Bio Factsheet

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Answering exam questions on cells

AQA, Edexcel, OCR and WJEC specifications for AS-Level or A-Level all cover:

- **cell structure and ultrastructure;**
- **cell fractionation techniques;**
- **cell differentiation into different types of cell and their microscopical appearances**

This Factsheet contains different types of question which can be set on these topics and advice on how to answer them effectively. Details of things to be avoided, for example, common errors and 'shortfalls' in examination technique will be described.

In mark schemes a semi-colon indicates one marking point. An oblique / indicates an alternative to the mark point. An underlined word or phrase means that it must be used in the answer. Examiners will only award the mark if all the information in the marking point is given correctly and if the point is given in the correct context.

Question 1

The table below refers to a bacterial cell, a palisade mesophyll cell and a liver cell and to the structures which are found inside them.

If a feature is present in the cell, place a tick (✓) in the appropriate box and if a feature is absent from the cell, place a cross (✗) in the appropriate box.

Feature	Bacterial cell	Palisade cell	Liver cell
Cell wall			
Vacuole			
Mitochondria			
Chloroplasts			
Mesosomes			
Microvilli			
Nuclear membrane			

(6 marks)

Mark scheme

Feature	Bacterial cell	Palisade cell	Liver cell
Cell wall	✓	✓	✗
Vacuole	✗	✓	✗
Mitochondria	✗	✓	✓
Chloroplasts	✗	✓	✗
Mesosomes	✓	✗	✗
Microvilli	✗	✗	✓
Nuclear membrane	✗	✓	✓

1 mark awarded for each correct line. *(6 marks)*

A common error of technique is to only insert ticks and to leave spaces instead of inserting crosses (or vice versa). The stem of the question instructs you to insert ticks and crosses and so examiners may penalise answers which do not comply. They will always penalise answers showing combinations of ticks, crosses and empty boxes.

If you wish to correct an error, make sure you block out the tick or cross and then write in the correct answer. If you show a tick-cross combination (✓) it will not score a point.

A frequent biological error is to tick chloroplasts in bacterial cells. Bacteria do not contain chloroplasts, but they may contain photosynthetic pigments in mesosome-type structures. Often candidates do not know that liver cells, (an example specified on specifications), possess microvilli.

***Remember** – as a general rule, biological terms must be spelt correctly to be awarded a mark, although if the same misspelt biological term is used several times in an answer, it will only be penalised once*

Question 2

Read through the following passage about conducting tissues in plants and then fill in the spaces with the most appropriate word or words.

In the stems of flowering plants the conducting tissues are present in ..... . Water and ..... are transported from roots to leaves in continual tubular elements called xylem ..... and also in elongated cells with perforated end cell walls, called ..... The xylem elements have cell walls strengthened by deposits of ..... . This substance is impermeable and so results in the ..... of the xylem protoplasts. However, it enables the xylem to have a ..... function as well as a conducting function in the plant. The ..... transports ..... in non-nucleated ..... tubes which have associated nucleated ..... cells. Between the xylem and phloem tissues in an herbaceous stem is a layer of ..... . The cells of this layer can divide by ..... to initiate ..... growth in woody plants.

(14 marks)

Mark scheme

vascular bundles; salts/minerals; vessels; tracheids; lignin; death; mechanical/supporting/strengthening; phloem; organic solutes/sugars/amino acids; sieve; companion; cambium; mitosis; secondary;

(*14 marks)*

The important thing when answering this type of question is to follow the advice in the question stem and read through the whole passage before putting pen to paper. In this way you should get an overview of the sense of the whole passage so that your inserts are coherent. For example, the candidate who immediately fills in the words on the first read through could write 'xylem' or 'phloem' as the first answer without noticing that these terms are given, later in the passage.

Each 'fill in' is marked independently, so if you are not sure of an answer at least have a guess and write something. If what you write is wrong it will not cause you to lose any other marks.

Question 3

The table below describes structural features and the main functions of the features of some organelles of eukaryotic cells. Complete the table by filling in the empty boxes A to H.

Organelle	Structural feature	Function(s) of feature
Nucleus	Nucleolus present	**A**
B	The inner membrane is folded into cristae	**C**
D	A vesicle containing hydrolytic enzymes	Breakdown of old organelles. Cell lysis
Smooth endoplasmic reticulum	Consists of flattened membrane-bound sacs called cisternae	**E**
Rough endoplasmic reticulum	Has ribosomes bound to its surface	**F**
Golgi body	**G**	**H**

(10 marks)

More alert candidates will realise that some features have more than one main function. The clues are given in the third column – the plural in the heading and the two functions in the third box down. The fact that the number of allocated marks is greater than the number of boxes also gives a clue.

Mark scheme

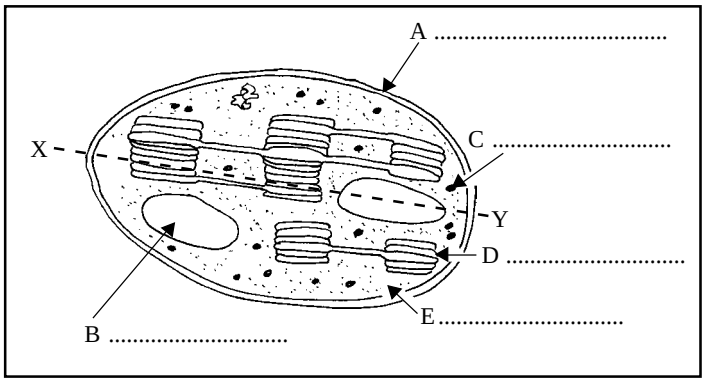
Organelle	Structural feature	Function(s) of feature
Nucleus	Nucleolus present	**Ribosome manufacture/ synthesis of ribosomal RNA;**
Mitochondrion;	The inner membrane is folded into cristae	**To increase surface area for enzyme attachment; for electron transport chain /oxidative phosphorylation;**
Lysosome;	A vesicle containing hydrolytic enzymes	Breakdown of old organelles. Cell lysis
Smooth endoplasmic reticulum (SER)	Consists of flattened membrane-bound sacs called cisternae	**Synthesis/transport of lipids/steroids;**
Rough endoplasmic reticulum	Has ribosomes bound to its surface	**Polypeptide synthesis;**
Golgi body	**A stack of flattened membrane-bound sacs called cisternae;**	**Assembly of polpetides into proteins; conjugation of proteins with other molecules;**

A common biological error is to state that 'ribosomes synthesize protein'. Remember that the ribosomes synthesize polypeptides, which are later assembled into protein, either in RER transport vesicles or within the Golgi body, after the RER vesicles fuse with the cisternae.

Be careful that you use the singular spelling for 'mitochondrion' (and 'lysosome'). In these cases the table obviously refers to single organelles. Because the spelling 'mitochondria' is different from the singular you may lose the mark.

Question 4

The drawing below shows the structure of a chloroplast.



(a) (i) Name structures labelled A to E, on the diagram. *(5 marks)*

(ii) State where in the chloroplast:
1. the light dependent reaction occurs. *(1 mark)*
2. the light independent reaction occurs. *(1 mark)*

(b) Describe three similarities in the structure of chloroplasts and mitochondria. *(3 marks)*

(c) The chloroplast shown in the drawing was magnified 8500 times. Calculate the actual length of the chloroplast along axis XY. Show your working and express your answer in micrometers. *(2 marks)*

Total 12 marks

Mark scheme

(a) (i) A = double membrane; B = starch grain; C = lipid droplet; D = granum/stack of thylacoids; E = stroma; *(5 marks)*

(ii) 1. granum/thylacoid membranes/quantosomes; *(1 mark)*
2. Stroma; *(1 mark)*

(b) both have double outer membranes;
both have many internal membranes/a large internal surface area;
both contain DNA/ribosomes;
both contain lipid droplets; *(max 3 marks)*

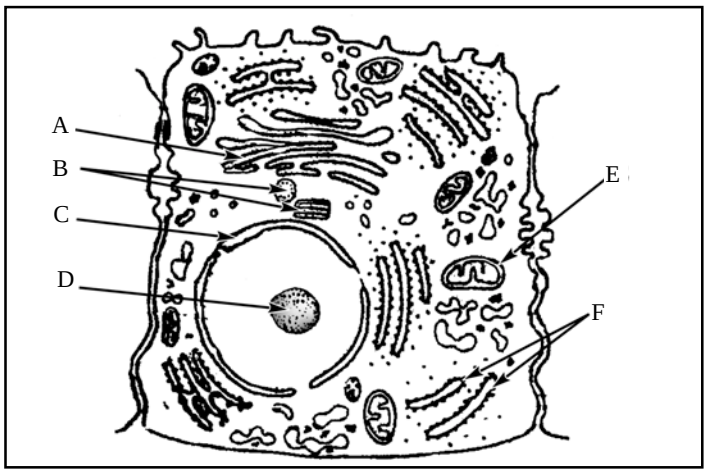
(c) Length of XY = 5.1 cm/51 mm which is 51,000 μm
Length of mitochondrion = 51,000 ÷ 8,500;
= 6.0 μm ; *(2 marks)*

In (a)(i) a common error made by candidates is to mistake the lipid droplet for a ribosome. Ribosomes would be far smaller and probably barely visible at this magnification. Most problems occur with a question like part (b). To score the marks you must refer to <u>both</u> mitochondria and chloroplasts. The question asks for three similarities so do not waste time by giving more – even though more are listed in the mark scheme you can only score three marks. The question asks for structure so do not waste time in giving irrelevant functional information, which may cause you to lose marks. For example, candidates may be tempted to explain that the 'large internal surface area' is to 'accommodate more enzymes for more efficient activity'.

One of the skills you have to demonstrate is your mathematical ability and magnification calculations are frequently asked for to test this skill. To ensure gaining the marks always:

- show your working for which 1 or (2 marks) may be awarded.
- show units, particularly in the answer. If units are missing marks will not be awarded.
- do not give an answer to more decimal places than can be accurately measured. In the above measurement you can only measure XY, using a ruler, to the nearest half mm (51 ± 0.5 mm). So the answer is 6.0 μm. If you give 6.02 μm you will lose the mark.

Question 5
The diagram below shows an electron micrograph of a liver cell.



(a) (i) Name parts labelled A to F. *(6 marks)*

(ii) Name two structures shown in the diagram which would not be present in a plant cell. *(2 marks)*

(iii) Name two structures present in a palisade mesophyll cell which are not present in a liver cell. *(2 marks)*

(b) What evidence, shown in the diagram of the liver cell, suggests that it is:
(i) metabolically active and involved in the secretion of enzymes? *(4 marks)*

(ii) involved in the synthesis or modification of lipids? *(1 mark)*

Total 15 marks

Mark scheme
(a) (i) A = golgi body/cisterna; B = centriole; C = double nuclear membrane; D = nucleolus; E = mitochondrion; F = rough endoplasmic reticulum; *(6 marks)*

(ii) centriole; microvilli; *(2 marks)*

(iii) large vacuole; chloroplasts; cell wall; *(max 2 marks)*

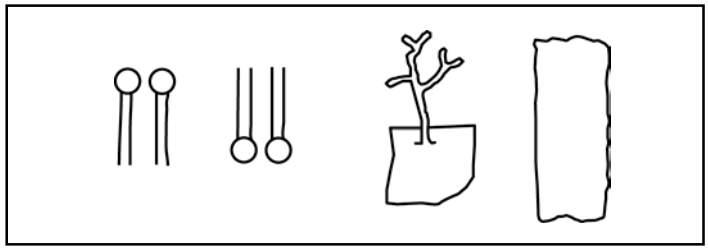
(b) (i) the presence of many mitochondria;
large/much rough endoplasmic reticulum with many ribosomes;
large golgi body;
presence of microvilli;
large nucleus; *(max 4 marks)*

(ii) the presence of much smooth endoplasmic reticulum; *(1 mark)*

A common error made by candidates in (a)(i) is to confuse the smooth endoplasmic reticulum (SER) with the golgi body. Remember that the golgi body is more 'structured' than the SER, consisting of a stack of 'penny-shaped' cisternae. Candidates often fail to refer to 'double' in the nuclear membrane label, but examiners invariably insist on its inclusion for the mark to be awarded. In part (a)(iii) 'chloroplasts' is acceptable but not 'chlorophyll', because chlorophyll is not a structure.

In a question such as (b)(i) candidates often become sidetracked into explaining the evidence. The question only asks what the evidence is. Thus the candidate who writes 'presence of many mitochondria to generate energy to enable protein synthesis' will score no more marks than the candidate who gives the basic point stated in the mark scheme. Do not waste time answering more than is asked for, and remember that if you do give unwanted information which is incorrect you will almost certainly lose marks, because your answers will be out of context. The allocation of four marks in (b)(i) should indicate to the candidate that four pieces of evidence are required.

Question 6
The diagram below shows some of the components of the plasma membrane.



(a) (i) Using the information shown and your own knowledge, draw a diagram to show the structure of the plasma membrane. *(3 marks)*

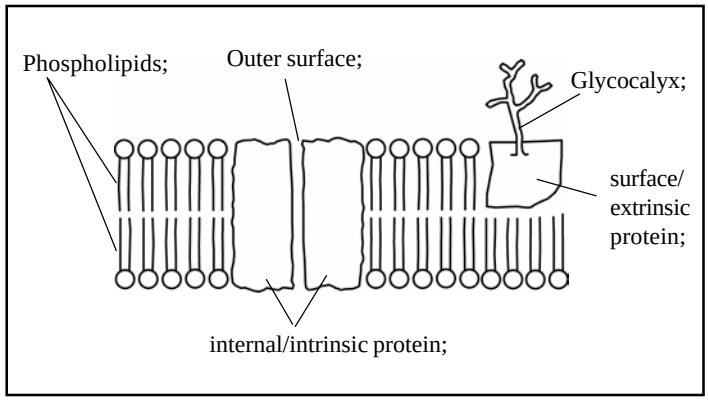
(ii) On your diagram label the components drawn and indicate the outer surface of the membrane. *(5 marks)*

(b) State two functions of the proteins in the plasma membrane. *(2 marks)*

(c) Explain how the following substances cross the plasma membrane:
(i) carbon dioxide. *(2 marks)*
(ii) glucose. *(3 marks)*

Total 15 marks

Mark scheme
(a) (i) and (ii) correct orientation of phospholipids in a bilayer;
intrinsic protein drawn in correctly;
extrinsic protein and glycocalyx drawn in correctly; *(3 marks)*



(5 marks)

(b) Any two of: transport/receptors/recognition/attachment sites/ enzymes;; *(2 marks)*

(c) (i) diffusion;
down concentration gradient;
as hydrogen carbonate ions/as dissolved CO_2; *(max 2 marks)*

(ii) either: facilitated diffusion;
glucose binds to carrier/protein;
protein changes shape/carries glucose across;
or: active transport;
glucose binds to carrier/protein;
energy or ATP required;
protein changes shape/carries glucose across;
ref. needs Na+ to be carried at the same time;
(max 3 marks)

The commonest error in part (a) is to show a glycocalyx on both sides of the membrane. The glycocalyx is only on the outside surface. In part (c)(i) candidates tend to omit references to hydrogen carbonate ions/carbon dioxide must be dissolved to pass the membrane. In (c)(ii) candidates rarely refer to the association between glucose and sodium transport.

Question 7
Read through the following passage about cell fractionation in animal tissues and then answer the questions relating to it.

Cell fractionation is a technique used to prepare samples of the various cell organelles. The organelles can be separated into fractions according to their mass using differential centrifugation. Tissues are first cut into small pieces and placed into chilled, isotonic, buffered saline. The tissue is then homogenised to break open the cells and to release the organelles. The resulting suspension is then filtered and centrifuged at low speed to remove large debris and unopened cells. The supernatant then contains the organelles suspended in chilled, isotonic, buffered saline.

The suspension of organelles is then subjected to the following sequence of differential centrifugation, the sediments being collected at each stage and the supernatant centrifuged again in the next step.

1. *suspension centrifuged at 500 – 600 g for 5 – 10 minutes. Sediment 1 collected.*
2. *supernatant centrifuged at 10,000 – 20,000 g for 15 – 20 minutes. Sediment 2 collected.*
3. *supernatant centrifuged at 100,000 g for 60 minutes. Sediment 3 collected.*

(a) Suggest a reason for obtaining samples of specific types of organelle. *(1 mark)*

(b) Explain why:
(i) the temperature during the process is kept low. *(2 marks)*
(ii) the saline must be isotonic. *(2 marks)*
(iii) the saline is buffered. *(2 marks)*

(c) (i) When centrifuging, what does the letter 'g' denote? *(1 mark)*
(ii) What organelles would you expect to find in:
sediment 1? *(1 mark)*
sediment 2? *(2 marks)*
sediment 3? *(2 marks)*

(iii) Explain why different organelles separate into the different sediments. *(2 marks)*
(iv) Sediment two contains two types of cell organelle. Suggest a technique that could be used to separate them. *(1 mark)*
Total 16 marks

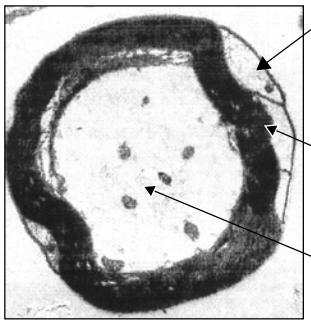
Mark scheme
(a) so that their functions/biochemistry can be studied; *(1 mark)*

(b) (i) to slow down/inactivate their metabolism so that they are less likely to be damaged;
to minimise self-digestion/autolysis of the organelles; *(2 marks)*
(ii) to prevent osmosis from damaging of the organelles;
by swelling/bursting due to water uptake/shrinking due to water loss; *(2 marks)*
(iii) to minimise pH changes during the process;
so that enzymes in the organelles do not denature; *(2 marks)*

(c) (i) 1 'g' is normal earth gravity, so 100 'g' denotes 100 times normal gravity; *(1 mark)*
(ii) sediment 1 = nuclei; *(1 mark)*
sediment 2 = mitochondria; lysosomes; *(2 marks)*
sediment 3 = ribosomes; fragments of endoplasmic reticulum; *(2 marks)*
(iii) different types of organelle have different masses/nuclei heaviest, ribosomes lightest;
organelles which have small mass need a larger 'g' force to sediment them than organelles of high mass; *(2 marks)*
(iv) sucrose density gradient centrifugation; *(1 mark)*

In part (b) the verb used is 'explain' and your answer should reflect this. For example, in part (b)(iii) a simple statement that 'pH changes are minimised' would only score one of the available marks – further explanation is needed to score the second mark. In part (c)(ii) the mark allocations indicate how many answers there are for each sediment – but you have to remember, (from your revision), the relative masses of the different organelles so that you can work out the answer. In part (c) (iii) the verb used is 'explain' and so a simple descriptive statement will not suffice as an answer. For example, a simple statement that 'the organelles separate due to the different 'g' forces acting on them' would be unlikely to score. An answer with the detail shown in the marks scheme would be expected. Section (c)(iv) has a hard answer, probably only known to really well-prepared candidates, but remember, exam questions must be designed to distinguish between candidates of high, medium and low capability. If you learn all your work thoroughly you should become a candidate of high capability. Similarly, in (c)(iii) the 'fragments of endoplasmic reticulum' mark will probably only be scored by really knowledgeable candidates.

Question 8
The photograph below shows a voluntary motor nerve fibre, cut in transverse section, as seen under the low power of an electron microscope.



(a) Label structures A, B and C. *(3 marks)*

(b) Make an accurate drawing of the nerve fibre in the photograph. Your drawing should show the photographed fibre at X2 magnification. Do not label your drawing. *(4 marks)*
Total 7 marks

Mark scheme
(a) A = schwann cell; B = myelin sheath; C = axon; *(3 marks)*

(b) correct magnification;
relative proportion of different parts correct;
amount of detail acceptable and accurate;
good quality of drawing; *(4 marks)*

A skill that you must develop, and which examiners frequently test, is the ability to observe biological structures for accurate detail and to illustrate them. Examiners will expect your drawings to be an accurate, detailed illustration of the structure, not a textbook diagram of the structure. You must use a sharp pencil (do not draw in ink), lines should join up cleanly, (no 'little tails' should appear), and shading, if necessary, should be judicious and appropriate. A small amount of tolerance will be given on the magnification factor, but not much.

In part (a) the question asks for 'structures'. Thus 'myelin' will not score because it is a substance – 'myelin sheath' is required.

Acknowledgements:
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