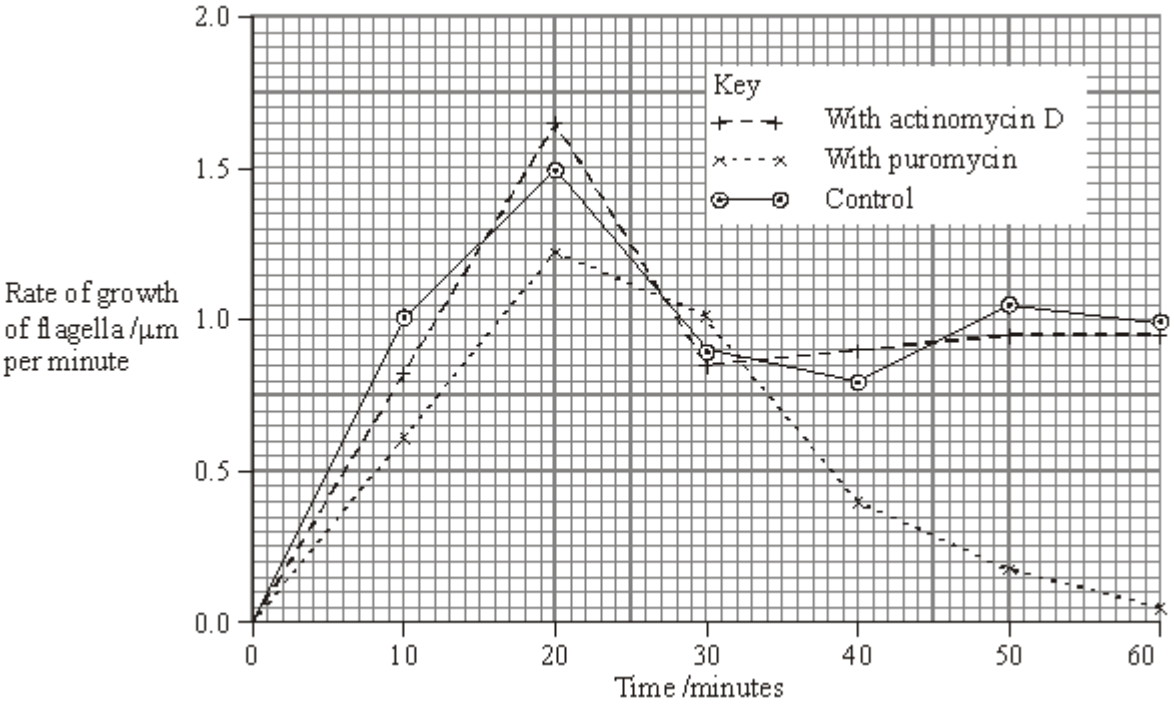
(c) The researchers investigated the rate at which the flagella grew in three different media.

1. A medium containing actinomycin D, which prevents transcription by binding to the guanine in DNA

2. A medium containing puromycin, which prevents translation by attaching to ribosomes

3. A control medium

The results are shown in the graph.



(i) Describe how the rate of growth was affected by puromycin.

_____

_____

_____

_____

(2)

(ii) The researchers concluded

1. that the cells used mRNA that is already present in the cytoplasm for the regrowth of the flagella;

2. that some of the regrowth uses protein molecules already present in the cell.

Explain the evidence for each of these conclusions.

1. _____

_____

_____

_____

2. _____

_____

_____

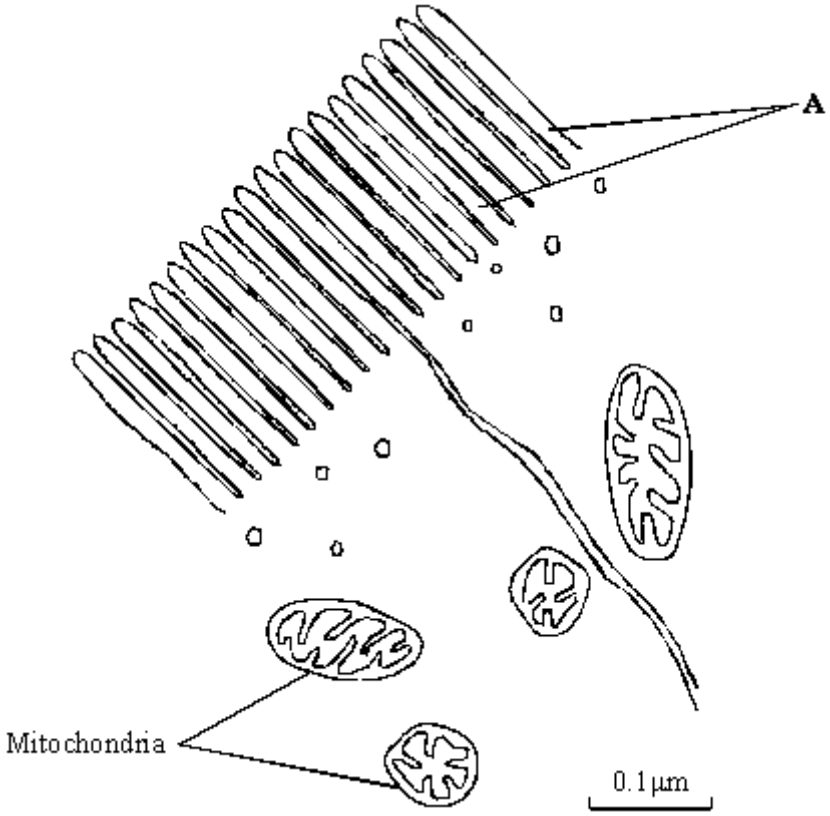
_____

(4)

(Total 11 marks)

Q11.

The drawing shows an electron micrograph of parts of epithelial cells from the small intestine.



(a) (i) Name the structures labelled **A**.

_____

(1)

(ii) Explain how these structures help in the absorption of substances from the small intestine.

_____

_____

(1)

(b) (i) The scale bar on this drawing represents a length of 0.1µm. Calculate the magnification of the drawing. Show your working.

Magnification _____

(2)

(ii) Explain why an electron microscope shows more detail of cell structure than a light microscope.

_____

_____

_____

(2)

(c) The length of mitochondria can vary from 1.5 μm to 10 μm but their width never exceeds 1μm. Explain the advantage of the width of mitochondria being no more than 1μm.

_____

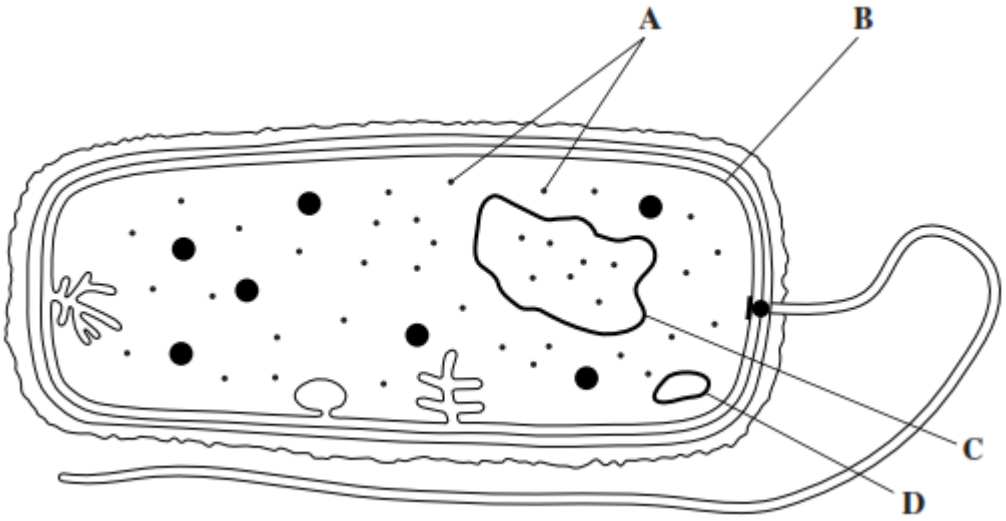
_____

(1)

(Total 7 marks)

Q12.

The diagram shows a bacterium.



(a) Name

(i) organelle **A** _____

(1)

(ii) structure **B** _____

(1)

(b) Give **two** ways in which the structure of this bacterium is different from the structure of cells lining the alveoli of a human lung.

1. _____

_____

2. _____

_____

(2)

(c) Structures **C** and **D** are made of the same type of biological molecule. They have a similar function.

What is the function of **C** and **D**?

_____

_____

(1)

(Total 5 marks)

Q13.

(a) Describe the appearance and behaviour of chromosomes during mitosis.

(5)

(b) Describe and explain the processes that occur during meiosis that increase genetic variation.

(5)

(Total 10 marks)

Q14.

A student investigated mitosis in the tissue from an onion root tip.

(a) The student prepared a temporary mount of the onion tissue on a glass slide. She covered the tissue with a cover slip. She was then given the following instruction.

"Push down hard on the cover slip, but do not push the cover slip sideways."

Explain why she was given this instruction.

_____

_____

_____

_____

(2)

The image below shows one cell the student saw in the onion tissue.

© Ed Reschke/
Oxford Scientific/Getty Images

(b) The student concluded that the cell in the image above was in the anaphase stage of mitosis.
Was she correct? Give **two** reasons for your answer.

1. _____

_____

2. _____

_____

(2)

(c) The student counted the number of cells she observed in each stage of mitosis. Of the 200 cells she counted, only six were in anaphase.

One cell cycle of onion root tissue takes 16 hours. Calculate how many minutes these cells spend in anaphase.

Show your working.

Answer = _____ minutes

(2)

(Total 6 marks)

Q1.

(a) Binary fission;

Reject mitosis

1

(b) 1. Keep lid on Petri dish
OR
Open lid of Petri dish as little as possible.

2. To prevent unwanted bacteria contaminating the dish.
OR
L. monocytogenes may be dangerous / may get out.

OR

3. Wear gloves
OR
Wear mask
OR
Wash hands;

4. To prevent contamination from bacteria on hands / mouth
OR
Prevent spread of bacteria outside the lab;

OR

5. Use sterile pipette
OR
Flame the loop
OR
Flame the neck of the container of the culture;

6. To maintain a pure culture of bacteria

4 max

(c) Cinnamon;

1

(d) 1. Thyme is the most effective / best (at 4 °C);

2. Clove and cinnamon same effectiveness at 4 °C as 35 °C (so suitable);

3. Bay and nutmeg are less effective at 4 °C than 35 °C (so unsuitable).

3

(e) Less kinetic energy
OR
Less movement of oil molecules / of phospholipid molecules

1 max

[10]

Q2.

(a) 16 gains 2 marks;

(accept 15.5 . 16.5)

(principal of calculation i.e.
measured distance (31-33mm / 3.1-3.3cm) gains 1 mark)
Mag

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]

Q3.

(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 μm^2);
2. Training led to an increase in the area (of inner mitochondrial membrane);
    1. *Accept **Graph 1** as mean number of mitochondria per μm^2*
    2. *Accept **Graph 2** as area of inner mitochondrial membrane*

2

[9]

Q4.

(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 <u>osmosis</u> 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]

Q5.

(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]

Q6.

(a) X = mitochondria;
Y = (rough) endoplasmic reticulum;
Accept ribosomes/ER/RER for Y
Reject smooth endoplasmic reticulum for Y

2

(b) (i) (Sections cut at) different angles/in different planes;
Ignore name given to organelle

1

(ii) Z modifies/packages/transports/secretes mucus/ Z adds sugars to proteins;
X provides ATP/energy (for this);
Accept makes in relation to Z but not X
Ignore names of organelles if function correct

2

[5]

Q7.

(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]

Q8.

(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]

Q9.

(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]

Q10.

(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]

Q11.

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

1

(ii) increased surface area (for diffusion);

1

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

(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]

Q12.

(a) (i) Ribosome(s);

1

(ii) Plasma/cell (surface) membrane;

Accept membrane unless disqualify with, e.g. nuclear membrane

1

(b) **Two** suitable comparisons, accepting bacterial cell has;

Examples,
Bacterial cell has capsule/slime layer;
Cell wall;
(Bacterial) flagellum;
Mesosome;
Different size ribosomes;
Circular DNA;
Human cell has nucleus;
Membrane-bound organelles;
Two named examples of membrane-bound organelles;

Reject ref to thin and flat

2 max

(c) Carry genetic information/genes;

Reject/ignore to carry DNA to carry genetic code

Accept genetic material with coded information – information for protein synthesis

Ignore genetic material on its own

1

[5]

Q13.

(a) (During prophase)

1. Chromosomes
coil / condense / shorten / thicken / become visible;

2. (Chromosomes) appear as (two sister) chromatids joined at the centromere;

(During metaphase)

3. Chromosomes line up on the equator / centre of the cell;

4. (Chromosomes) attached to spindle fibres;

5. By their centromere;

(During anaphase)

6. The centromere splits / divides;

7. (Sister) chromatids / chromosomes are pulled to opposite poles / ends of the cell / separate;

(During telophase)

8. Chromatids / chromosomes
uncoil / unwind / become longer / thinner.

No marks for naming the stages

Reject references to homologous chromosomes / pairing of chromosomes

Ignore references to spindle formation during prophase

5 max

(b) 1. Homologous chromosomes pair up;

2. Independent segregation;

3. Maternal and paternal chromosomes are re-shuffled in any combination;

4. Crossing over leads to exchange of parts of (non-sister) chromatids / alleles between homologous chromosomes;

5. (Both) create new combinations of alleles;

5

[10]

Q14.

(a) 1. Push hard – spread / squash tissue;
2. Not push sideways – avoid rolling cells together / breaking chromosomes.

Neutral – to see cells clearly

2

(b) No (no mark)
Yes (no mark)

1. Chromosomes / chromatids are (in two groups) at poles of spindle / at ends of spindle;

Do not accept 'ends of cell'

2. V-shape shows that (sister) chromatids have been pulled apart at their centromeres / that centromeres of (sister) chromatids have been pulled apart.

2

(c) 28.8 / 29.

If incorrect, allow:

$\frac{6}{200} \times 960$ *= 1 mark*

2

[6]