Helicate

HELICATE · AS AND A-LEVEL BIOLOGY · TOPIC BANK

# 3.2.1 Cell structure

Topic question bank

Version 1 · 2 October 2026

Name

Date

| QUESTIONS | TOTAL MARKS | TIME | YOUR SCORE |
|---|---|---|---|
| 9 | 70 | No time limit | / 70 |

## Contents


| Subtopic | Questions | Marks |
|---|---|---|
| Structure of eukaryotic cells<br>Specification 3.2.1.1 | 01–03 | 28 |
| Structure of prokaryotic cells and of viruses<br>Specification 3.2.1.2 | 04–06 | 20 |
| Microscopes and measuring cells<br>Specification 3.2.1.3 (AT d) | 07–08 | 11 |
| Cell fractionation and ultracentrifugation<br>Specification 3.2.1.3 | 09 | 11 |
| **Total** | | **70** |


## Instructions

- Answer the questions in the spaces provided. Show all your working.
- The marks for each question are shown in brackets. Use them to judge how much detail to give.
- Work through a subtopic at a time, then mark your answers with the matching mark scheme.

Original questions by Helicate for AQA AS and A-level Biology (7401/7402), specification section 3.2.1. Not affiliated with or endorsed by AQA.

Do not write outside the box

## Structure of eukaryotic cells 3.2.1.1

Scientists used a transmission electron microscope to examine thin sections of four types of mammalian cell, **P**, **Q**, **R** and **S**. For each type of cell, they estimated the percentage of the cell volume taken up by five types of organelle. They also found the mean volume of each type of cell.

The four types of cell were:

- a cell that secretes a digestive enzyme
- a heart muscle cell
- a cell that secretes a steroid hormone
- a white blood cell that ingests and digests bacteria.

Table 1 shows the results.

**Table 1**

| Cell | Percentage of cell volume occupied by | | | | | Mean cell volume / $\mu m^3$ |
|---|---|---|---|---|---|---|
| | Mitochondria | Rough endoplasmic reticulum | Smooth endoplasmic reticulum | Golgi apparatus | Lysosomes | |
| P | 8 | 21 | 1 | 4 | 1 | 1 200 |
| Q | 34 | 1 | 2 | 1 | 1 | 15 000 |
| R | 14 | 2 | 18 | 3 | 1 | 2 000 |
| S | 6 | 5 | 2 | 3 | 9 | 1 500 |

**0 1 . 1** Which cell is most likely to be the white blood cell that ingests and digests bacteria?
**Tick (✓) one box.**

**[1 mark]**

**P** ☐

**Q** ☐

**R** ☐

**S** ☐

**Question 1 continues on the next page**

Do not write outside the box

**0 1 . 2** Cell **R** is the cell that secretes the steroid hormone. Steroid hormones are lipids.
Use Table 1 to explain why cell **R**, and not cell **P**, is the cell that secretes the steroid hormone.

**[3 marks]**

**0 1 . 3** Cell **Q** is the heart muscle cell.
Use Table 1 to calculate how many times greater the total volume of mitochondria is in one cell **Q** than in one cell **R**.

**[2 marks]**

**Answer** _____ **times greater**

**0 1 . 4** The scientists estimated the percentages in Table 1 from thin sections of cells viewed with a transmission electron microscope.
Suggest **two** reasons why these estimates may not be accurate.

**[2 marks]**

**1**

**2**

**Question 1 continues on the next page**

Do not write outside the box

**0 1 . 5** A student concluded that cell **Q** produces more ATP per minute than any of the other cells in Table 1.
Evaluate this conclusion.

**[2 marks]**

.....

.....

.....

.....

10

**0 2 . 1** Yeast is a single-celled fungus.
Which row shows the structures present in a yeast cell?
**Tick (✓) one box.**

**[1 mark]**

| Cell wall | Chloroplast | Nucleus | |
|---|---|---|---|
| Yes | Yes | Yes | ☐ |
| Yes | No | Yes | ☐ |
| No | No | Yes | ☐ |
| Yes | No | No | ☐ |

**0 2 . 2** Which row correctly identifies a tissue **and** an organ in a mammal?
**Tick (✓) one box.**

**[1 mark]**

| Tissue | Organ | |
|---|---|---|
| Epithelium | Small intestine | ☐ |
| Small intestine | Digestive system | ☐ |
| Epithelial cell | Epithelium | ☐ |
| Small intestine | Epithelium | ☐ |

**Question 2 continues on the next page**

Do not write outside the box

Fish that live in sea water gain salts from the water around them. Specialised cells in their gills, called ionocytes, move chloride ions out of the blood and into the sea water by active transport.

Compared with other cells in the gills, each ionocyte has:

- many more mitochondria
- a cell-surface membrane with many deep folds
- more ribosomes attached to the rough endoplasmic reticulum.

**0 2 . 3** Explain how these features adapt ionocytes for their function.

**[4 marks]**

**0 2 . 4** A scientist examined a thin section of an ionocyte using a transmission electron microscope.
Describe the structures the scientist would see in the nucleus of this cell.

**[3 marks]**

**9**

**Turn over for the next question**

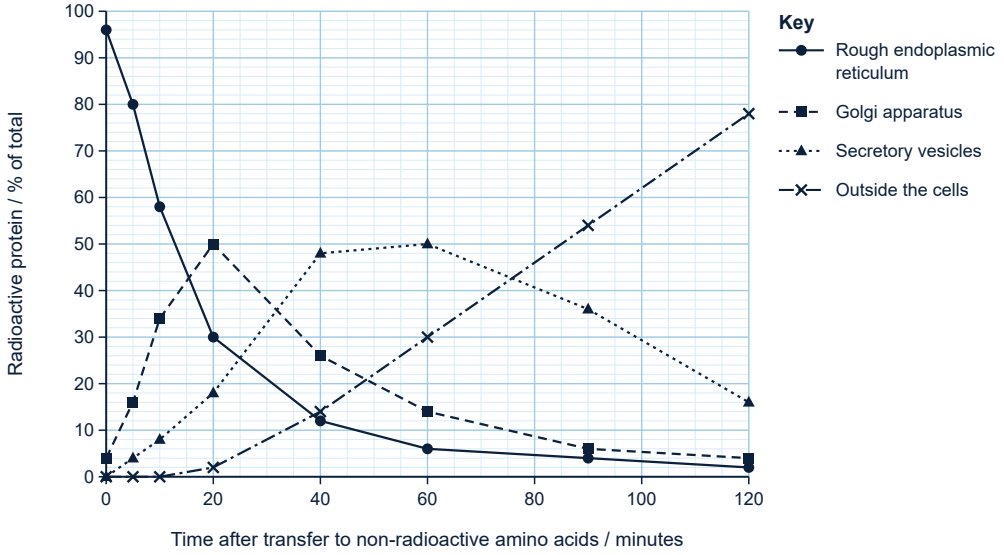
Do not write outside the box

Scientists investigated how a protein is made and secreted by cells from a gland. They:

- gave the cells amino acids containing a radioactive isotope for 3 minutes, so that the proteins made during this time were radioactive
- then transferred the cells to a solution containing a large excess of the same amino acids that were **not** radioactive
- at intervals, measured the percentage of the radioactive protein in four locations.

Figure 1 shows the results.

**Figure 1**




**0 3 . 1** Explain why the scientists transferred the cells to a solution containing a large excess of non-radioactive amino acids.

**[1 mark]**

**Question 3 continues on the next page**

Do not write outside the box

**0 3 . 2** Between 40 and 90 minutes, the percentage of radioactive protein outside the cells increased at a constant rate.
Use Figure 1 to calculate this rate.

**[2 marks]**

**Answer** _____ **% min$^{-1}$**

**0 3 . 3** Use Figure 1 and your knowledge of the roles of organelles to explain how the radioactive protein was made and secreted by these cells.

**[6 marks]**

9

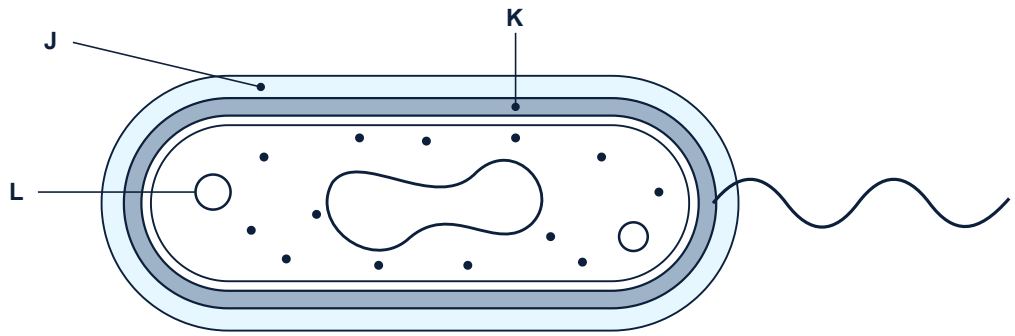
**Turn over for the next question**

Do not write outside the box

## Structure of prokaryotic cells and of viruses 3.2.1.2

Figure 2 shows a bacterium. Structures **J**, **K** and **L** are labelled.

**Figure 2**




**0 4 . 1** Name structures **J**, **K** and **L**.

**[2 marks]**

**J** .....

**K** .....

**L** .....

**Question 4 continues on the next page**

Do not write outside the box

**0 4 . 2** Use Figure 2 and your knowledge to describe how the structure of this bacterium differs from the structure of a palisade cell in a leaf.

**[5 marks]**

7

**Turn over for the next question**

Do not write outside the box

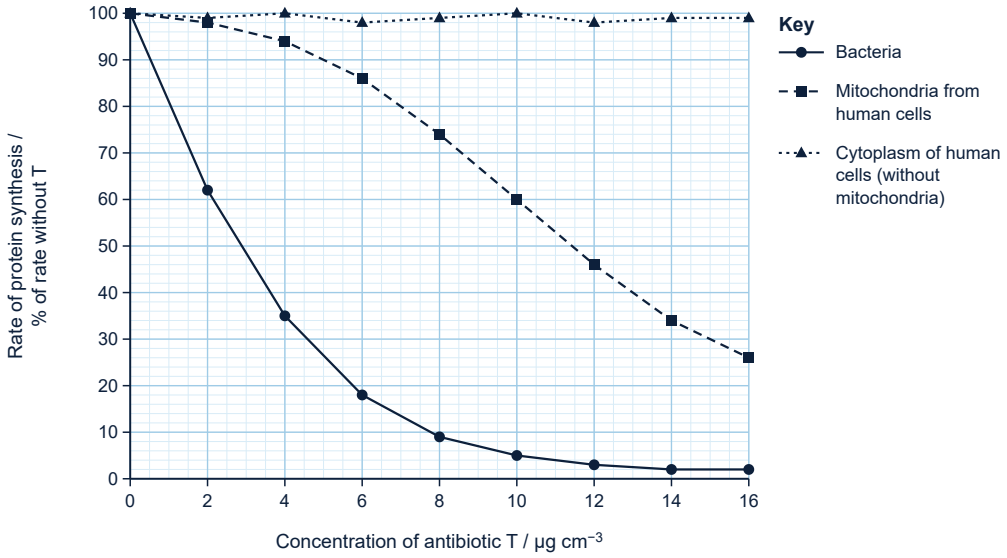
Antibiotic T stops translation by binding to ribosomes. Scientists measured the rate of protein synthesis at different concentrations of T in:

- a species of bacterium
- mitochondria isolated from human cells
- the cytoplasm of human cells, with the mitochondria removed.

Mitochondria contain their own ribosomes, which make some of the proteins used in mitochondria. These ribosomes are similar to the ribosomes of prokaryotes.

Figure 3 shows the results.

**Figure 3**




**0 5 . 1** Use your knowledge of cell structure to explain the results for the bacterium **and** for the cytoplasm of human cells.

**[2 marks]**

**Question 5 continues on the next page**

Do not write outside the box

**0 5 . 2** People who take high doses of T for a long time sometimes feel tired and have weak muscles.
Use Figure 3 to suggest why.

**[2 marks]**

**0 5 . 3** A doctor suggested that a concentration of 6 μg $cm^{-3}$ of T in the blood would treat a bacterial infection without harming the patient.
Use Figure 3 to evaluate this suggestion.

**[3 marks]**

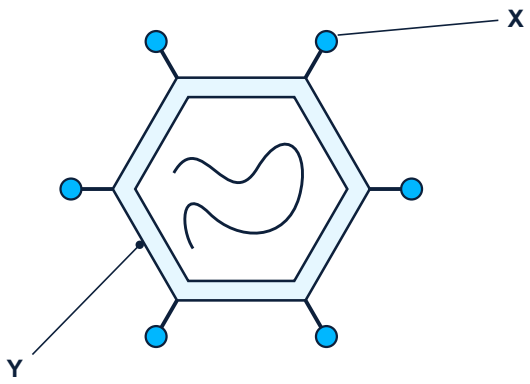
7

**Turn over for the next question**

Do not write outside the box

Figure 4 shows the structure of a virus particle. Structures **X** and **Y** are labelled.

**Figure 4**




**0 6 . 1** Which row correctly describes a virus particle?
**Tick (✓) one box.**

**[1 mark]**

| Made of cells | Contains genetic material | Has a cell-surface membrane | |
|---|---|---|---|
| Yes | Yes | Yes | ☐ |
| No | Yes | Yes | ☐ |
| No | Yes | No | ☐ |
| No | No | No | ☐ |

**0 6 . 2** Name structure **Y** and give its function.

**[2 marks]**

**Name** .....

**Function** .....

.....

**Question 6 continues on the next page**

Do not write outside the box

**0 6 . 3** This virus infects cells lining the human nose and throat, but it does not infect liver cells.
Use Figure 4 to suggest an explanation for this.

**[2 marks]**

**0 6 . 4** Explain why antibiotic T would **not** be effective in treating an infection caused by this virus.

**[1 mark]**

6

**Turn over for the next question**

Do not write outside the box

## Microscopes and measuring cells 3.2.1.3 (AT d)

**0 7 . 1** Which statement explains why a transmission electron microscope has a higher resolution than an optical microscope?
**Tick (✓) one box.**

**[1 mark]**

Electrons have a shorter wavelength than light. ☐

Electrons have a longer wavelength than light. ☐

Electron microscopes produce images with a higher magnification. ☐

Specimens for electron microscopes are stained with heavy metals. ☐

**0 7 . 2** A student wanted to watch chloroplasts moving inside living cells of a pondweed leaf. The chloroplasts are about 5 μm long. The resolution of the student's optical microscope is $2 \times 10^{-7}$ m.
Use this information to explain why the student used an optical microscope and not a transmission electron microscope.

**[2 marks]**

**Question 7 continues on the next page**

Do not write outside the box

When the transmission electron microscope was first used to study cells, specimens were treated with chemicals, dried and cut into thin sections. Using this method, some scientists saw small dense granules in the cytoplasm of cells from one tissue.

Later, other scientists prepared cells from the same tissue by freezing them very rapidly, without using chemicals. This method keeps cell structures much closer to their state in living cells. No granules were seen.

**0 7 . 3** The later scientists concluded that the granules were artefacts.
Evaluate this conclusion.

**[2 marks]**

5

A student used an optical microscope to measure cells from the lining of the cheek. An eyepiece graticule is a scale in the eyepiece of the microscope. To calibrate the graticule at ×400 magnification, the student viewed a stage micrometer. This is a slide with a scale 1 mm long, divided into 100 equal divisions.

At ×400 magnification, 25 divisions on the eyepiece graticule lined up exactly with 6 divisions on the stage micrometer.

**0 8 . 1** One cheek cell measured 24 eyepiece graticule divisions across.
Calculate the actual diameter of this cell in μm.

**[2 marks]**

**Answer** _____ **μm**

**Question 8 continues on the next page**

Do not write outside the box

**0 8 . 2** The student changed to a lower magnification.
Explain why the student needed to calibrate the eyepiece graticule again.

**[1 mark]**

**0 8 . 3** The student made a drawing of the cell. The diameter of the cell in the drawing was 70 mm.
Use your answer to Question 08.1 to calculate the magnification of the drawing.
Give your answer to **two** significant figures.

**[2 marks]**

**Answer**

**0 8 . 4** Suggest how the student could obtain a more representative value for the diameter of cheek cells.

**[1 mark]**

6

**Turn over for the next question**

Do not write outside the box

## Cell fractionation and ultracentrifugation 3.2.1.3

Scientists separated the organelles in liver cells. They:

- cut liver tissue into small pieces and placed them in a solution that was ice-cold, buffered and had the same water potential as the tissue
- homogenised the tissue in a blender
- filtered the homogenate.

**0 9 . 1** Explain why the solution was ice-cold, buffered **and** had the same water potential as the tissue.

**[3 marks]**

**Ice-cold**

**Buffered**

**Same water potential**

**0 9 . 2** Suggest why the homogenate was filtered.

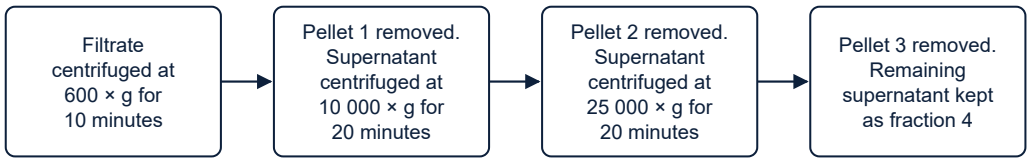
**[1 mark]**

**Question 9 continues on the next page**

Do not write outside the box

The scientists then centrifuged the filtrate at increasing forces, as shown in Figure 5. The force is shown as a multiple of the force of gravity (× g).

**Figure 5**




They measured the amount of DNA and the activity of two enzymes in each fraction. Most of the DNA in a liver cell is in the nucleus. Enzyme **M** is found only in mitochondria. Enzyme **L** is found only in lysosomes.

Table 2 shows the results.

**Table 2**

| Fraction | DNA / % of total | Activity of enzyme M / % of total | Activity of enzyme L / % of total |
|---|---|---|---|
| Pellet 1 | 92 | 6 | 4 |
| Pellet 2 | 5 | 80 | 30 |
| Pellet 3 | 2 | 12 | 58 |
| Fraction 4 (final supernatant) | 1 | 2 | 8 |

**0 9 . 3** The scientists concluded that lysosomes are smaller or less dense than mitochondria.
Use Table 2 to explain how the results support this conclusion.

**[3 marks]**

**Question 9 continues on the next page**

Do not write outside the box

**0 9 . 4** Use Table 2 to give **two** reasons why pellet 3 is not a pure sample of lysosomes.

**[2 marks]**

**1** .....

.....

**2** .....

.....

**0 9 . 5** 8% of the activity of enzyme **L** was in fraction 4, the final supernatant.
Suggest why.

**[1 mark]**

.....

.....

.....

**0 9 . 6** The scientists then centrifuged fraction 4 at 100 000 × g for 60 minutes.
Which structures would form most of the new pellet?
**Tick (✓) one box.**

**[1 mark]**

Nuclei ☐

Mitochondria ☐

Ribosomes ☐

Cell walls ☐

11

**END OF QUESTIONS**

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