

PEARSON EDEXCEL A-LEVEL BIOLOGY B • 9B10

BIOLOGY



EXAM QUESTION PACK

TOPIC 2: CELLS, VIRUSES AND REPRODUCTION OF LIVING THINGS
EUKARYOTIC AND PROKARYOTIC CELL STRUCTURE AND FUNCTION

SCORE

/143

PERCENTAGE

%

STEMUP

These questions belong to Pearson Edexcel, not to us.

The examination questions and mark schemes in this pack were written and published by Pearson Edexcel. They are past assessment materials, reproduced here so that students can revise from them.

What we do not own

STEMUP is not affiliated with Pearson Edexcel and does not own, and makes no claim to own, any of the question or mark scheme material in this pack. Pearson has not endorsed, approved or been involved in the production of it. Pearson, Edexcel and the qualification titles used here belong to their respective owners and appear for identification only.

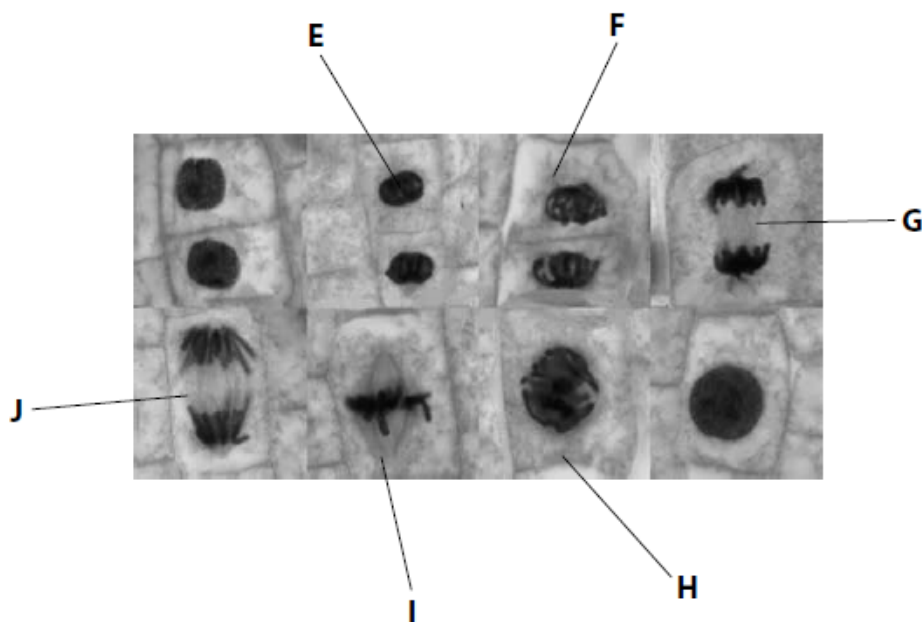
Where to find the originals

Pearson publishes its past papers and mark schemes free of charge. Always check the current specification at [qualifications.pearson.com](https://www.pearson.com/qualifications) before you revise, because content and wording can change between series.

If you hold the rights to any material in this pack and would like it amended or removed, contact admin@stemup.co.uk and we will act on it.

Q1.

The photograph below shows cells dividing by mitosis.



(a) The actual length of cell **J** is 23.5 μm .

(i) Calculate the magnification of this photograph.

(3)

Answer

(ii) Describe what has happened in cell **J**.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

(b) (i) Which sequence of letters represent the cells in order of their appearance in the phases of mitosis?

(1)

- ☐ **A** E, F, G, H, I, J
- ☐ **B** G, F, H, I, J, E
- ☐ **C** H, I, J, G, F, E
- ☐ **D** J, I, H, G, F, E

(ii) Give a reason why there are differences in the appearance of cells **E** and **G**.

(1)

.....

.....

(Total for question = 9 marks)

Q2. Bacteria and viruses can cause human diseases.

(a) Distinguish between the structure of bacteria and viruses

(3)

.....

.....

.....

.....

.....

.....

(b) Infection with a bacterium can result in the development of active immunity to that bacterium. This results in the production of antibodies by plasma cells.

(i) Describe how infection with a bacterium results in the production of plasma cells.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

(ii) Explain how antibodies help a person to recover from an infection.

(2)

.....

.....

.....

.....

.....

(iii) A person who has had an organ transplant has to take immunosuppressive drugs. This prevents the immune system from destroying the organ transplant. Some of these drugs work by inhibiting the production of cytokines.

Suggest what effect these drugs could have on a person infected with a bacterium or a virus.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

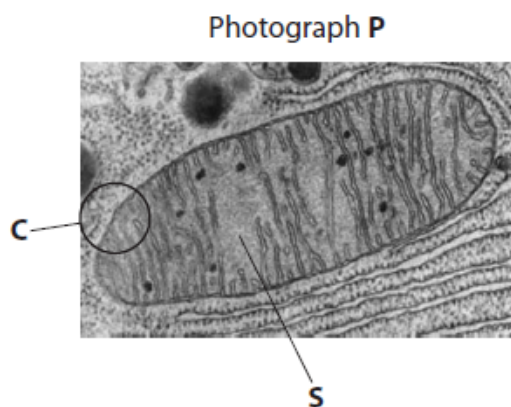
(Total for Question = 13 marks)

Q3.

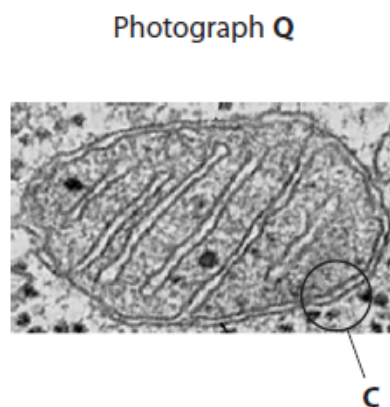
Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Photographs **P** and **Q** are electron micrographs of mitochondria.

Each photograph was taken using a different electron microscope.



Sourced from: <http://book.bionumbers.org/how-big-are-mitochondria/>



Source: Cellupedia

(i) What is the structure labelled **S**?

(1)

- ☐ **A** crista
- ☐ **B** matrix
- ☐ **C** stroma
- ☐ **D** thylakoid

(ii) Explain the difference in appearance of the parts labelled **C** using the two different electron microscopes.

(2)

.....

.....

.....

.....

.....

.....

(Total for question = 3 marks)

Q4.

Mitochondria and chloroplasts in eukaryotic cells are thought to have originated millions of years ago by a process called endosymbiosis.

In endosymbiosis, free-living prokaryotic organisms were engulfed by their new host cells.

The table shows the lipid composition of the membranes of these two organelles.

Type of lipid	Percentage of total lipid composition of membranes (%)	
	In mitochondria	In chloroplasts
phosphatidyl A	43	0
phosphatidyl B	35	0
phosphatidyl C	6	1
phosphatidyl D	3	7
phosphatidyl E	13	0
monogalactosyldiacylglycerol F	0	55
digalactosyldiacylglycerol G	0	24
sulfolipid H	0	8

(i) Analyse the data and use your knowledge to explain why these two organelles are thought to have originated from different prokaryotic organisms.

(3)

.....

.....

.....

.....

.....

.....

.....

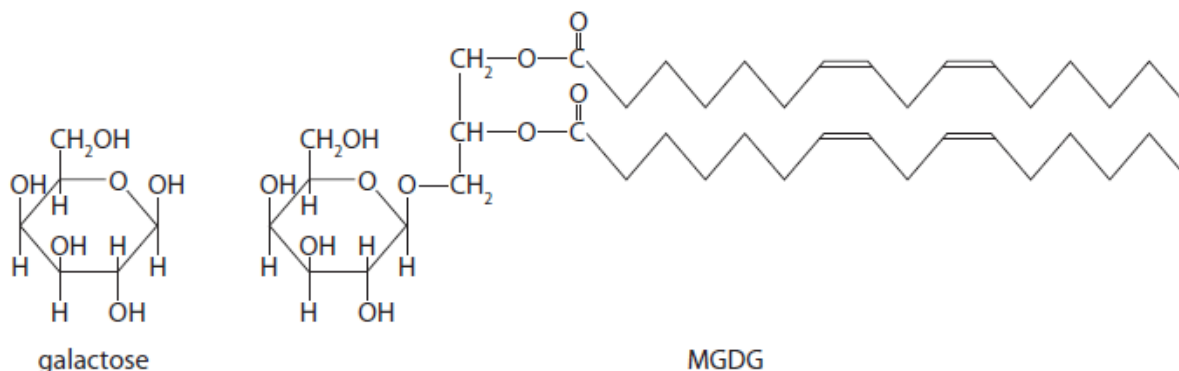
.....

.....

(ii) Digalactosyldiacylglycerol (DGDG) is synthesised from galactose and monogalactosyldiacylglycerol (MGDG).

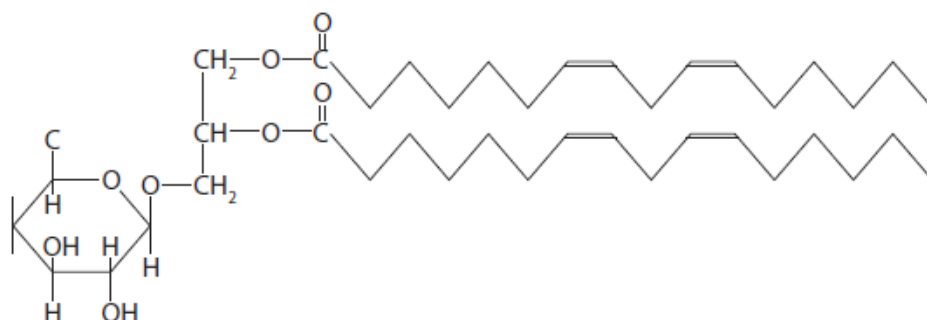
The galactose forms a 1,6 glycosidic bond with the MGDG.

The diagram shows the structure of galactose and MGDG.



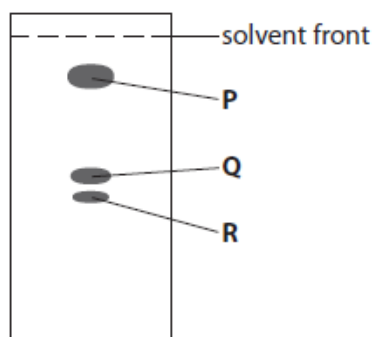
Complete the diagram below to show the structures of the products formed when DGDG is synthesised from galactose and MGDG.

(3)



(iii) Chromatography can be used to separate MGDG, DGDG and sulfolipid extracted from chloroplasts.

The diagram shows the position of these three lipids, **P**, **Q** and **R**, on a chromatogram.



Which row in the table identifies the position of these three lipids in this chromatogram ?

(1)

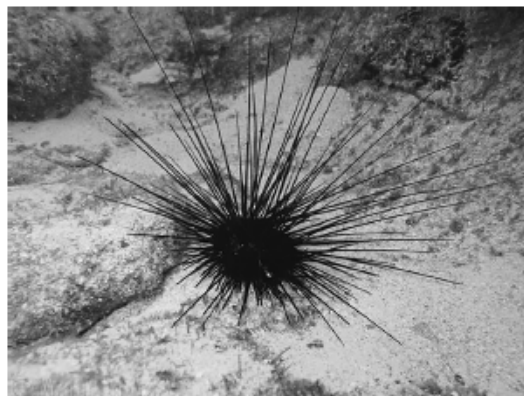
	Lipid in position P	Lipid in position Q	Lipid in position R
☐ A	DGDG	sulfolipid	MGDG
☐ B	MGDG	DGDG	sulfolipid
☐ C	sulfolipid	DGDG	MGDG
☐ D	sulfolipid	MGDG	DGDG

(Total for question = 7 marks)

Q5.

A sea urchin is an invertebrate animal that lives on the seabed.

The photograph shows a sea urchin.



Sea urchin embryos are often used to study embryonic development. In the early stages of embryonic development, a sea urchin embryo is similar to a mammalian embryo.

A scientist carefully removed one of the 128 cells from the hollow structure and injected fluorescent dye into its cytoplasm

She replaced this cell in a new position on the opposite side of the hollow structure.

The embryo then developed normally. The repositioned cell formed healthy tissue, appropriate to its new position.

The tissue formed by an embryonic cell is called the 'fate' of the cell.

(i) Explain how the scientist could identify the fate of the repositioned cell.

(2)

.....

.....

.....

.....

.....

(ii) The scientist found that repositioning this cell changed its fate.

Explain the scientist's finding.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Q6.

Leigh syndrome is a genetic disorder inherited from the mother. The mother carries genes for the disorder in her mitochondrial DNA.

Draw and label a mitochondrion.

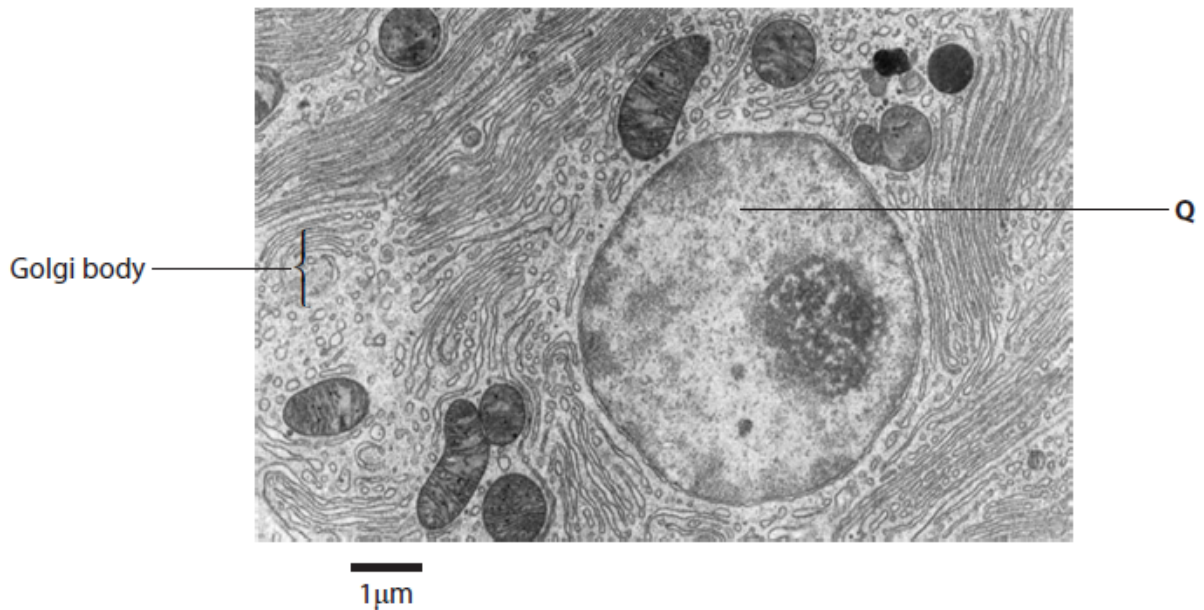
(4)

(Total for question = 4 marks)

Q7.

The pancreas is an organ that secretes digestive enzymes.

The electron micrograph shows part of a secretory cell from a human pancreas.



Name organelle **Q**.

(1)

(Total for question = 1 mark)

Q8.

Food poisoning can be caused by food that is contaminated with pathogenic microorganisms.

A number of different viruses can cause food poisoning.

One virus that can cause food poisoning is the Norovirus.

Noroviruses are RNA viruses.

(i) The following four statements are features of viruses:

1. have envelopes
2. contain reverse transcriptase
3. surrounded by a protein coat
4. have a helical structure

Which of the following is correct for all RNA viruses?

(1)

- ☐ **A** statement 1, statement 2 and statement 3
- ☐ **B** statement 2 only
- ☐ **C** statement 3 only
- ☐ **D** statement 1 and statement 4

(ii) Which of the following groups of viruses are also RNA viruses?

(1)

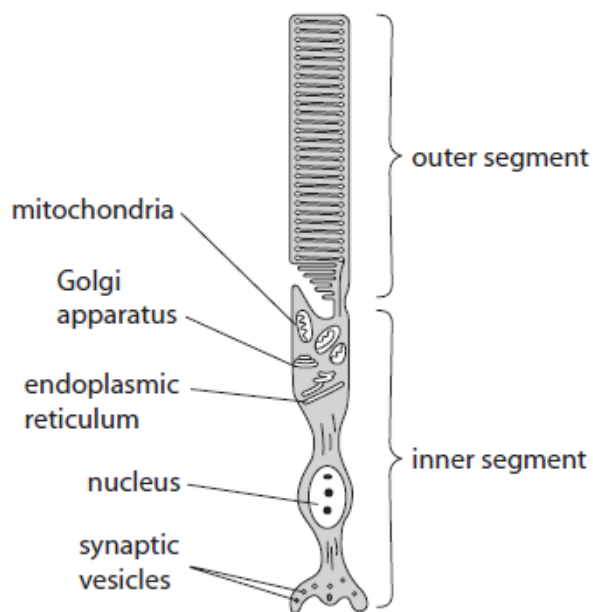
- ☐ **A** Ebola virus, human immunodeficiency virus and tobacco mosaic virus
- ☐ **B** Ebola virus, λ phage and tobacco mosaic virus
- ☐ **C** Human immunodeficiency virus, λ phage and tobacco mosaic virus
- ☐ **D** λ phage and tobacco mosaic virus

(Total for question = 2 marks)

Q9.

Answer the question with a cross in the boxes you think are correct ☐. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.

The diagram shows the structure of a rod cell.



(i) How many of the labelled organelles have a double membrane?

(1)

☐ **A** 0

☐ **B** 1

☐ **C** 2

☐ **D** 3

(ii) Which of the following statements about the effect of light on rod cells are correct?

(1)

1. rhodopsin breaks down into opsin and trans-retinal
2. voltage-gated sodium channels open in the membrane
3. more neurotransmitter is released from the presynaptic terminal

☐ **A** 1 only

☐ **B** 1 and 2

☐ **C** 1 and 3

☐ **D** 2 and 3

(Total for question = 2 marks)

Fungi break down dead plant and animal material in ecosystems.

Some types of fungi produce cellulase enzymes. These enzymes break down cellulose.

The breakdown of cellulose can be detected using Benedict's solution.
This solution turns red if monomers from the breakdown of cellulose are present.

Give a reason why more cellulose is found in dead plant material than in dead animal material.

(1)

.....

.....

Q11.

The retina contains rod cells and bipolar neurones.

Rod cells contain large numbers of mitochondria.

Explain the role of mitochondria in the functioning of rod cells.

(2)

.....

.....

.....

.....

.....

(Total for question = 2 marks)

Q12.

Salmonella are Gram negative bacteria found in the large intestine of humans.

Which is the correct statement about *Salmonella*?

(1)

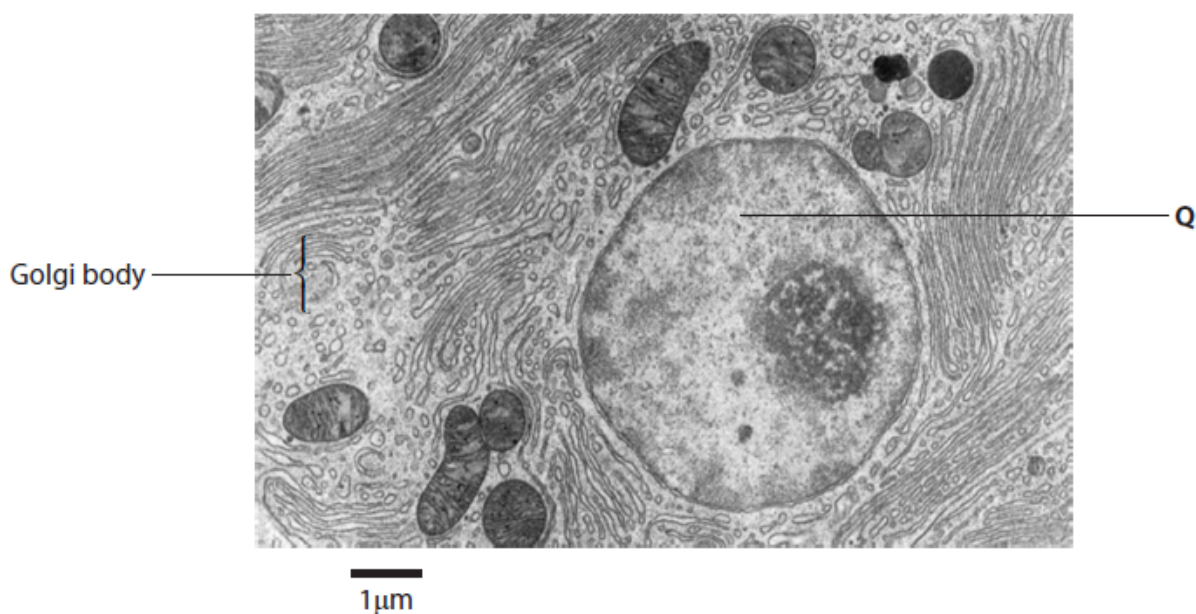
- ☐ **A** *Salmonella* has a thick peptidoglycan cell wall and produces endotoxins
- ☐ **B** *Salmonella* has a thick peptidoglycan cell wall and produces exotoxins
- ☐ **C** *Salmonella* has a thin peptidoglycan cell wall and produces endotoxins
- ☐ **D** *Salmonella* has a thin peptidoglycan cell wall and produces exotoxins

(Total for question = 1 mark)

Q13.

The pancreas is an organ that secretes digestive enzymes.

The electron micrograph shows part of a secretory cell from a human pancreas.



Describe the role of the Golgi body in producing secreted enzymes.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

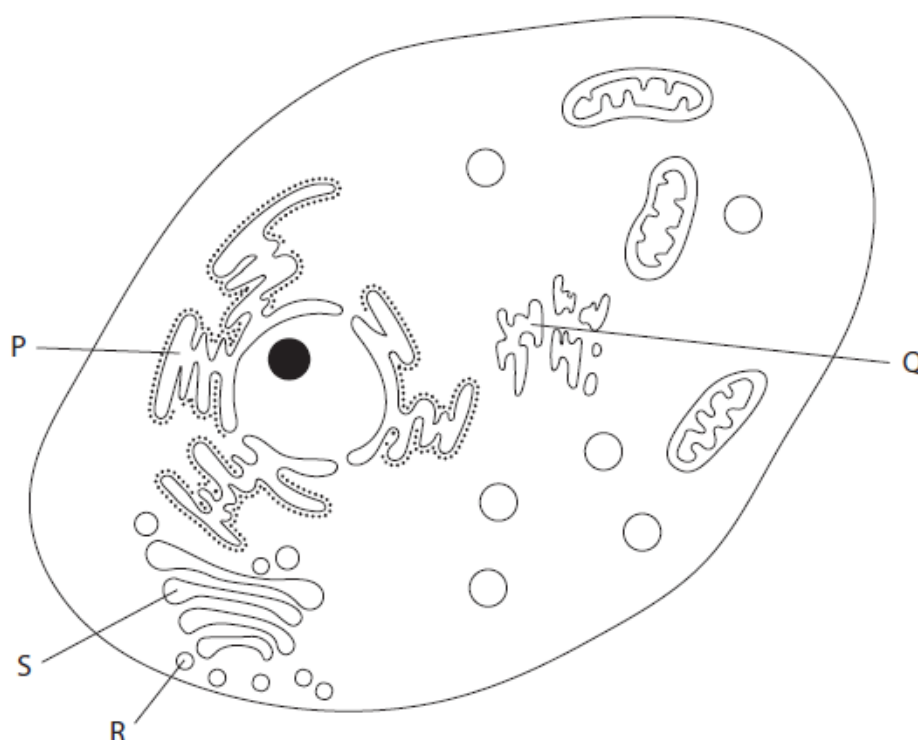
.....

(Total for question = 3 marks)

Q14.

Answer the question with a cross in the box you think is correct ☐. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.

The diagram shows the structure of an animal cell.



(i) Which of the following is the name of the structure labelled Q?

(1)

- ☐ **A** centriole
- ☐ **B** nucleus
- ☐ **C** rough endoplasmic reticulum

☐ **D** smooth endoplasmic reticulum

(ii) These cells were cultured in radioactively-labelled amino acids.

In which sequence would the cell structures in the diagram become radioactive during protein synthesis?

(1)

☐ **A** Q S R

☐ **B** S P R

☐ **C** P R Q

☐ **D** P S R

(iii) Explain one function of lysosomes.

(2)

.....

.....

.....

.....

.....

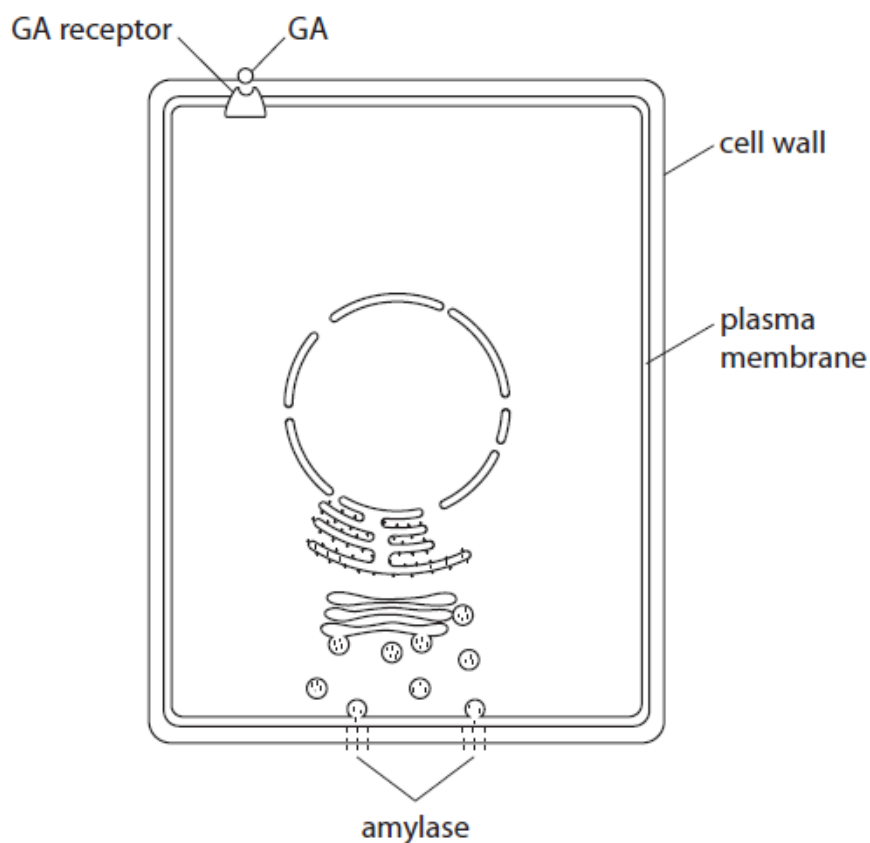
.....

(Total for question = 4 marks)

Q15.

Gibberellin stimulates cells in the aleurone layer of cereal grains, such as barley, to produce the enzyme amylase.

The diagram shows a cell from the aleurone layer with some of the structures involved in the production of amylase.



Gibberellin binds to a protein receptor in the cell surface membrane and this stimulates transcription in the nucleus.

(i) Describe the process of transcription in the nucleus of this cell.

(2)

.....

.....

.....

.....

.....

.....

(ii) Describe the processes occurring after transcription that result in the release of amylase from the cell shown in the diagram.

(5)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for question = 7 marks)

Mark Scheme

Q1.

Question Number	Acceptable Answer	Additional guidance	Mark
(a)(i)	- length of cell = 20 (mm) (1) - conversion into μm = $20000 \div 23.5$ (1) - magnification = 851 (1) [ecf applies for mp 2 and 3]	Accept ± 1 mm Accept other appropriate calculation, e.g. measure in cm or converting 23.5 μm to mm or cm Correct answer gains full marks	(3)

Question Number	Acceptable Answer	Additional guidance	Mark
(a)(ii)	A description that makes reference to the following: - centromeres have separated (1) - spindle fibres have {shortened / contracted} (1) - chromatids pulled apart (1) - chromatids have moved to opposite poles (1)		(4)

Question Number	Acceptable Answer	Additional guidance	Mark
(b)(i)	C		(1)

Question Number	Acceptable Answer	Additional guidance	Mark
(b)(ii)	Because E is {in cytokinesis / in late telophase / dividing its cytoplasm} but G is still in {anaphase / mitosis} (1)		(1)

Q2.

Question Number	Answer	Additional Guidance	Mark
(a)	1. bacteria are cells, viruses are {not / particles} ; 2. idea of bacteria surrounded by {cell wall / slime / capsule } , viruses surrounded by {protein / capsids / envelope} ; 3. bacteria have { plasmids / ribosomes / other named structure} , viruses do not have {plasmids / ribosomes / other named structure } ; 4. bacteria (genome) are DNA, viruses can be DNA or RNA ; 5. bacterial DNA is double-stranded, viral genetic material is single (or double) stranded / eq ; 6. idea that bacteria have {circular / eq} genetic material, viruses have {linear / straight} genetic material ;	NB piece answers together throughout Accept only matched structures 2. Accept for envelope: membrane / phospholipid layer / eq 3. Accept bacteria have membranes, flagella cytoplasm, glycogen, lipid droplets 6. Not in context of plasmid	(3)

Question Number	Answer	Additional Guidance	Mark
(b)(i)	1. reference to humoral (immune) response ; 2. reference to {phagocytosis / eq} by {phagocytes / named phagocyte} ; 3. reference to macrophages as { antigen-presenting cells / APCs} (to T helper cells) ; 4. reference to B cells as { antigen-presenting cells / APCs} (to itself) ; 5. idea that T helper cells release cytokines for B cell {activation / stimulation} ; 6. idea of B cells {forming clones / dividing /eq} (to form B effector cells) ; 7. reference to {differentiation of B cells into plasma cells / formation of plasma cells from B cells} (subsequent to cloning) ;	2. Accept dendritic cells / Langerhans cells / B cells 3 Accept dendritic cells / Langerhans cells 4. Accept antigen binds to B cells 6. Not to form plasma cells	(4)

Question Number	Answer	Additional Guidance	Mark
(b)(ii)	1. reference to {opsonisation / antibodies bind to bacteria / eq} ; 2. (as a result) enhancing phagocytosis / eq ; 3. reference to {immobilisation / agglutination / eq } (of bacteria) ; 4. idea of antibodies neutralising toxins / eq ;	1. Not reference to killing bacteria 2. Accept easier, better	(2)

Question Number	Answer	Additional Guidance	Mark
(b)(iii)	1. idea that the immune response will be weaker ; 2. person may not recover from this infection / eq ; 3. idea of {other (opportunistic) infection / cancer} ; 4. reference to cytokines released from {T helper / CD4 } cells ; 5. idea that cytokines are involved in {activation / division } of {B cells / T killer cells} ; 6. credit consequence of impaired B cell function ; 7. credit consequence of impaired T killer cell function ;	1. Accept in context of either humoral or cell-mediated immune response 6. Accept e.g. no antibody produced by plasma cells 7. Accept e.g. infected cells not destroyed	(4)

Q3.

Question Number	Answer	Additional Guidance	Mark
(i)	B matrix	A is incorrect because crista are folds in the membrane C is incorrect because stroma is in chloroplasts D is incorrect because thylakoids are in chloroplasts	

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to the following: - because the resolution of the microscope used for P is {lower / worse} (1) - to distinguish {the small distance between the two membranes / the membranes as separate structures} (1)	ACCEPT converse for Q throughout DO NOT ACCEPT magnification ACCEPT (inter membrane) space can be seen between membranes / the inner and outer membrane can be seen / two lines can be seen	

Q4.

Question Number	Answer	Additional Guidance	Mark
(i)	An explanation that makes reference to the following: - because different types of lipid are found in the mitochondria and chloroplasts (1) - because mitochondria are associated with { respiration / oxidative phosphorylation} whereas chloroplasts are associated with {photosynthesis / light-dependent reactions / photophosphorylation} (1) - because mitochondria contain {electron transport proteins / cytochromes / cristae / stalked particles} whereas chloroplasts contain {grana / chlorophyll / photosystems / carotenoids} (1)	Accept a description of the differences e.g. a lipid high in mitochondria is low in chloroplast, only two of the lipids are found in both organelles Do not accept a list of values from the table without some sort of comparison Accept any other membrane difference	(3)

Question Number	Answer	Additional Guidance	Mark
(ii)	A diagram that shows the following: - a glycosidic bond between C 1 on galactose and C 6 on MGDG (1) - rest of molecules complete (1) - water molecule (1)	ecf if glycosidic bond drawn between C1 and C 4 Accept H₂O / water	(3)

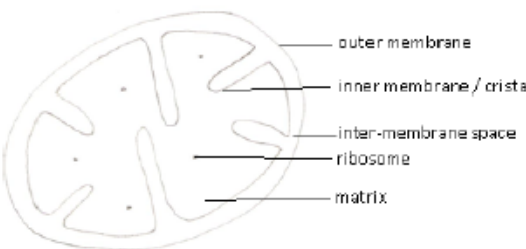
Question Number	Answer	Mark
(iii)	The only correct answer is B A is not correct because DGDG is larger than MGDG so will not travel as far and sulfolipid is the smallest quantity so will be the smallest spot C is not correct because DGDG is larger than MGDG so will not travel as far and sulfolipid is the smallest quantity so will be the smallest spot D is not correct because sulfolipid is the smallest quantity so will be the smallest spot	(1)

Q5.

Question Number	Acceptable Answer	Additional Guidance	Mark
(i)	An explanation that makes reference to the following points: - examine cells from different tissues in the mature sea urchin, under a microscope (1) - cells descended from the repositioned cell are fluorescent due to traces of the dye injected (1)		(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to the following: - the cell was (still) pluripotent (1) - therefore cell signalling in the new position could determine the fate of the cell (1) - causing activation of transcription factors for transcription of genes relevant to the new position (1) - leading to synthesis of proteins for development into different tissue (1)	Allow totipotent	(4)

Q6.

Question Number	Answer	Additional Guidance	Mark
	A drawing that shows the following: Drawing marks : • 2 membranes drawn (1) • (continuous) inner membrane (of two) folded (1) Label marks : Any two from • {inner membrane / crista} and outer membrane (1) • inter-membrane space (1) • matrix (1) • ribosome (1)		(4)

Q7.

Question Number	Answer	Additional Guidance	Mark
	Q: nucleus	Do not accept nucleolus	(1)

Q8.

Question Number	Answer	Mark
(i)	The only correct answer is C <i>A is not correct because not all RNA viruses have envelopes and only the retroviruses contain reverse transcriptase</i> <i>B is not correct because only the retroviruses contain reverse transcriptase</i> <i>D is not correct because not all RNA viruses have envelopes and they are not all helical</i>	(1)

Question Number	Answer	Mark
(ii)	The only correct answer is A <i>B is not correct because λ phage has DNA</i> <i>C is not correct because λ phage has DNA</i> <i>D is not correct because λ phage has DNA</i>	(1)

Q9.

Question Number	Answer	Additional Guidance	Mark
(i)	C 2 <i>A is incorrect as the nucleus and mitochondria have double membranes</i> <i>B is incorrect as the nucleus and mitochondria have double membranes</i> <i>D is incorrect as only the nucleus and mitochondria have double membranes</i>		1

Question Number	Answer	Additional Guidance	Mark
(ii)	A 1 only <i>B is incorrect because voltage gated channels will not open when light affects rod cells</i> <i>C is incorrect because less neurotransmitter is released when light affects rod cells</i> <i>D is incorrect because less neurotransmitter is released when light affects rod cells</i>		1

Q10.

Question Number	Acceptable Answer	Additional Guidance	Mark
	plant cells have cellulose walls, whereas animal cells do not		(1)

Q11.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to the following: - release energy / make ATP (1) - for {ion pump / Na⁺ - K⁺ pump / active transport of ions / regeneration of rhodopsin / combine opsin and retinal /convert trans retinal into cis retinal} (1)	DO NOT ACCEPT active transport alone	(2)

Q12.

Question Number	Answer	Mark
	The only correct answer is C <i>A is not correct because Salmonella are gram negative bacteria so will have a thin peptidoglycan cell wall</i> <i>B is not correct because Salmonella are gram negative bacteria so will have a thin peptidoglycan cell wall and they produces endotoxins</i> <i>D is not correct because Salmonella produces endotoxins</i>	(1)

Q13.

Question Number	Answer	Additional Guidance	Mark
	A description that makes reference to three of the following: - vesicles containing protein from rER {move to / fuse with} Golgi (1) - proteins {modified / glycosylated / carbohydrates / lipids attached} (1) - proteins leave (Golgi) in vesicles (1) - vesicles fuse with cell membrane (1)	Accept quarternary structure formed / conjugated protein formed Accept package into vesicles	(3)

Q14.

Question Number	Answer	Additional Guidance	Mark
(i)	The only correct answer is: D smooth endoplasmic reticulum <i>A is incorrect as centriole has microtubules</i> <i>B is incorrect as a nucleus has a nucleolus</i> <i>C is incorrect as there are no ribosomes</i>		1 comp

Question Number	Answer	Additional Guidance	Mark
(ii)	The only correct answer is: D P S R <i>A is incorrect because the SER is not involved in protein synthesis</i> <i>B is incorrect because Golgi should be after the RER</i> <i>C is incorrect because the SER is not involved in protein synthesis</i>		1 comp

Question Number	Answer	Additional Guidance	Mark
(iii)	An explanation that makes reference to the following: • (because lysosomes) contain enzymes (1) and one from • to {digest / hydrolyses} {pathogens / bacteria / viruses / proteins / antigens} (1) • to digest (old) organelles (1) • for apoptosis / autolysis of cells (1)	Accept correct named hydrolytic enzyme, e.g. protease / lysozyme Accept other correct biological molecules Accept breakdown pathogens / bacteria / viruses / proteins / antigens with hydrolytic / digestive enzymes for 2 marks Accept self-digest (damaged) cell	2 exp

Q15.

Question Number	Answer	Additional guidance	Mark
(i)	A description that makes reference to two the following: • DNA strands separate (1) • antisense strand used as template (for mRNA) (1) • RNA polymerase synthesises mRNA (1)		(2)

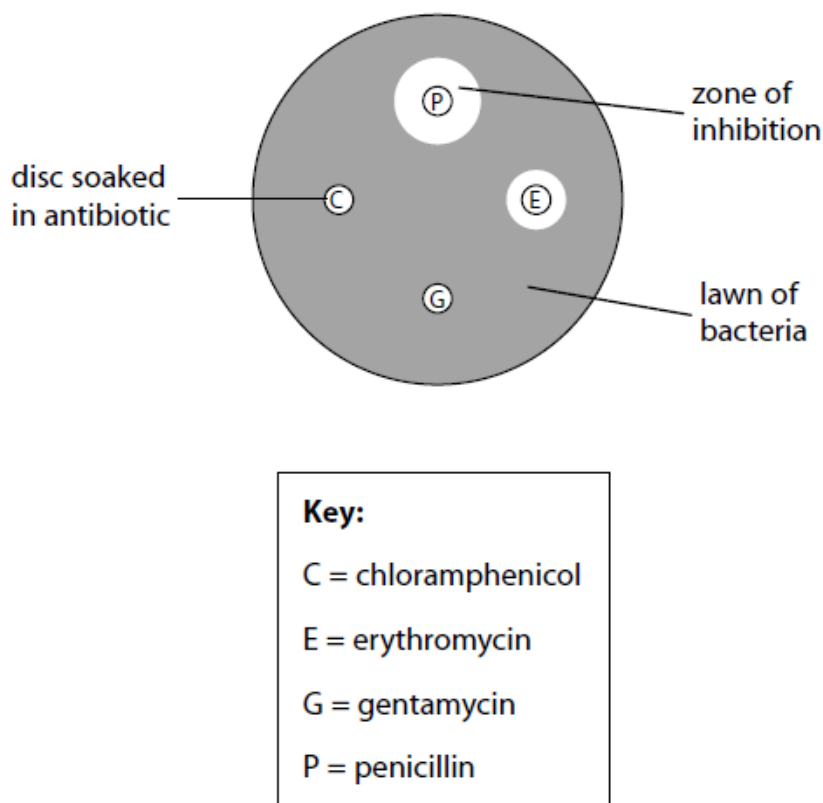
Question Number	Answer	Additional guidance	Mark
(ii)	A description that makes reference to five of the following: - mRNA leaves through nuclear pores (1) {translation occurs at / mRNA travels to} ribosomes / rough endoplasmic reticulum (1) - codons (on mRNA) pair with anticodons on tRNA / tRNA brings amino acid (to the ribosome) (1) - peptide bonds form between amino acids (1) - amylase enters Golgi and is {modified / processed} / amylase {is packaged into vesicles / travels in vesicles} (1) - exocytosis releases {amylase / protein} (1)	Accept protein for amylase Accept description for exocytosis	(5)

Q1.

The resistance of one type of bacteria to a range of different antibiotics was investigated.

A lawn of bacteria was prepared by spreading a suspension of the bacteria over the surface of agar. Paper discs that had been soaked previously in different antibiotics were placed on top of the bacteria. The antibiotics were all the same concentration. The culture was incubated for 48 hours.

The diagram below shows the appearance of the culture after incubation.



Explain why these results indicate that the bacteria must be Gram positive.

(3)

.....

.....

.....

.....

.....

.....

(Total for question = 3 marks)

Q2.

A student read that more than half of raw chickens on sale in supermarkets are contaminated with bacteria from the genus *Campylobacter*.

Some species of *Campylobacter* cause food poisoning in humans.

The student carried out an experiment to test the effectiveness of various antibiotics against *Campylobacter*.

The photograph shows the student's agar plates at the end of the experiment.



The white circles labelled A-H are filter paper discs. These discs were soaked in different antibiotics then placed on the surface of the agar.

One of the antibiotics the student used was penicillin.

Describe the effect of penicillin on bacterial cells.

(3)

.....

.....

.....

.....

.....

.....

Q3.

Antibiotics can affect bacteria.

The table describes the mode of action of four antibiotics.

Antibiotic	Mode of action
benzylpenicillin	disrupts peptidoglycan structure
streptomycin	binds to 70S ribosomes
ciprofloxacin	inhibits enzymes involved in prokaryotic DNA replication
rifamycin	inhibits prokaryotic RNA polymerase

(i) Name the antibiotic that affects Gram positive bacteria only.

(1)

.....

(ii) Give one reason why these antibiotics will not affect human cells.

(1)

.....

.....

.....

.....

(Total for question = 2 marks)

Q4.

The photograph shows part of a bacterial cell surrounded by viruses, as seen using an electron microscope.



(i) Which of these structures would be present in a bacterial cell but absent in a palisade mesophyll cell?

(1)

- ☐ **A** cellulose cell wall and nucleoid
- ☐ **B** cellulose cell wall and nucleolus
- ☐ **C** peptidoglycan cell wall and nucleoid
- ☐ **D** peptidoglycan cell wall and nucleolus

(ii) Which virus contains DNA?

(1)

- ☐ **A** Ebola
- ☐ **B** HIV
- ☐ **C** λ (lambda) phage
- ☐ **D** tobacco mosaic

(iii) Explain why an electron microscope, rather than a light microscope, was used to produce this photograph.

(2)

.....

.....

.....

.....

.....

(Total for question = 4 marks)

Q5. Human diseases can be caused by many different types of organism, such as bacteria and viruses.

(a) Give **two** differences between the genetic material of bacteria and viruses.

(2)

.....

.....

.....

.....

(b) Tuberculosis (TB) is caused when droplets, containing the bacterium *Mycobacterium tuberculosis*, are inhaled into the lungs.

In the lungs, large numbers of the bacterium are formed rapidly. These can be ingested by macrophages. Eventually, tubercles (tissue masses), containing dormant bacteria inside macrophages, may form.

(i) Describe how macrophages ingest the bacteria.

(2)

.....

.....

.....

.....

.....

(ii) Suggest why treatment with antibiotics may not be effective against the dormant bacteria in the tubercles.

(2)

.....

.....

.....

.....

.....

(iii) TB can be prevented by vaccination. Explain how a person can develop artificial active immunity following vaccination.

(3)

.....

.....

(c) In a person with TB, the dormant bacteria in tubercles may be activated after several years. The bacteria multiply rapidly, resulting in severe lung damage.

The bacteria are released from the tubercles. These bacteria can inhibit the activity of T cells and infect other organs.

Explain why the activity of these bacteria and the inhibition of T cells means that a person may quickly develop severe symptoms leading to death.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

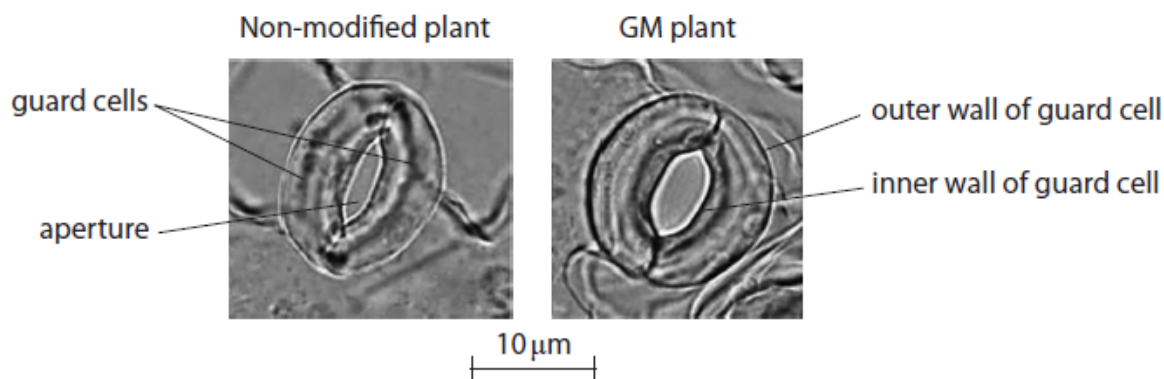
(Total for Question = 13 marks)

Q6.

Genetically modified (GM) crop plants have been produced that have stomata with a wider aperture than non-modified crop plants.

This difference in the width of the aperture is only evident in daylight.

The photographs show the appearance of each type of stoma in daylight.



Sourced from: http://www.aip.nagoya-u.ac.jp/en/public/nu_research/images/Wang_f1.jpg

(i) Calculate the magnification of the GM plant photograph using the scale bar.

Give the answer in standard form.

(2)

Answer

(ii) Calculate how many times wider the aperture of the stoma of the GM plant is compared with the stoma of the non-modified plant.

(1)

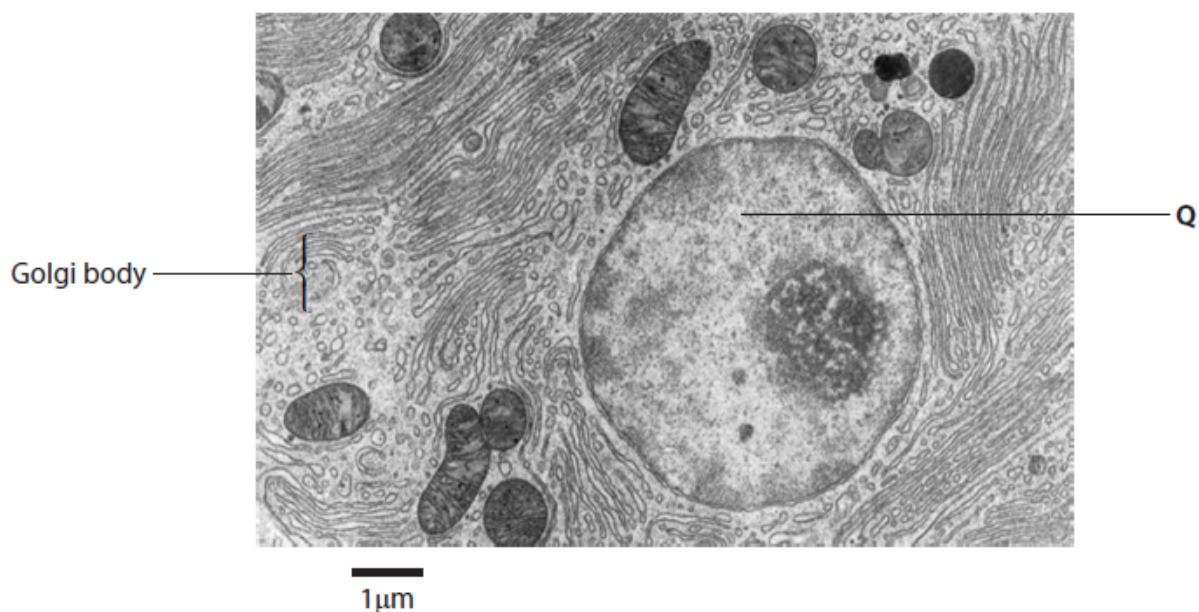
Answer

(Total for question = 3 marks)

Q7.

The pancreas is an organ that secretes digestive enzymes.

The electron micrograph shows part of a secretory cell from a human pancreas.



Calculate the maximum diameter of organelle Q.

(2)

Answer

(Total for question = 2 marks)

Q8.

Ultraviolet (UV) radiation damages DNA and is used in microbiology to produce aseptic conditions.

The effectiveness of UV radiation was investigated, using three species of pathogenic bacteria.

The table provides information about the bacteria used in this investigation.

Bacteria	Gram staining	Infected part of body
<i>P. aeruginosa</i>	negative	blood
<i>S. aureus</i>	positive	lung
<i>E. coli</i>	negative	intestine

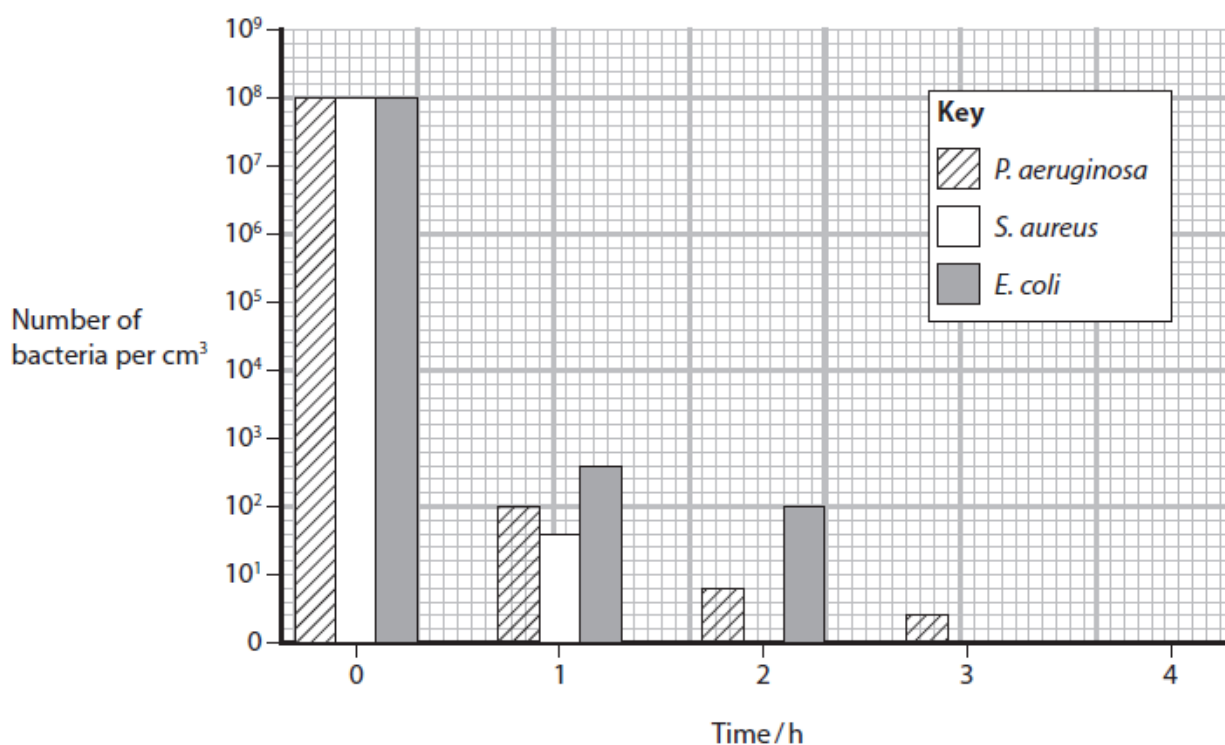
(i) Compare and contrast the structure of the wall of Gram positive bacteria and Gram negative bacteria.

(3)

(ii) In this investigation, living bacteria of each species were exposed to UV radiation for four hours.

The numbers of living bacteria were counted each hour during the four-hour period.

The graph shows the results of this investigation.



Calculate the percentage change in numbers of living *E. coli* after two hours of exposure to UV radiation.

(2)

Answer %

(iii) A student concluded from this investigation that if food is exposed to UV radiation, it would remove all risk of food poisoning.

Criticise the validity of this conclusion.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

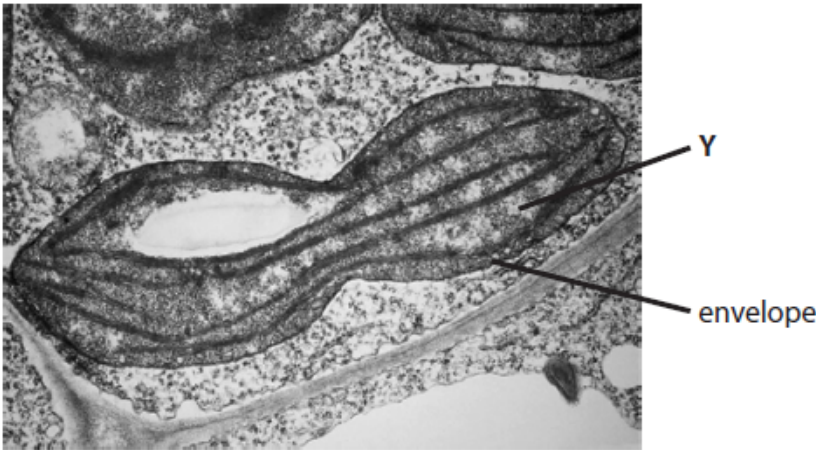
.....

(Total for question = 9 marks)

Q9.

When a photosynthetic plant cell grows, the number of chloroplasts in the cell increases. This increase in the number of chloroplasts can result from the division of chloroplasts already present in the cell.

The electron micrograph shows a chloroplast dividing.



The envelope consists of two membranes. These membranes are separated by a gap of 10×10^{-3} to $20 \times 10^{-3} \mu\text{m}$.

The magnification of this electron micrograph is $\times 12\,000$.

(i) Calculate the maximum width of this gap in this electron micrograph.

(2)

Answer

(ii) Explain why the envelope in this electron micrograph cannot be seen as two separate membranes.

(2)

.....

.....

.....

.....

.....

.....

(Total for question = 4 marks)

Q10.

The pathogenic effects of bacteria can be due to the toxins they release.

Endotoxins are released by Gram negative bacteria.

(i) Name **one** type of Gram negative bacteria that releases endotoxins.

(1)

.....

(ii) Give **one** difference between the structure of Gram negative bacteria and Gram positive bacteria.

(1)

.....

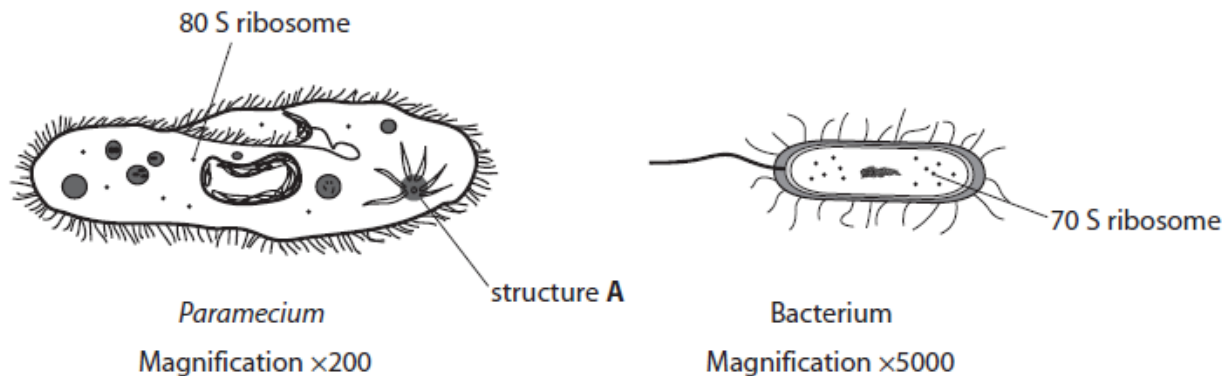
.....

.....

(Total for question = 2 marks)

Q11.

The drawings show two single-celled organisms that live in ponds, *Paramecium* and a bacterium.



Which of the following statements is correct?

(1)

- ☐ **A** Both *Paramecium* and the bacterium are eukaryotes
- ☐ **B** Both *Paramecium* and the bacterium are prokaryotes
- ☐ **C** *Paramecium* is a eukaryote and the bacterium is a prokaryote
- ☐ **D** *Paramecium* is a prokaryote and the bacterium is a eukaryote

Q12.

Plant stems contain xylem and phloem, tissues specialised for transport.

The photomicrograph shows a longitudinal section of phloem tissue.



State why stains, such as methylene blue, are sometimes used when preparing a microscope slide.

(1)

.....

.....

(Total for question = 1 mark)

Q13.

Cysteine proteases are enzymes found in fruits such as pineapples.

When a protease enzyme is added to fat-free skimmed milk, the milk turns from cloudy to clear.

Cysteine proteases are also found in the predatory bacterium *Bdellovibrio bacteriovorus* (BvB).

These bacteria are harmless to humans but prey on Gram negative bacteria.

(i) Give two differences between Gram negative and Gram positive bacteria.

(2)

.....

.....

.....

.....

.....

.....

(ii) The cell of the predatory BvB is 1µm in length and can swim 100 times its length per second.
Calculate the swimming speed of this bacterial cell in mm s⁻¹.

(2)

Answer

(iii) The BvB bacteria have been described as 'living antibiotics'.
Explain why the BvB bacteria might be useful in the future for treating bacterial infections.

(2)

.....

.....

.....

.....

.....

.....

.....

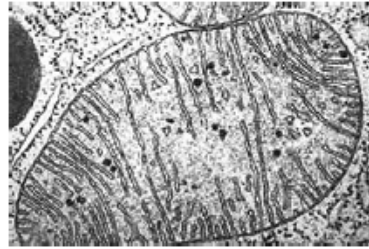
.....

(Total for question = 6 marks)

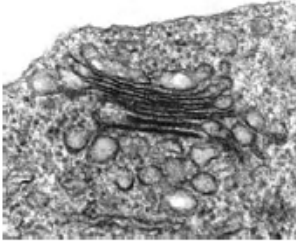
Q14.
The electron micrographs show four different organelles.



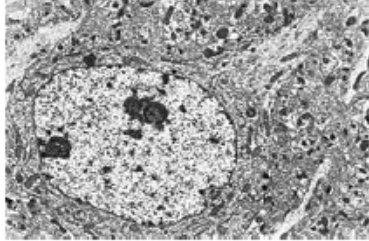
A



B



C



D

Which of these organelles contains the photosynthetic pigments?

(1)

☐ **A**

☐ **B**

☐ **C**

☐ **D**

Q15.

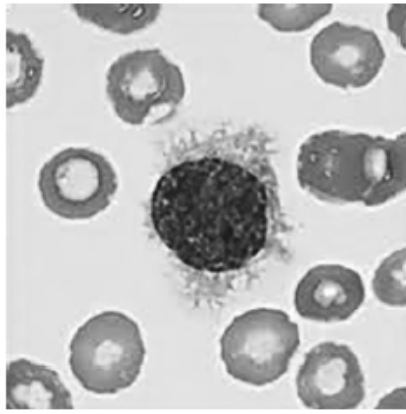
Leukaemia is a type of cancer involving abnormal white blood cells.

In 2015, scientists announced that 1 in 5 people aged 90 or over had mutations linked to leukaemia.

The current UK population is about 64 million, of which 0.8% are aged 90 or over.

Hairy cell leukaemia is a rare form of the disease in which there is an increase in the number of abnormal B lymphocytes.

The photomicrograph shows one of these B lymphocytes.



The hairy cell lymphocytes have an unusually large nucleolus.

State the function of the nucleolus in this hairy cell lymphocyte.

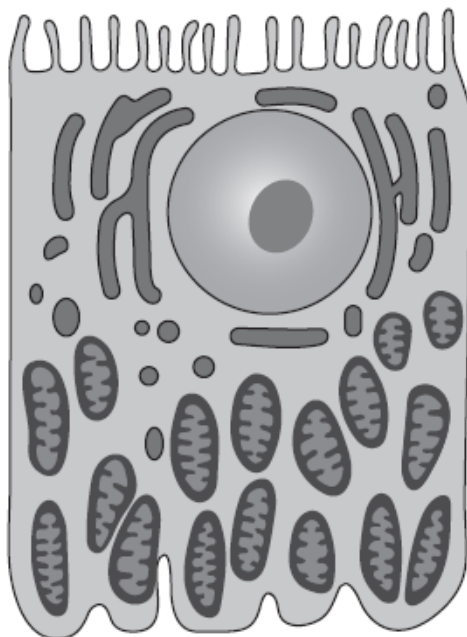
(1)

.....

.....

Q16.

The diagram shows a cell from the proximal convoluted tubule of the nephron.



Explain how the features shown in the diagram enable this cell to carry out its function.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

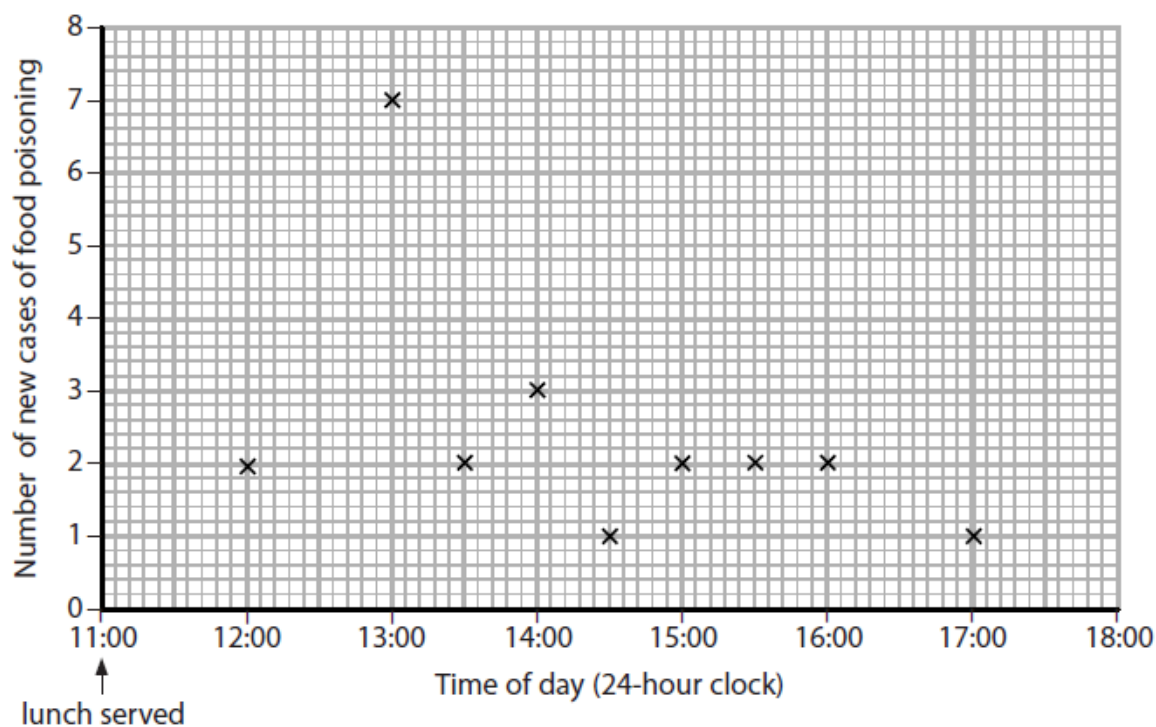
(Total for question = 4 marks)

Q17.

Food poisoning can be caused by food that is contaminated with pathogenic microorganisms.

A number of different bacteria can cause food poisoning.

The graph shows the number of new cases of food poisoning after a lunch party.



(i) Explain why it is likely that this food poisoning resulted from food contaminated with *Staphylococcus* rather than with *Salmonella*.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

(ii) Describe the techniques microbiologists could use to confirm that this food poisoning was caused by *Staphylococcus*.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for question = 7 marks)

Q18.

Some antibiotics work by inhibiting the production of ribosomes in bacteria.

The structure of ribosomes in bacteria is similar to the structure of ribosomes in mitochondria.

These antibiotics can destroy cancer cells in humans.

The diagram shows the membranes of a mitochondrion from a cancer cell treated with these antibiotics.



(i) Give one difference in the membranes of this mitochondrion compared with the membranes of a mitochondrion from an untreated cancer cell.

(1)

.....

.....

.....

(ii) Some cancer cells depend on oxidative phosphorylation for ATP production.

Explain why the antibiotics that inhibit the production of ribosomes prevent oxidative phosphorylation when used to treat cancer cells.

(2)

.....

.....

.....

.....

.....

.....

(iii) Some scientists suggested that inhibiting both glycolysis and mitochondrial respiration may be an effective way of treating cancer cells.

Explain why this suggestion may be an effective way of treating cancer cells.

(2)

.....

.....

.....

.....

.....

.....

(Total for question = 5 marks)

Q19.

Infections caused by *Chlamydia* and human papillomavirus (HPV) are sexually transmitted.

The HPV is a non-enveloped DNA virus.

Chlamydia infection is caused by the bacterium, *Chlamydia trachomatis*.

Compare and contrast the structure of a bacterial cell with the structure of HPV.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for question = 3 marks)

Q20.

Some antibiotics work by inhibiting the production of ribosomes in bacteria.

The structure of ribosomes in bacteria is similar to the structure of ribosomes in mitochondria.

(i) Describe the structure of a ribosome.

(2)

.....

.....

.....

.....

.....

.....

(ii) Describe the role of ribosomes in protein synthesis.

(2)

.....

.....

.....

.....

.....

.....

(Total for question = 4 marks)

Mark Scheme

Q1.

Question Number	Acceptable Answer	Additional guidance	Mark
	An explanation that makes reference to the following: - there is a zone of inhibition around the penicillin disc / because penicillin only affects Gram positive bacteria (1) Plus two from the following points: - because it has a thick cell wall (1) - because penicillin interferes with formation of cross links (1) - during synthesis of new cell wall (1) - this results in bacteria being susceptible to osmotic shock (1)		(3)

Q2.

Question Number	Acceptable Answer	Additional Guidance	Mark
	A description that makes reference to the following: - inhibits formation of (new) crosslinks in peptidoglycan in cell wall (1) - causing lysis of cell due to osmotic pressure (1) - therefore penicillin is bactericidal (1)		(3)

Q3.

Question Number	Answer	Additional Guidance	Mark
(i)	benzylpenicillin		(1)

Question Number	Answer	Additional Guidance	Mark
(ii)	An answer that makes reference to one of the following: - human cells are {eukaryotic / lack cell wall / lack peptidoglycan} (1) - human cells have different {ribosomes / enzymes} (1)	ACCEPT these antibiotics only affect prokaryotes	(1)

Q4.

Question Number	Answer	Mark
(i)	The only correct answer is C <i>A is not correct because cellulose is not found in a bacterial cell</i> <i>B is not correct because cellulose and nucleoli are not found in a bacterial cell</i> <i>D is not correct because nucleoli are not found in a bacterial cell</i>	(1)

Question Number	Answer	Mark
(ii)	The only correct answer is C <i>A is not correct because Ebola contains RNA</i> <i>B is not correct because HIV contains RNA</i> <i>D is not correct because tobacco mosaic virus contains RNA</i>	(1)

Question Number	Answer	Additional Guidance	Mark
(iii)	An explanation that makes reference to the following: - the resolution is higher / better (1) - because wavelength of electrons is short(er) (1)	ACCEPT converse ACCEPT wavelength smaller	(2)

Q5.

Question Number	Answer	Additional Guidance	Mark
(a)	- bacteria have DNA, viruses have DNA or RNA ; - idea that bacteria have {circular / eq} genetic material, viruses have {linear / straight} ; - bacterial DNA is double-stranded, viral {DNA / RNA} is single (or double) stranded / eq; - bacteria (may) have plasmids, viruses do not have plasmids / eq;	NB piece answers together throughout Do not accept in context of plasmid	(2)

Question Number	Answer	Additional Guidance	Mark
(b)(i)	- reference to {phagocytosis / endocytosis / engulfing} ; - credit details of phagocytosis ; - reference to bacterium inside a {vacuole / vesicle / phagolysosome} ;	eg formation of {pseudopodia / membrane extensions around bacteria} / cytoplasmic streaming / binding to bacteria Not phagolysosome	(2)

Question Number	Answer	Additional Guidance	Mark
(b)(ii)	- idea that bacteria need to be accessible to antibiotics ; - idea of bacteria inside macrophages ; - reference to waxy layer of (these) bacteria ; - idea that (bacteriostatic) antibiotics affect dividing bacteria; - reference to antibiotic resistance (of these bacteria) ;	Not bacteriocidal antibiotics	(2)

Question Number	Answer	Additional Guidance	Mark
(b)(iii)	- idea of {dead / attenuated / eq} {organisms / pathogen / bacterium / eq} put into person; - reference to (stimulation of) {specific / primary} (immune) response ; - credit details of T helper cell activation ; - credit details of B cell activation ; - credit details of T killer cell activation ; - reference to production of memory cells ;	NB not simply crediting ref to vaccination as in stem of question Accept antigen eg macrophages as APCs eg involvement of cytokines, B cells as APCs eg involvement of cytokines, infected cells as APCs	(3)

Question Number	Answer	Additional Guidance	Mark
(c)	- reference to {further lung damage / severe breathing problems / eq} ; - idea that the <i>Mycobacterium</i> get into the {blood / lymph}; - idea that organ failure (leads to death) ; - idea of {reduced / weakened} immune response (due to a loss of T cells) ; - credit detail of role of T (helper) cells ; - credit detail of effect of no T killer cells ; - credit detail of effect of no B cells ; - ref to {secondary / opportunistic / other} infections (causing death) ;	eg cannot obtain enough oxygen eg production of cytokines eg infected cells will not be destroyed eg no antibody produced	(4)

Q6.

Question Number	Answer	Additional Guidance	Mark
(i)	- length of scale line given in μm - magnification calculated	1.7×10000 / 17000 1.7×10^3 / 0.0017×10^6	

Question Number	Answer	Additional Guidance	Mark
(ii)	width of GM aperture divided by width of non-modified aperture	In the range of 1.3 to {4 / 4.0} to no more than 1 decimal place DO NOT ACCEPT with units or %	

Q7.

Question Number	Answer	Additional Guidance	Mark
	- correct calculation of magnification ($\times 10\,000$) - correct calculation of diameter (1)	<u>Example of calculation:</u> magnification: $10\,000\ \mu\text{m} \div 1\ \mu\text{m}$ $= \times 10\,000$ diameter: $54\ \text{mm} \div 10\,000$ $= 5.4\ \mu\text{m}$ Accept range between $5.3\ \mu\text{m}$ to $5.5\ \mu\text{m}$ Correct answer with units gains full marks	(2)

Q8.

Question Number	Answer	Additional Guidance	Mark
(i)	An answer that makes reference to three of the following: Similarity - both have peptidoglycan (1) Two differences from: - positive has {more / thicker layer of} peptidoglycan than negative / positive has a thicker cell wall than negative (1) - positive has teichoic acid, negative does not (1) - negative has outer membrane, positive does not (1) - negative (most) has periplasmic space, positive does not (1) - negative has {more lipid / lipopolysaccharide / porin proteins}, positive does not (1)	Accept periplasm	(3)

Question Number	Answer	Additional Guidance	Mark
(ii)	- subtraction using values from graph (1) - calculation of percentage change (1)	$10^8 - 10^2 = 99\,999\,900$ $\div 10^8 \times 100 = 99.9999$ Correct answer gains full marks, with no working shown.	(2)

Question Number	Answer	Additional Guidance	Mark
(iii)	An answer that makes reference to the following: - it is effective if irradiation longer than 3 hours (1) - it is effective against E. coli which infect the intestine (1) - not all species of {pathogenic bacteria / bacteria causing food poisoning} investigated / only three types of bacteria investigated (1) - toxins may remain in food (1)	Accept effectiveness depends on how long it is irradiated for	(4)

Q9.

Question Number	Answer	Additional Guidance	Mark
(i)	- maximum width $\times$ magnification (1) - correct gap width with appropriate units (1)	$20 \times 10^{-3} \times 12\,000 = 240$ $= 0.24\text{ mm} / 240\text{ }\mu\text{m} / 240\,000\text{ nm} / 24 \times 10^4\text{ nm}$ Accept correct minimum gap width with appropriate units for 1 mark	(2)

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to the following: - because the resolution of the microscope is {not high enough / is too low} (1) - as the membranes are too close together to be distinguished as separate structures (1)	Do not accept magnification Accept as separate lines Do not accept magnification	(2)

Q10.

Question Number	Answer	Additional Guidance	Mark
(i)	<i>Salmonella</i> (species) (1)	Candidates may name other types of bacteria, each of which will need looking up ACCEPT phonetic spellings ACCEPT <i>Shigella</i>, <i>Neisseria</i>, <i>Escherichia</i>, <i>Pseudomonas</i>, <i>Klebsiella</i>, <i>Proteus</i>, <i>Providencia</i>, <i>Escherichia</i>, <i>Morganella</i>, <i>Aeromonas</i>, <i>Citrobacter</i> ACCEPT specific examples e.g. <i>E.coli</i> IGNORE pathogens DO NOT ACCEPT gram positive bacteria e.g. <i>Actinomyces</i>, <i>Clostridium</i>, <i>Mycobacterium</i>, <i>Streptococci</i>, <i>Staphylococci</i>, <i>Nocardia</i>	(1) EXP

Question Number	Answer	Additional Guidance	Mark
(ii)	gram negative bacteria have {a thinner peptidoglycan cell wall / an (outer) lipopolysaccharide (layer) / an outer membrane } (1)	ACCEPT converse for gram positive bacteria ACCEPT less peptidoglycan murein for peptidoglycan larger periplasm (space) no teichoic acid (in cell wall)	(1) GRAD

Q11.

Question Number	Acceptable Answer	Additional Guidance	Mark
	C (<i>Paramecium</i> is a eukaryote and the bacterium is a prokaryote)		(1)

Q12.

Question Number	Answer	Additional Guidance	Mark
	An answer that makes reference to the following: so that some organelles are clearly visible (1)	Accept converse Allow named organelles	(1)

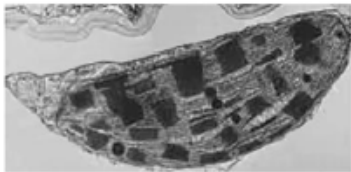
Q13.

Question Number	Answer	Additional Guidance	Mark
(i)	An answer that makes reference to two of the following: - Gram positive bacteria have more peptidoglycan than Gram negative bacteria (1) - Gram positive stains {purple / blue} (with Gram stain), but Gram negative do not stain {purple / blue} (with Gram stain) (1) - Gram positive contains {teichoic acid / lots of murein} but Gram negative do not (1) - Gram positive have no {periplasmic space / outer membrane} but Gram negative do (1)	Allow Gram positive have a thicker cell wall than Gram negative Allow Gram positive stains {purple / blue} (with Gram stain), but Gram negative stain red (with Gram stain) Allow Gram positive have low {lipid / phospholipid} content but Gram negative have high {lipid / phospholipid} content	(2)

Question Number	Answer	Additional Guidance	Mark
(ii)	An answer that makes reference to the following: - conversion of micrometres to mm (1) - calculation of speed (1)	Example calculation $1\mu\text{m} = 0.001\text{ mm}$ $0.001 \times 100 = 0.1\text{ (mm s}^{-1}\text{)}$ Correct answer with no working gains full marks	(2)

Question Number	Answer	Additional Guidance	Mark
(iii)	An explanation that makes reference to two of the following: - BvB can kill gram negative bacteria (1) - without side effects for humans (1) - therefore could be useful when treating resistant bacterial infections (1)	Allow bacteria cannot become resistant to BvB	(2)

Q14.

Question Number	Acceptable Answer	Additional guidance	Mark
(c)	A ()		(1)

Q15.

Question Number	Acceptable Answer	Additional guidance	Mark
	synthesis of ribosomes		(1)

Q16.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to the following: • large numbers of mitochondria (1) • to provide ATP for active uptake of {glucose / salts / amino acids} (1) • microvilli providing large surface area (1) • for many carrier proteins for {glucose / salts / amino acids} (1)	Accept correct named minerals	4

Q17.

Question Number	Answer	Additional Guidance	Mark
(i)	An explanation that makes reference to three of the following: - because the food poisoning was happening {after one hour /within a few hours} of the meal (1) - indicating that exotoxins caused the food poisoning (1) - because endotoxins are only present after {about 12 hours / several hours / when the bacterial cells are destroyed} (1) <i>Staphylococcus</i> releases exotoxins / endotoxins come from <i>Salmonella</i> (1)	Accept soon after meal / quickly / by {12 / 1} o'clock Do not accept <i>Staphylococcus</i> is an exotoxin / <i>Salmonella</i> is an endotoxin	(3)

Question Number	Answer	Additional Guidance	Mark
(ii)	A description that makes reference to any four of the following: - isolate the bacteria from the {food / patient / faeces / vomit} (1) - look at the colonies to see if they have a {characteristic / named characteristic} (of <i>Staphylococcus</i>) (1) - use Gram stain to show presence of Gram positive bacteria (1) - grow on selective media that identify {<i>Staphylococcus</i> / eliminates other bacteria} (1) - use antibodies against <i>Staphylococcus</i> (1)	Accept a description of how this is done e.g. streak plating from a faecal sample Accept <i>Staphylococci</i> will appear purple with Gram stain Accept differential media / selective agar / named example e.g. mannitol salt agar / with antibiotics	(4)

Question Number	Answer	Additional Guidance	Mark
(i)	{fewer / smaller} cristae / less folding of the inner membrane / reduced surface area of inner membrane		(1)
(ii)	An explanation that makes reference to two of the following: (fewer cristae / lower surface area) therefore reduced electrontransport chain (1) - because ribosomes prevented from synthesising {enzymes / ATPase / electron transport molecules} (1) - credit reason linked to protein not made (1)	e.g. no enzymes to catalyse steps in Krebs cycle, noATPase channels for {protons to pass through / phosphorylation of ADP}, no ETC so no redox reactions ACCEPT less intermembrane space foraccumulation of protons = 1 mark	(2)
(iii)	An explanation that makes reference to the following: - no ATP will be produced (if both inhibited / glycolysis inhibited) (1) - therefore no {energy / ATP} for metabolic process / named metabolic processes / cell division} (1)		(2)

Q19.

Question Number	Answer	Additional Guidance	Mark
	An answer that makes reference to the following: Similarities - both contain DNA (1) Differences - HPV is surrounded by {protein / capsid} and chlamydia by {a cellwall / peptidoglycan} (1) - HPV is hollow and chlamydia has {cell membrane / cytoplasm / ribosomes / glycogen granules / lipid droplets / plasmids}	ACCEPT DNA strands in HPV ACCEPT chlamydia has {cell membrane / cytoplasm / ribosomes / glycogen granules / lipiddroplets / plasmids} but HPV does not	(3)

Q20.

Question Number	Answer	Additional Guidance	Mark
(i)	An answer that makes reference to the following: - composed of protein and RNA (1) (arranged in) two {(sub) units / parts} (1)	ACCEPT large and small subunit / 60S and 40Ssubunit / 50S and 30S subunit	(2)
(ii)	An answer that makes reference to two of the following: - translation (1) - to hold the tRNA on the mRNA (1) - whilst peptide bonds form to join (adjacent) amino acids together(1)		(2)