A LEVEL Cambridge Topical Past Papers

BIOLOGY

2020 — 2024

P2

1 – (9700/22_Summer_2020_Q1) – *Cell Structure*

Picornaviruses are small viruses that are 30 nm in diameter. Picornaviruses are able to enter the cells of mammals and birds and can replicate within these cells.

Fig. 1.1 shows the entry of a picornavirus into its host cell.

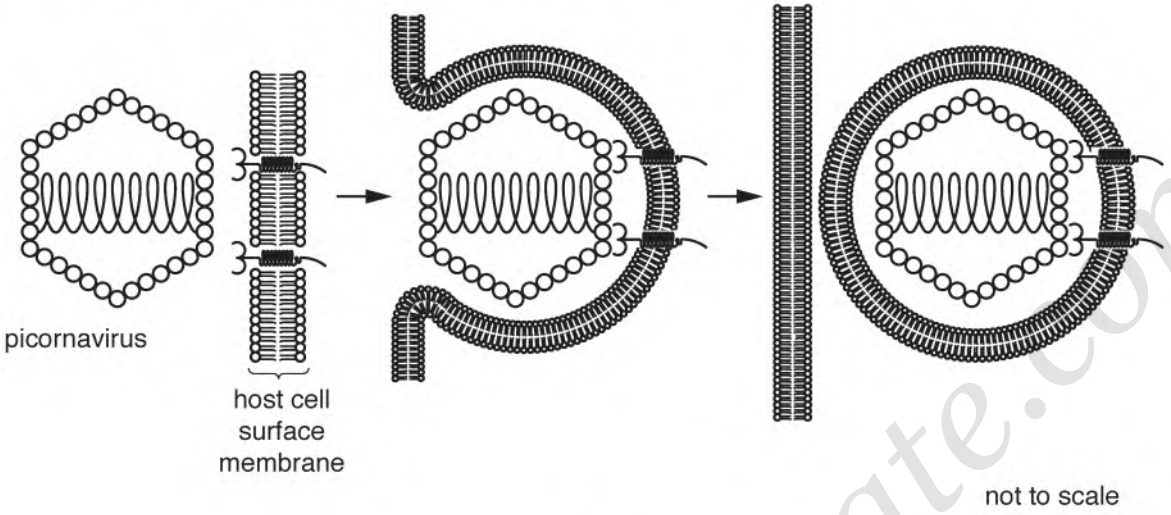


Fig. 1.1

(a) State the key features of a virus, such as picornavirus.

.....

.....

.....

.....

.....

..... [2]

(b) State, with reasons, whether a picornavirus can be seen using the light microscope.

.....

.....

.....

.....

.....

.....

..... [3]

(c) With reference to Fig. 1.1, describe how the picornavirus enters the host cell.

.....

.....

.....

.....

.....

.....

.....

..... [3]

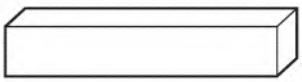
2 – (9700/23_Summer_2020_Q6) – *Cell Structure*

A student carried out an investigation to estimate the water potential of potato tissue. The main steps in the procedure and in the analysis of results are outlined in Fig. 6.1.

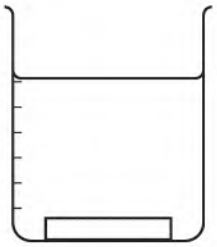
beaker	concentration of sucrose solution / mol dm^{-3}
1	0.0
2	0.1
3	0.2
4	0.3
5	0.4
6	0.5

Six different concentrations of sucrose solution were prepared and an equal volume of each was placed in a labelled beaker.

↓



Six equal-sized blocks of potato tissue were cut out of the same potato, blotted dry and weighed.



One potato block was immersed in the solution in each beaker for 30 minutes.

After this time, the block was removed, blotted dry and reweighed.

↓

The experiment was repeated twice.

↓

The mean percentage change in mass of potato tissue was calculated for each concentration of sucrose used.

↓

A graph was drawn of mean percentage change in the mass of potato tissue against concentration of sucrose.

Fig. 6.1

(a) Explain why the different concentrations of sucrose result in different mean percentage changes in mass of potato tissue.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [3]

(b) State how the graph is used to estimate the water potential of the potato tissue.

.....

.....

.....

.....

..... [1]

3 – (9700/22_Winter_2020_Q4) – *Cell Structure, The Mitotic Cell Cycle, Immunity*

In the immune system, a plasma cell develops from an activated B-lymphocyte. Mature plasma cells synthesise and secrete antibody molecules.

(a) Fig. 4.1 is a diagram of a transmission electron micrograph of a plasma cell.

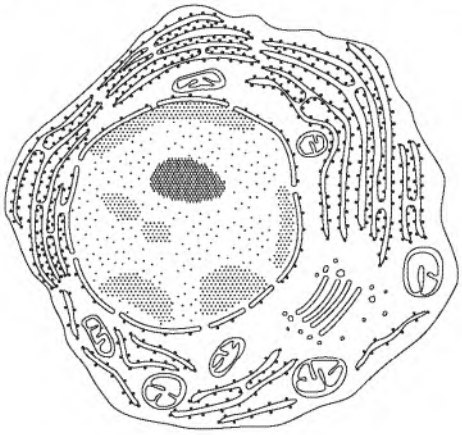


Fig. 4.1

The plasma cell can be seen in greater detail using an electron microscope compared with using a light microscope.

(i) Describe the **extra** detail of the nucleus that can be seen using an electron microscope.

.....

.....

.....

.....

.....

.....

..... [3]

(ii) Explain why cell structures, such as ribosomes and the rough and smooth endoplasmic reticulum, cannot be seen using a light microscope.

.....

.....

.....

.....

..... [2]

(b) The transition from the activated B-lymphocyte to the fully mature plasma cell requires a number of mitotic cell cycles to occur. This process, which is known as clonal expansion, results in a large number of genetically identical plasma cells.

Fig. 4.2 describes events, **A** to **F**, that occur during the mitotic cell cycle of the B-lymphocyte.

A centrioles replicate

B DNA polymerase catalyses the formation of phosphodiester bonds

C condensation of chromosomes

D nuclear envelope reassembles around each set of daughter chromosomes

E centromeres move towards poles

F chromosomes line up at spindle equator

Fig. 4.2

Table 4.1 lists the stages occurring during one cell cycle of the B-lymphocyte. These stages are not in the correct order.

Table 4.1

stage of cell cycle	correct letter from Fig. 4.2
G_2 phase	
metaphase	**F**
cytokinesis	
prophase	
S phase	
anaphase	
G_1 phase	
telophase	

Complete Table 4.1 by writing the letter of the event described in Fig. 4.2 that correctly matches the stage of the cell cycle listed.

Leave a **blank space** if there is **no** matching description for the stage in the list. Use each letter **once** only.

One of the letters in Table 4.1 has already been added for you.

[5]

(c) Clonal expansion also results in the production of memory B-lymphocytes.

Explain the importance of clonal expansion **and** the production of memory B-lymphocytes in providing protection for a person against an infectious disease.

.....

.....

.....

.....

.....

.....

.....

..... [3]

(d) Myasthenia gravis is an example of a disease where the immune system fails to distinguish between self and non-self.

Explain what is meant by this statement.

.....

.....

.....

.....

.....

..... [2]

[Total: 15]

4 – (9700/21_Summer_2021_Q1) – *Cell Structure, Biological Molecules*

Fig. 1.1 is a transmission electron micrograph of cells from duckweed, *Spirodela oligorrhiza*.

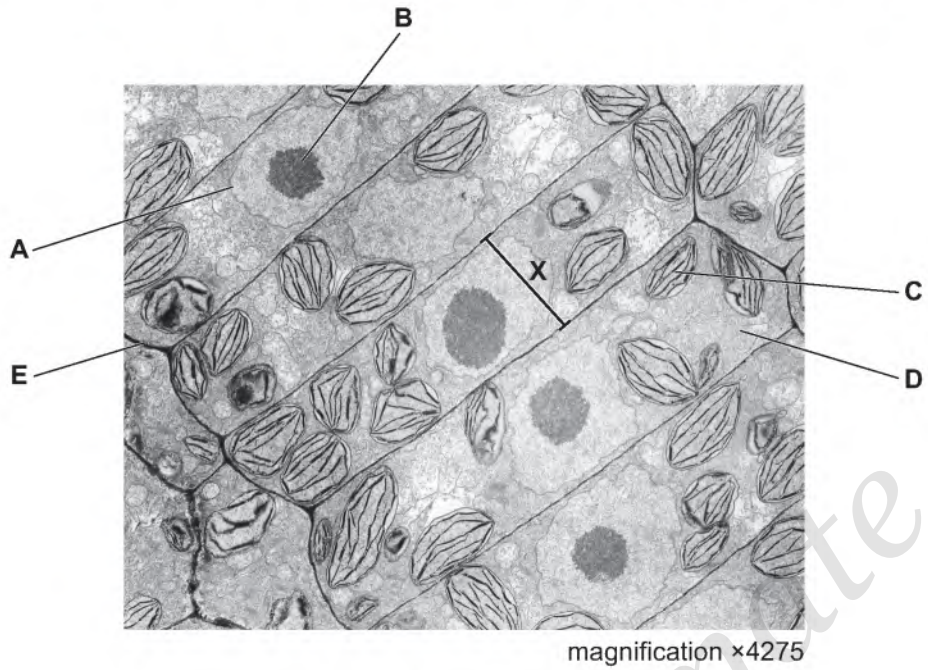


Fig. 1.1

(a) Calculate the actual width of the cell labelled **X**.

Write down the formula you will use to make your calculation.

Show your working and give your answer in micrometres to one decimal place.

formula

..... μm [3]

(b) (i) Table 1.1 lists some biological molecules found in plant cells.

Complete Table 1.1 by choosing **one** letter from Fig. 1.1 that indicates a cell structure where each biological molecule is found.

Table 1.1

biological molecule	letter from Fig. 1.1
DNA	
cellulose	
phospholipid	
histone proteins	

[4]

(ii) State the name of a cell structure, **visible in Fig. 1.1**, where ATP is synthesised.

..... [1]

(iii) Name a cell structure that produces mRNA.

..... [1]

(c) Describe the evidence from Fig. 1.1 that shows that the image is a transmission electron micrograph.

.....

.....

.....

.....

.....

.....

..... [2]

5 – (9700/21_Summer_2021_Q6) – *Cell Structure, Enzymes, Cell Membranes And Transport*

Lysosomes are cell structures that contain enzymes known as acid hydrolases.

Fig. 6.1 shows some processes that occur in animal cells.

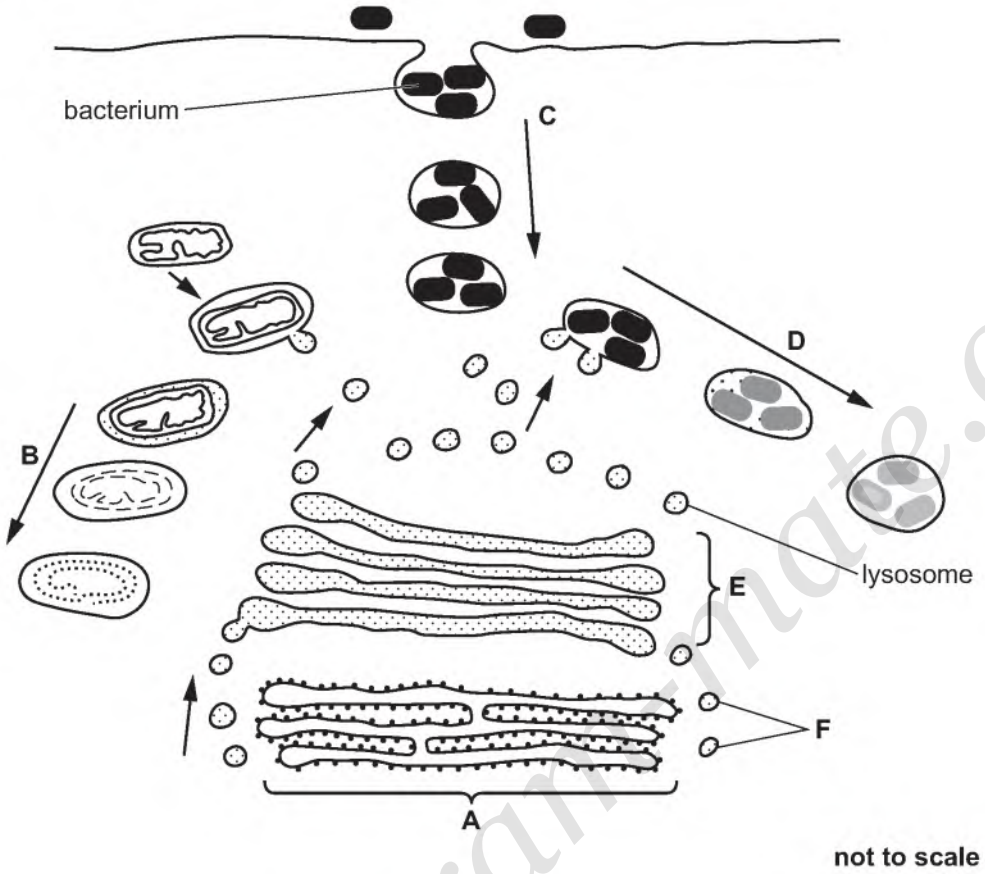


Fig. 6.1

(a) Name the cell structures labelled **A** and **E**.

A .....

E .....

[2]

(b) State the function of the structures labelled **F**.

.....

..... [1]

(c) Name the process by which bacteria are taken into the cell at **C**.

..... [1]

(d) With reference to the processes occurring at **B** and at **D** in Fig. 6.1, outline the role of acid hydrolases in lysosomes.

.....

.....

.....

.....

.....

.....

..... [3]

(e) Carrier proteins in the membranes of lysosomes maintain a lower pH than the surrounding cytoplasm by moving hydrogen ions.

Suggest how the carrier proteins maintain the lower pH within the lysosomes.

.....

.....

.....

.....

..... [2]

ANSWERS

1 – (9700/22_Summer_2020_Q1) – *Cell Structure*

(a)	*any two from* protein coat / capsid ; **A** capsomeres nucleic acid core / DNA or RNA ; acellular / AW ;	**2**
(b)	*any three from* *no, because* resolution of light microscope, too low / not high enough ; only able to distinguish points 200nm or more apart *or* size of virus / 30 nm, too small for resolution of (light microscope) of 200 nm ; **A** range 100-300 nm wavelength of light too long ; *idea that* virus too small to interfere with light waves ;	**3**
(c)	*any three from* virus binds to receptors (on host cell surface membrane) ; *ref. to* specificity / complementary shapes / complementary binding ; endocytosis ; description ; e.g. membrane infolds / pinches in vesicle formed ; **A** vacuole	**3**

2 – (9700/23_Summer_2020_Q6) – *Cell Structure*

(a)	*any three from* *idea that* water moves down a water potential gradient / from a high to low water potential / AW ; sucrose solutions produce differences in water potential inside the cell and externally *or* different concentrations of external sucrose solution produces different gradients of water potential ; high concentration of, sucrose / solutes, is, lower / more negative, water potential ; ora loss of water by osmosis out of potato cells lowers mass of block ; ora for gain of mass no net gain or loss means water potential inside and out are equal ;	**3**
(b)	concentration where the, curve / line, crosses the *x*-axis (and use a reference table) *or* the concentration at which there is zero percentage change in mass (and use a reference table) ;	**1**

3 – (9700/22_Winter_2020_Q4) – *Cell Structure, The Mitotic Cell Cycle, Immunity*

(a)(i)	*any **three** from:* **I** heterochromatin / euchromatin envelope / two membranes / double membrane / inner and outer membrane ; nuclear pores ; **A** pores in nuclear envelope *for two marks* (outer surface of) outer membrane with ribosomes ; *ref. to* (outer nuclear) membrane continuous with RER ; **R** inner membrane AVP ; e.g. perinuclear space **A** intermembranous space pore complexes	**3**
(a)(ii)	*any **two** from:* resolution / resolving power, is, low / lower / poor / AW / 200 nm / 0.2 µm ; (**A** range 100–300 nm) **A** electron microscope has a higher resolution further detail ; e.g. ribosomes / ER, smaller than 200 nm can only see cell structures greater than (limit of) resolution cannot see structures smaller than 200 nm cell structures too small for the resolution (*needs ref. to resolution)* cell structures, too small to / do not, interfere with light waves ; AW	**2**
(b)	if letter used in more than one row, **R** these rows correct interphase knowledge G2 = **A**, S = **B**, G1= **blank ;** *cytokinesis* **blank ;** *prophase* **C ;** *anaphase* **E ;** *telophase* **D ;**	**5**
(c)	*any **three** from:* *large numbers of B-lymphocytes / plasma cells (in primary immune response)* **1** large quantity of (specific) antibody, produced / released **or** (large quantity of) antibody to form antibody-antigen complexes / to bind antigen (for phagocytosis) / AW ; *large numbers of memory B-lymphocytes so* **2** provide long term immunity / memory cells long-lived / provides immunological memory ; **A** remain in, circulation (for a long time) AW **3** able to produce fast(er), secondary (immune) response ; **A** second response will be fast(er) **A** immune response faster on second encounter (with antigen / pathogen) / AW **4** higher concentration / faster production, of antibodies (than primary response) ; **I** 'more' alone **5** person does not have, symptoms / become ill (of / from, same disease) ; **A** presence of same, pathogen / antigen, does not cause disease **6** AVP ; memory cells can (divide to) produce plasma cells more plasma cells present than primary response able to form more memory cells	**3**

(d)	*any **two** from:* immune response / antibodies produced, against, self antigens ; **I** immune system attacks self **A** autoimmunity / autoimmune disease *idea that* faulty B-lymphocytes not destroyed ; **A** *ref. to* T-lymphocytes *if in correct context* (specific) antibody, binds to / acts on / AW, self-antigen / receptor, on the (cell surface membranes of) muscle cells / at neuromuscular junction ; **A** antibody binds to acetylcholine receptors *ref. to* consequence to muscle cells ; e.g.(nerve) impulse conduction impaired action of transmitter substance hindered	**2**

4 – (9700/21_Summer_2021_Q1) **–** *Cell Structure, Biological Molecules*

(a)	actual width = image width ÷ magnification ; **A** A = I ÷ M M = I ÷ A I = A × M or magnification triangle working = width divided by 4275 ; e.g. 16 000 ÷ 4275 17 000 ÷ 4275 18 000 ÷ 4275 19 000 ÷ 4275 ; 3.7 (μm) 4.0 (μm) 4.2 (μm) 4.4 (μm) ; **R** answer if given to more than 1 dp or whole number	**3**
(b)(i)	DNA – **A** / **B** / **C** ; cellulose – **E** ; phospholipid – **A** / **C** ; histone proteins – **A** / **B** ;	**4**
(b)(ii)	chloroplast / mitochondrion ;	**1**
(b)(iii)	nucleus ; **A** chloroplast / mitochondrion **R** nucleolus	**1**

(c)	*any two from* **1** (section at) high <u>resolution</u> ; **A** suggestion of a correct value of resolution for a TEM **2** any named structure visible in Fig. 1.1 that can, only be seen in a TEM / not be seen in a photomicrograph ; e.g. internal structure of chloroplasts / thylakoid(s) / grana e.g. internal structure of mitochondria / cristae **3** high magnification / higher magnification (magnification > 1000 / higher than with light microscope) ; *in context of higher than light microscope* **4** (very) thin ; **5** 2D / no surface contours / no surface features / AW ; **A** not 3D	**2**

5 – (9700/21_Summer_2021_Q6) – *Cell Structure, Enzymes, Cell Membranes And Transport*

(a)	**A** rough endoplasmic reticulum ; **E** Golgi, body / apparatus / complex ;	2
(b)	transport from, (R)ER / ribosomes, to Golgi ; **A** from **A** to **E** **A** transport from Golgi to, cell surface membrane / phagosome **A** separate, acid hydrolases / enzymes, from, rest of cell / AW	1
(c)	phagocytosis / endocytosis ;	1
(d)	*any three from* 1 break down / digest / destroy, bacteria / pathogen(s) ; 2 break down / digest / destroy, (worn out / defective / AW), organelles / named organelle (in animal cell) ; **A** autophagy 3 catalyse / speed up, hydrolysis ; 4 any **two** named substrates ; e.g. (any named) polysaccharides / proteins / (phospho)lipids / (named) nucleic acids 5 *idea that* recycle / reuse, biological molecules within cell ; 6 (macrophage / phagocyte) cut up to present antigen ;	3
(e)	moves / pump(s), hydrogen ions / protons, into the lysosome against concentration gradient ; active transport / uses ATP / energy from respiration / ref to conformational change of carrier ; **R** if a ref to facilitated diffusion	2

6 – (9700/23_Summer_2021_Q1) – *Cell Structure, Cell Membranes And Transport*

(a)	*structure max 2 marks* 1 RER has ribosomes **R** *if context is within lumen* **or** SER does not have ribosomes ; 2 RER, flattened sacs / cisternae, and SER tubular ; AW 3 RER continuous with, (external) nuclear membrane ; **ora** **I** near to nuclear membrane **R** continuous with internal nuclear membrane 4 *ref. to* RER, more regular / layered, arrangement **or** SER more irregular / disorganised, arrangement ; *function* 5 RER produces / transports, proteins / glycoproteins ; **A** polypeptides **A** examples of post-translational modification 6 SER produces, lipids / cholesterol / steroids ; **A** stores **I** produces hormones	3
(b)	*any two from* *ref. to* phosphate (group) and two fatty acid, chains / tails / residues ; **A** two hydrocarbon chains correct *ref. to* attachment, phosphate / fatty acids, to glycerol ; AVP ; e.g. *ref. to* ester bond *ref. to* additional group e.g. choline-containing *ref. to*, saturated / unsaturated, (fatty acid tails) *award marks from an annotated diagram*	2

(c)(i)	flattened sacs / cisternae ; stack / layered / described ; *any one from* *idea that* each cisterna in stack is, separate / not interconnected ; smooth (outer surface) / no ribosomes ; close to, nucleus / RER ; single membrane ; AVP ; e.g. two distinct faces *ref. to* swollen ends to cisternae	2
(c)(ii)	*ignore events occurring before vesicle formation* *any three from* vesicle moves to, cell surface / cell (surface) membrane ; **A** plasma membrane movement of vesicle via, cytoskeleton / microtubules ; vesicle fuses with (cell surface) membrane (and protein released) ; AW e.g. vesicle makes contact with membrane and becomes part of it **I** attaches to / binds to exocytosis ; **I** bulk transport / excreted / secreted *allow in context of release only or movement from Golgi and release*	3
(c)(iii)	*any one relevant e.g.* acts as (self-)antigen / recognition site / cellular recognition / receptor / membrane stability / cell adhesion ; **I** involved in cell signalling	1

7 - (9700/23_Summer_2021_Q6) - *Cell Structure, The Mitotic Cell Cycle*

(a)	correct working ; e.g. 14 000 000 ÷ 1400 (**A**–**B** = 13 to 15 mm) (x) 9286 / 9642 / **10 000** / 10 357 / 10 714 ; *incorrect conversions used in working or incorrect measured value of* **A**–**B** *can be awarded the answer mark as ecf – the working must show use of dividing by 1400 (or incorrect conversions of 1400)*	2
(b)	*any four from* two chromatids drawn with, non-metacentric centromere / chromosome arms unequal length ; (sister) chromatid ; centromere ; *allow as a constriction* telomere ; *must be labelled at / towards the end* AVP ; e.g. four telomeres labelled **or** telomere sectioned off at each chromatid end and one labelled DNA and histones gene / allele *must be shown as a section*	4
(c)	**R** homologous chromosomes *any one from* most condensed state ; AW **I** chromosomes, are condensing / condense chromosomes (all) in one, plane / focus ; **A** *idea of* all at the equator (so clearly visible) **I** line up. horizontally / vertically	1
(d)	anaphase ;	1