Unit 1 · Cell Biology

HARDER PRACTICE QUESTIONS

Full marks 46

Write your answers on separate paper. Show your working. 1 mm = 1,000 µm and 1 µm = 1,000 nm.

1 Two steps with a microscope [4]

In an electron micrograph magnified 15,000 times, a mitochondrion measures 30 mm long and 12 mm wide. A cheek cell is about 60 µm across.

i. Find the real length and width of the mitochondrion.

ii. How many such mitochondria could lie end to end across the cheek cell?

iii. Bibek wants to print a poster on which a ribosome 25 nm across is a dot 5 mm across. What magnification does he need?

iv. At that magnification, how wide would the whole cheek cell be on the same poster? Is the poster possible?

2 A flat cell and a cube [4]

Two cells have the same volume. Cell P is a flat box 60 µm long, 60 µm wide and 1 µm thick. Cell Q is a cube.

i. Find the volume of cell P and the side of cell Q to the nearest 0.1 µm.

ii. Find the ratio of surface area to volume of each.

iii. Which supplies its inside more easily, and by about how many times?

iv. Why doesn't a cell have to stay very small if it stays flat?

3 Cut one big cell into small ones [3]

A cube-shaped cell of side 10 µm is shared out, with no change in total volume, into cube-shaped cells of side 1 µm.

i. How many small cells are there?

ii. Find the total surface area before and after.

iii. Use your answer to say why a large animal is made of many cells instead of one huge one.

4 Predict, then explain [4]

Write your prediction first, then explain it.

Copy and complete the table, writing "harmed", "not harmed" or "harmed only in part" in each empty box. Then explain your answers for the yeast cell and the human cell.

	E. coli	**a yeast cell**	**a human cell**
A drug that stops peptidoglycan being made			
A drug that jams 70S ribosomes			

5 Reading an experiment [4]

Cells of the pancreas are fed radioactive amino acids for a few minutes and then ordinary ones. Later, the share of the radioactive protein in each part of the cell is measured.

Time after feeding (min)	Rough ER (%)	Golgi body (%)	Vesicles near the membrane (%)
3	85	10	5
20	40	45	15
60	10	30	60
120	5	10	85

Salina writes: "The Golgi body's share rises from 10% to 45% in the first 20 minutes, so the protein is made in the Golgi body."

i. What path does the table show?
ii. Why is Salina's claim wrong? Use two numbers from the table.
iii. Which organelle in this path is not shown in the table but must have worked first, and why?
iv. Why are the cells given radioactive amino acids for only a few minutes?

6 What if? [4]

A poison stops only the Golgi bodies working. Say what goes wrong in each case, and why.

i. a pancreas cell making a digestive enzyme
ii. a white blood cell that has just swallowed a bacterium, after its old lysosomes are used up
iii. a plant cell in the last stage of dividing
iv. a developing sperm

7 Which explanation fits the evidence? [3]

Hämmerling grafted the stalk of an *Acetabularia* species with a rayed cap onto the base of a species with a smooth disc cap. Dorji says the cap's shape is set by the stalk's cytoplasm. Reshma says it is set by the nucleus.

i. What cap grew in the end, and whose explanation does that support?
ii. Hämmerling also did the graft the other way round. Why was that worth doing?
iii. Instructions from the nucleus had to reach the tip of the stalk. What carries them?

8 Correct the misconceptions [4]

The paragraph has four mistakes. Write each mistake and correct it.

Kiran wrote: "Bacteria have no organelles at all, so they have no ribosomes and can't make proteins. Plants have chloroplasts in place of mitochondria, so plant cells respire only in the daytime. A plant cell's wall decides which substances may enter the cell. Chlorophyll is dissolved in the stroma, where light is trapped."

9 Weigh up the evidence [3]

Karma says: "The nucleus has two membranes, so by the endosymbiotic theory's evidence it must once have been a swallowed bacterium." Compare the nucleus with a mitochondrion and say whether Karma's reasoning is sound. Would a lysosome make a better candidate? Give a reason.

10 Design a fair test [4]

Binita thinks the hotter the water, the more a beetroot's cell membranes leak. She has a beetroot, a knife, glasses, a thermometer, a clock, and hot and cold water.

i. What will she change, and what will she look at?
ii. Name three things she must keep the same.
iii. Why must each cube be rinsed until the water runs clear before the test?
iv. What result would support her idea?

11 Estimate it [3]

Take *E. coli* as a box 2 μm long and 0.8 μm wide and deep, and a ribosome as a cube 25 nm wide. Take the cell to have 20,000 ribosomes (the unit says "tens of thousands"). Estimate what fraction of the cell they fill. Is "packed with ribosomes" fair?

12 Think [3]

A mature human red blood cell has no nucleus and no mitochondria.

i. Can it divide? Give a reason.
ii. Where does it get its ATP, and how much compared with a cell with mitochondria?
iii. Why can't it make new proteins to replace worn-out ones, even if it still has a few ribosomes?

13 Make your own [3]

Design a cell whose job is to make a steroid hormone in large amounts and to swim to where it is needed. List three parts it should have plenty of, or must have, and say why. Also name one part it can do with little of, and why.