Unit 1 · Cell Biology

ANSWER KEY · FOR TEACHERS

Full marks 42

Give the marks for the points in the marking scheme; an answer in other words that says the same is right.

1 Key words

K · 4

1. nucleoid
2. peptidoglycan
3. cellulose
4. fluid mosaic
5. cristae
6. grana
7. stroma
8. nucleolus

Each carries 0.5 mark.

2 Label the diagram

K · 3

1. outer membrane
2. matrix
3. inner membrane
4. crista
5. DNA
6. intermembrane space

Each carries 0.5 mark.

3 Multiple choice

i. **c.** peptidoglycan — K · 1

Bacterial walls are peptidoglycan (murein). Cellulose is in plant walls, chitin in fungal walls, and pectin in the middle lamella between plant cells.

ii. **c.** *Nostoc* — U · 1

Nostoc is a cyanobacterium, a prokaryote. *Amoeba* is a protist, yeast a fungus and *Spirogyra* a green alga: all eukaryotes.

iii. **b.** inner membrane of the mitochondrion — K · 1

F_1 particles, the ATP synthase of respiration, cover the inner membrane's cristae, facing the matrix. (Chloroplasts have a similar enzyme on their thylakoids, but the names F_1 particle and oxysome are used for the mitochondrion's.)

iv. **c.** Golgi bodies — U · 1

Vesicles from the Golgi bodies (dictyosomes) gather across the middle of the dividing cell and join into the cell plate, which becomes the new wall.

v. **b.** nine triplets of microtubules round an empty middle — U · 1

A centriole is 9 + 0: nine triplets and nothing in the middle. Nine pairs round two central ones (9 + 2) is a cilium or flagellum.

4 Match the columns

K · 3

1. ribosome → **e.** joins amino acids into proteins
2. lysosome → **c.** digests worn-out parts of the cell
3. smooth ER → **g.** makes lipids and steroid hormones
4. Golgi body → **a.** modifies, packs and sends out proteins
5. centrosome → **f.** forms the spindle in an animal cell
6. vacuole → **b.** keeps a plant cell turgid

Each carries 0.5 mark.

Science Playground, Katunje, Bhaktapur
Book a class visit: https://science-playground.com/booking

5 Very short answers

a. MARKING SCHEME — K · 1

✓ 400× written.

b. MARKING SCHEME — K · 1

✓ All three named.

c. MARKING SCHEME — U · 1

✓ 9 + 0 for the centriole and 9 + 2 for the cilium.

6 Short answers

a. MARKING SCHEME — U · 2

✓ The plant cell swells against its firm cell wall, which pushes back and stops more water entering, so it only becomes turgid.

✓ A red blood cell has no wall, only a thin membrane, which stretches until it tears.

b. MARKING SCHEME — U · 2

✓ They have their own DNA and 70S ribosomes, so they make some of their own proteins and divide by themselves.

✓ Most of their proteins are made from genes in the nucleus, so they can't live on their own.

c. MARKING SCHEME — U · 2

✓ Ribosomes on rough ER; none on smooth ER.

✓ Rough ER makes proteins; smooth ER makes lipids and steroid hormones, or detoxifies.

d. MARKING SCHEME — A · 2

✓ Our cytoplasm's ribosomes are 80S, so the drug doesn't jam them.

✓ Our mitochondria have 70S ribosomes, which it can jam.

7 Long answer

ANSWER — U · 4

1. **Nucleus:** the gene is copied into messenger RNA, which leaves through a nuclear pore.
2. **Ribosomes on the rough ER:** read the RNA and make the enzyme, which passes into the ER's lumen and is folded.
3. **Vesicles** carry it from the ER to the cis face of the **Golgi body**, which finishes it (often adding sugars), and sends it out of the trans face in a new vesicle.
4. The vesicle joins the **cell membrane** and releases the enzyme outside (exocytosis).

Mitochondria supply the ATP for every step.

MARKING SCHEME

✓ Nucleus: the gene is copied into messenger RNA, which leaves through a nuclear pore.

✓ Ribosomes on the rough ER read the RNA and make the enzyme, which passes into the ER's lumen and is folded.

✓ A vesicle carries it to the cis face of the Golgi body, which finishes it and sends it out of the trans face in a new vesicle.

✓ The vesicle joins the cell membrane and releases the enzyme outside (exocytosis); mitochondria supply the ATP.

8 Numerical problems

a. ANSWER — A · 2

Length = 120 mm ÷ 400 = 0.3 mm = **300 µm**.

Width = 20 mm ÷ 400 = 0.05 mm = **50 µm**.

MARKING SCHEME

✓ Real size = image size ÷ magnification, with length 120 mm ÷ 400 = 0.3 mm = 300 µm.

✓ Width 20 mm ÷ 400 = 0.05 mm = 50 µm.

Science Playground, Katunje, Bhaktapur
Book a class visit: https://science-playground.com/booking

b. ANSWER A · 3

i. Real size = 75 mm ÷ 25,000 = 0.003 mm = **3 µm**.

ii. 4 cm = 40 mm = 40,000 µm. Magnification = 40,000 µm ÷ 8 µm = **5,000×**.

MARKING SCHEME

- ✓ Real size = image size ÷ magnification used for the mitochondrion.
- ✓ Its length = 0.003 mm = 3 µm.
- ✓ Drawing: 4 cm = 40,000 µm, so magnification = 5,000×.

c. ANSWER A · 4

Side	Surface area	Volume	Ratio
1 µm	6 µm^2	1 µm^3	6 per µm
5 µm	150 µm^2	125 µm^3	1.2 per µm
10 µm	600 µm^2	1,000 µm^3	0.6 per µm

As the cell gets bigger, the ratio gets **smaller**: ten times the width gives ten times less surface for each unit of volume. A cell takes in food and oxygen and lets out wastes through its surface, so a cell that grew too big couldn't supply its inside fast enough. That is one reason cells stay small, and why big organisms are made of many cells instead of one huge one.

MARKING SCHEME

- ✓ Ratio 6 per µm for the 1 µm cube.
- ✓ Ratio 1.2 per µm for the 5 µm cube and 0.6 per µm for the 10 µm cube.
- ✓ The ratio gets smaller as the cell gets bigger.
- ✓ A cell supplies its inside through its surface, so a cell too big couldn't bring in food and oxygen fast enough.

9 Think

ANSWER HA · 3

The first is a **cell from the pancreas** (or another gland): it makes and secretes proteins, such as digestive enzymes, so it needs many ribosomes on rough ER to make them and much Golgi to pack and send them out. The second is a **leaf cell** (the palisade layer): it photosynthesizes, so it needs many chloroplasts, and its vacuole keeps it turgid. The third is a **root cell** (or a cell of a tuber): out of the light, it can't photosynthesize, so it has no chloroplasts, and it stores the food sent down from the leaves as starch in its leucoplasts (amyloplasts). A cell's parts tell you its job.

MARKING SCHEME

- ✓ First: a cell of the pancreas or another gland; rough ER makes the proteins it secretes and the Golgi body packs and sends them out.
- ✓ Second: a leaf cell; chloroplasts photosynthesize and the vacuole keeps it turgid.
- ✓ Third: a root or tuber cell; out of the light, so no chloroplasts, and it stores food as starch in leucoplasts.

10 Activity: Beetroot, when the membrane dies

(not marked)

WHAT STUDENTS SHOULD FIND

The cold water stays almost clear and the hot water turns red. The red pigment (betanin) is kept in the cells' vacuoles. While the membranes are alive and whole, it can't get out; heat damages the membranes' lipids and proteins, they leak, and the pigment escapes. The wall was there all along and lets the pigment through, so it was the membrane that held it in.

See it at Science Playground

Exhibits and plants at the center, Bhaktapur, that go with this unit. Book a class visit at science-playground.com/booking.

- **Animal Cell Model** (exhibit): Find the nucleus and the mitochondria, each inside its own membrane: this is a eukaryotic cell. A bacterium, a prokaryote, has neither.

Science Playground, Katunje, Bhaktapur
Book a class visit: https://science-playground.com/booking

- **Plant Cell Model** (exhibit): Find the cell wall outside the cell membrane, and the chloroplast; then check which of the two cell models has centrioles.

Marks by level	Knowledge	Understanding	Application	Higher ability	Total
Marks	14	14	11	3	**42**

Science Playground, Katunje, Bhaktapur
Book a class visit: https://science-playground.com/booking