

1. (Annotated diagram illustrating the process may be used to gain some or all the marks.)

the mechanism whereby cells take in solids and / or solutions;
involves the formation of vesicles;
infolding of cell membrane;
called phagocytosis when solids / organisms are engulfed;
phagocytosis is called feeding in some unicellular organisms;
called pinocytosis when solutions are taken in
(vesicles are much smaller);
may be receptor-mediated (e.g. HIV);
requires energy / active process;

[5]

2. labelled diagram of generalised prokaryotic (P) and generalised eukaryotic (E) animal cell 2 max

(Marks must be awarded if the following comparisons

are made as either annotations to the diagram or in narrative/table form.)

P is usually smaller in size, E is larger;

both have cytoplasm / protoplasm;

P has no nucleus / nucleoid region, E has (membrane-bound) nucleus;

P has one chromosome / circular, E has two or more chromosomes;

P has DNA only, E has DNA with protein (histones);

P has no membrane-bound organelles, E has some membrane-bound organelles;

E has mitochondria, P does not;

E has other example of organelle, P does not;

both can have a flagellum / flagella;

if flagella then E has 9+2 fibrils, P does not;

P can have pili / slime layer / capsule, E does not;

P can have plasmids, E does not;

both have ribosomes;

P has small ribosomes, E has larger ones;

both have cell membrane;

P has cell wall, E has no cell wall;

E has centriole, P has no centriole;

[8]

3. (a) Must have both for [1].

diffusion is the movement of molecules from an area of high concentration to an area of low concentration;

osmosis is the diffusion of water across a partially permeable membrane;

1

- (b) hydrophilic head groups point outward;
hydrophobic tails form a lipid bilayer;
forms a (phospholipid) bilayer;
ions and polar molecules cannot pass through hydrophobic barrier;
helps the cell maintain internal concentration and exclude other molecules;

2 max

- (c) cellulose;
structural support / protection / maintain turgor pressure;

2

[5]

4. (a) two sets of chromosomes / each chromosome represented twice;
pairs of homologous chromosomes;
Do not accept haploid number, having 46 chromosomes, 2n 1 max
- (b) *Both A and B must be correctly identified for [1].*
A: interphase / G1, S, G2;
B: mitosis / phases of mitosis; 1
- (c) *Any three of the following [1] each.*
protein synthesis / translation
DNA replication / chromosome replication;
cell growth / increase in cell volume;
organelle doubling;
microtubule formation;
respiration / glycolysis;
increase energy stores;
transcription / mRNA production;
Accept first three answers only. 3 max
- (d) *Award [1] each for the following.*
animal cells:
pinching of cell membrane / form cleavage furrow;
centrioles;
plant cells:
cell plate formation;
cell wall built (during cytokinesis); 2 max
- (e) "A" part of cycle / interphase involves DNA synthesis
replication of DNA requires complementary base pairing /
A-T, G-C; produces two identical copies of DNA /
sister chromatids;
sister chromatids split at anaphase;
each new cell gets a copy of each DNA molecule /
genetically identical wrong base pairing causes mutations;
mutations can lead to cancer (by uncontrolled cell division) 3 max
5. (a) as the diameter of the molecule increases the permeability / relative ability
to move decreases (*accept converse*);
the relationship is logarithmic / non-linear / negative;
for molecules above 0.6 (± 0.1) nm relative ability to move changes little /
for molecules below 0.6 (± 0.1) nm relative ability to move changes rapidly; 2 max
- (b) "*U-1*" rule applies.
- (i) $10 \text{ mmol cm}^{-3} \text{ cells hr}^{-1}$ (*accept values within ± 5*); 1
- (ii) $370 \text{ mmol cm}^{-3} \text{ cells hr}^{-1}$ (*accept values within ± 10*); 1
- (c) (i) glucose uptake in facilitated diffusion levels out whereas uptake in simple
diffusion does not level out / continues to rise;
glucose uptake increases in both;
glucose uptake is higher in facilitated diffusion (than in simple diffusion);
glucose uptake in simple diffusion is constant / linear whereas in
facilitated diffusion uptake increases rapidly at the beginning / increase
is not constant; 3 max

[10]

- (ii) little / no change in glucose uptake;
most / all (protein) channels in use;

2

[9]

6. easy to prepare a sample for;
living material can be viewed / living processes (*e.g.* cytoplasmic streaming) can be seen;
colour images can be seen;
relatively portable;
relatively cheap;
larger field of view;

[3]

7. Award [1] per difference,

plant cells:

have cell walls, animal cells do not;
have plastids / chloroplasts, animal cells do not;
have a large central vacuole, animal cells do not;
store starch, animal cells store glycogen;
have plasmodesmata, animal cells do not;

animal cells:

have centrioles, plant cells do not;
have cholesterol in the cell membrane, plant cells do not;
plant cells are generally have a fixed shape / more regular whereas
animal cells are more rounded;

[6]

8. *phospholipid structure*

hydrophobic tail / hydrophilic head;
head made from glycerol and phosphate;
tail made from two fatty acids;
saturated / unsaturated fatty acid (in tail);

arrangement in membrane

phospholipids form a bilayer;
heads face outside the membrane / tails face inside the membrane /
hydrophobic interior / hydrophilic exterior of membrane;

*A suitable annotated diagram may incorporate all or many of the above points.
Award [5 max] for a suitable diagram that is labeled correctly.*

phospholipids held together by hydrophobic interactions;
 phospholipids layers are stabilized by interaction of hydrophilic heads
 and surrounding water;
 phospholipids allow for membrane fluidity / flexibility;
 fluidity / flexibility helps membranes to be (functionally) stable;
 phospholipids with short fatty acids / unsaturated fatty acids are more fluid;
 fluidity is important in breaking and remaking membranes (*e.g.* endocytosis /
 exocytosis);
 phospholipids can move about / move horizontally / "flip flop" to
 increase fluidity;
 hydrophilic / hydrophobic layers restrict entry / exit of substances;
 (*Plus up to [2] for quality*)

9 max

[9]

9. B

[1]

10. A

[1]

11. A

[1]

12. Award [1] for each of the following structures clearly drawn and labelled correctly. Award marks for labelled eukaryotic structures, then deduct [1] per labelled prokaryotic structure shown *e.g.* mesosome, cell wall.

nuclear membrane / nucleus (with nuclear membrane shown double with pores);
 ribosomes (free or attached to ER);
 endoplasmic reticulum / ER;
 plasma / cell membrane (*reject if shown as double line*);
 mitochondria (shown with inner and outer membrane);
 Golgi (apparatus);
 lysosomes;

[6]

13. uses / requires energy / ATP;
 goes against concentration gradient / lower to higher concentration;
 requires a protein in the cell membrane / pump / carrier protein (*reject channel*);
 hydrolysis of ATP / $\text{ATP} \rightarrow \text{ADP} + \text{phosphate}$;
 involves a conformational change in the pump / protein / diagram to show this;

[4]

14. prophase showing spindle fibres;
 prophase showing condensed chromatin;
 prophase showing replicated chromosomes;
 metaphase showing replicated chromosomes lining up at the equator;
 anaphase showing chromatids moving to opposite poles;
 telophase showing nucleus reforming;
 telophase showing cytokinesis occurring; 5 max
*The four diagrams must have the name of the phase, otherwise award [3 max].
 The four stages must be included to receive [5]. If correct number of
 chromosomes is not shown award [4 max].* [5]
15. two divisions in meiosis, only one in mitosis;
 meiosis results in haploid cells, mitosis in diploid cells;
 crossing over only occurs in meiosis;
 no S phase precedes meiosis II;
 chromosome behaviour in meiosis II and mitosis is similar / chromosome
 behaviour in meiosis I and mitosis is different;
 chiasmata only form during meiosis;
 homologous chromosomes move to the equator in pairs only in meiosis;
Do not accept number of cells produced - it is a result not a behaviour. [5]
16. hormone binding sites;
 enzymes;
 electron carriers;
 channels for (passive) transport;
 (pumps) for active transport;
 cell to cell recognition;
 receptors for neurotransmitters; 4 max
(Remember, up to TWO "quality of construction" marks per essay) [4]
17. (a) translates RNA into/synthesises polypeptides/proteins;
 lysosomes; mitochondria;
 aerobic respiration / production of ATP;
Do not accept production of energy. 4
- (b) eukaryotic;
 membrane bound organelles/nucleus (as reason for being a eukaryote)
 could be plant or animal;
 probably animal because of the lysosomes; 2 max [6]
18. (a) Award [1] for each two correct.
 I. plasma / cell membrane;
 II. cell wall;
 III. nucleoid (region) / DNA/genetic material;
 IV. cytoplasm/cytosol/protoplasm; 2 max
- (b) $26000 \times (\pm 1500)$; 1
Do not need to show working.

- (c) colour images instead of black and white / pigments can be observed;
can view living material;
larger field of view / whole cells can be seen;
easier sample preparation / cheaper/easier transport/portable; 2 max

[5]

19. *lysosome*: hydrolysis/digestion / break down of materials (macromolecules);
Golgi Apparatus: synthesis/sorting/transporting/secretion of cell products;
rough endoplasmic reticulum: site of synthesis of proteins (to be secreted) / intracellular
transport of polypeptides to Golgi Apparatus;
nucleus: controls cell activities/mitosis/replication of DNA/transcription of DNA
(to RNA)/directs protein synthesis;
mitochondrion: (aerobic) respiration/generates ATP;

[5]

20. C

[1]

21. skeletal muscle fibres are larger / have many nuclei / are not typical cells;
fungal hyphae are (sometimes) not divided up into individual cells;
unicellular organisms can be considered acellular;
because they are larger than a typical cell / carry out all life functions;
some tissues / organs contain large amounts of extracellular material;
e.g. vitreous humour of eye / mineral deposits in bone / xylem in trees / other example;
statement of cell theory / all living things/most tissues are composed entirely of
true cells;

[4]

22. (a) small cells have larger ratio (than larger cells) / ratio decreases as size increases;
surface area/membrane must be large enough to absorb nutrients/oxygen/
substances needed;
surface area/membrane must be large enough to excrete/pass out waste products;
need for materials is determined by (cell) volume;
cell size is limited (by $\frac{SA}{vol}$ ratio) / cells divide when they reach a certain size;
reference to diffusion across/through membrane/surface area; 3 max

- (b) Award [1 max] for each organelle. Mark first answer only.

- (i) translation / produces polypeptides / proteins / protein synthesis;
(ii) support of ribosomes / site of protein synthesis / synthesis of
proteins for secretion / folding of polypeptides;
(iii) produces glycoproteins / processing of proteins / forms lysosomes
/ formation of vesicles (for exocytosis); 3 max

- (c) Award [1] for each of the following pairs.
Mark first answer only in boxes 1, 2 and 3.

<i>prokaryotic cells</i>	<i>eukaryotic cells</i>
nucleoid / no nucleus / nuclear membrane	vs. nucleus / nuclear membrane;
naked DNA / no histones	vs. NA associated with protein / histone;
no mitochondria	vs. mitochondria present;
no Golgi / no ER	vs. Golgi / ER present;
circular DNA	vs. linear DNA;
no/very few membrane-bound organelles	vs. membrane-bound organelles;
ribosomes smaller / 70S	vs. ribosomes larger / 80S;
no mitosis / meiosis	vs. mitosis / meiosis;
flagella lack internal microtubules	vs. flagella have microtubules (9+2);

3 max

Allow [1] only for a similarity.

[9]

23. differentiation is development in different/specific ways;
cells carry out specialized functions / become specialized;
example of a differentiated cell in a multicellular organism;
cells have all genes / could develop in any way;
some genes are switched on / expressed but not others;
position / hormones / cell to cell signals / chemicals determine how a cell develops;
a group of differentiated cells is a tissue;

[4]

24. (a) genes found on the sex chromosomes / X / Y chromosome 1
Characteristics or traits are unacceptable replacement for genes.

- (b) parent genotypes ($X^C Y$ and $X^C X^c$) / same genotypes using alternative symbols /
four offspring genotypes ($X^C X^c$, $X^C X^C$, $X^c Y$, $X^C Y$);
Punnett square showing cross / other acceptable working;
all/100 % daughters normal colour vision (phenotype);
half/50 % the sons normal and half/50 % are colour blind (phenotype); 3 max
Award [0] for autosomal analysis.

- (c) law of segregation states that one half of the alleles enter one gamete
and the other half enter the other gamete;
meiosis reduces the chromosome number by half / diploid to haploid;
homologues carrying alleles separate (in anaphase I);
end result is four cells, half with one allele/homologue and the other half
with the other allele; 3 max

- (d) plant cells lack centrioles / animals cells have centrioles;
plants form a cell plate / new cell wall to divide cells / animal cells form
a cleavage furrow; 2

[9]

25. Award [1] for each of the following structures clearly drawn and labelled correctly in a diagram of a plasma membrane.
phospholipid bilayer;
protein channels / integral (intrinsic) membrane proteins;
peripheral (extrinsic) proteins associated with the membrane;
cholesterol embedded in the membrane;
glycoproteins / receptor proteins on the outside;
hydrophobic and hydrophilic portions of membrane indicated; (both needed for [1]) [5]
26. passive transport requires no energy;
molecules move down a concentration gradient;
water moves by osmosis;
from lower solute concentration to higher solute concentration / high water concentration to low water;
small uncharged molecules move by diffusion;
between phospholipid molecules;
charged molecules move by facilitated diffusion;
requires a protein channel; [5]
27. Award [1] for each of the following structures clearly drawn and labelled correctly in a diagram of a generalized prokaryotic cell.
size stated: 1 to 10 μm ;
cell wall;
cytoplasm;
flagella / flagellum;
mesosome;
plasma membrane;
ribosomes;
nucleoid region / DNA not enclosed in nuclear membrane;
plasmid;
pili;
capsule / slime layer; 6 max
Deduct [1] for each eukaryotic feature included, up to [3 max]. [6]
28. D [1]
29. A [1]
30. C [1]
31. D [1]

32. A

[1]

33. goes against concentration gradient / from low concentration to high concentration;
requires hydrolysis of ATP / requires energy from ATP;
proteins in membrane utilized;
specificity of carriers;
e.g. Na⁺-K⁺ pump / other suitable examples;
may involve conformational change in carrier protein;
moves ions / solutes;
maintains chemical / electrical gradient;

[5]

34. through endocytosis large particles are brought into cells across membranes;
through exocytosis large particles are removed from cells;
by the formation of vesicles;
active transport requiring ATP;
uses protein pumps;
to move materials against concentration gradients;
protein channels enable facilitated diffusion of molecules
down concentration gradient;
the molecules are too large or too charged to diffuse
directly through the membrane;
small polar and non-polar molecules / gases;
can diffuse directly through the membrane;
from an area of high concentration to an area of low
concentration/down the concentration gradient (until equilibrium is reached);
osmosis is the passive movement of water molecules;
across a partially/selectively permeable membrane;
from a region of lower solute concentration to a region
of higher solute concentration;

[8]

35. (a) I: protein coat / capsid / capsomere;
II: DNA/nucleic acid / RNA / genetic material; 2
- (b) $\text{size} = \frac{\text{diameter of drawing}}{\text{length of size bar}} \times 10\text{mm} / \text{equivalent working shown}$
52 nm (± 5 nm); (*units required*) 2
- (c) antibiotics block specific metabolic pathways /
cell production in bacteria;
viruses reproduce using the host cell metabolic pathways;
(host cell) pathways are not affected by antibiotics;
viruses do not have metabolic pathways; 3 max

- (d) some bacteria are resistant to an antibiotic /
 variation within bacterial populations includes antibiotic resistance;
 genes for antibiotic resistance originate as
 mutations (not caused by antibiotics);
 transfer of resistance genes (can occur) from strain to strain /
 species to species;
 bacteria that are resistant survive when an antibiotic is used and others die;
 resistant bacteria pass on their genes for resistance to offspring;
 proportion of resistant bacteria increases in each
 generation in the population/species;
 natural selection for bacteria that are resistant;

3 max

[10]

36. vesicle is made by pinching off a piece of membrane;
 fluidity of membrane allows this;
 vesicles can be used to transport material around inside cells;
 proteins are transported in vesicles;
 from the rough endoplasmic reticulum to the Golgi apparatus;
 from the Golgi apparatus to the plasma membrane;
 formation of vesicle from plasma membrane allows material to be taken in;
 endocytosis / pinocytosis / phagocytosis / phagolysosome is absorption of material
 using a vesicle;
 fusion of vesicle with plasma membrane allows material to be secreted/passed out;
 exocytosis is secretion of material using a vesicle;
 named example of endocytosis or exocytosis;

[8]

37. (a) beta sheet / alpha helix 1
- (b) fibrous proteins have a long and narrow shape,
 globular protein have rounded shape;
 fibrous mostly insoluble in water, globular protein soluble in water
 fibrous in secondary structure, globular in tertiary structure
 fibrous: collagen / myosin / silk / keratin / other fibrous protein;
 Globular: immunoglobulin / hemoglobin /
 catalase / named enzyme /
 other globular protein; 3 max
- (c) polar amino acids are hydrophilic / "water loving";
 polar amino acids form hydrophilic proteins / channels;
 allow hydrophilic / polar /
 charged particle substances through the membrane;
 controls shape / function / location of the protein in the membrane;
 polar amino acids on the surface proteins make them water soluble; 2 max
- Accept any of the above points if clearly explained using a
 suitable diagram*

[6]

38. D

[1]

39. B [1]
40. B [1]
41. D [1]
42. (a) growth;
(tissue) repair;
spermatogenesis / oogenesis / cloning / asexual reproduction;
maintenance; 2 max
- (b) the rate of material / heat exchange /
diffusion is proportional to surface area;
the rate of metabolism is proportional to mass/volume;
as a cell grows, the volume increases faster than the surface area /
as a cell grows,
surface area to volume ratio decreases;
(without cell division) material / heat cannot be exchanged
fast enough to meet the needs of the cell; 3 max
- (c) free ribosomes synthesize proteins for use within the cell/cytoplasm and attached
ribosomes produce proteins for export / use within lysosomes / membranes 1
43. (a) I: is the plasma membrane/cell (surface) membrane/phospholipid bilayer;
II: is the mesosome; 2
- (b) size of drawing divided by magnification /
figures using this equation; (*units not required*)
Award [1] for working even if length measurement is incorrect.
1.41 (± 0.02) μm ; (*units required*) 2
Accept answers given in m, cm, mm and nm.
- (c) protection / support / maintains shape / prevents bursting 1
- (d) bacterium/bacteria/prokaryote;
reason: [1 max]
as no nuclear membrane / no nucleus;
as no mitochondria / membrane bound organelles;
as mesosomes / small size / circular DNA;
(*Do not accept naked DNA or no histone.*) 2 max
Reject reasons if cell type is incorrectly identified.
- [6]
- [7]