Week 1

A-Level Biology

Homework bundle for this week

本周作业合集

exercises.lol

Contents 目录

A-Level Biology Name: ____________ Score: ______

1. Why does an electron microscope have a much higher resolution than a light microscope?
   - ☐ electrons have a much shorter wavelength than light
   - ☐ electrons are bigger than light
   - ☐ it uses more lenses
   - ☐ it magnifies more times
2. What is the main function of mitochondria?
   - ☐ respiration — releasing energy as ATP
   - ☐ photosynthesis
   - ☐ making lipids
   - ☐ storing water
3. A key feature of a prokaryotic cell is that it:
   - ☐ has no nucleus — its circular DNA lies free in the cytoplasm
   - ☐ has a nucleus holding linear DNA
   - ☐ contains many mitochondria
   - ☐ is larger than a eukaryotic cell
4. Which equation gives magnification?
   - ☐ image size ÷ actual size
   - ☐ actual size ÷ image size
   - ☐ image size × actual size
   - ☐ image size + actual size
5. The tiny organelle that joins amino acids to build proteins is the ________.

   ____
6. Prokaryotes have smaller 70S ribosomes, while the cytoplasm of eukaryotes has larger 80S ribosomes.

   ☐ True ☐ False
7. How many micrometres (μm) are in 1 mm?

   ________________ μm

8. Rough ER is studded with ribosomes and makes proteins, while smooth ER has none and makes lipids.

   ☐ True ☐ False

9. The small extra ring of DNA in a bacterium, separate from its main loop, is a ________.

   ____

10. At magnification $\times 5000$, a structure measures 25 mm in the image. What is its actual size, in µm?

    _________________ µm

A-Level Biology

1. **electrons have a much shorter wavelength than light**

   Shorter wavelength → higher resolution, so finer detail can be seen.

2. **respiration — releasing energy as ATP**

   Mitochondria are the site of aerobic respiration, producing ATP.

3. **has no nucleus — its circular DNA lies free in the cytoplasm**

   Prokaryotes have no nucleus and no double-membrane organelles; their DNA is circular and free.

4. **image size ÷ actual size**

   Magnification = size of image ÷ actual size (no units).

5. **ribosome**

   Ribosomes carry out protein synthesis; the nucleolus makes them.

6. **True**

   Correct — 70S in prokaryotes; 80S in eukaryotic cytoplasm (mitochondria and chloroplasts contain 70S, a clue to their origin).

7. **1000 µm**

   1 mm = 1000 µm (and 1 µm = 1000 nm).

8. **True**

   Correct — the "rough" look is the ribosomes on the rough ER, which make proteins; smooth ER makes lipids.

9. **plasmid**

   Plasmids carry extra genes (e.g. antibiotic resistance) and can be passed between bacteria.

10. **5 µm**

    25 mm ÷ 5000 = 0.005 mm = 5 µm.

1.1 The microscope in cell studies

Name: ______________ Class: _________ Date: ____________ **Total: 19 marks**

KEY WORDS microscope 显微镜 • eyepiece graticule 目镜测微尺 • stage micrometer 载物台测微尺 • photomicrograph 显微照片 • magnification 放大倍数

Objective

Build the skills to answer exam questions on **the microscope in cell studies** — calculating **magnification 放大倍数** and actual size, calibrating an **eyepiece graticule 目镜测微尺**, and comparing magnification with **resolution 分辨率**.

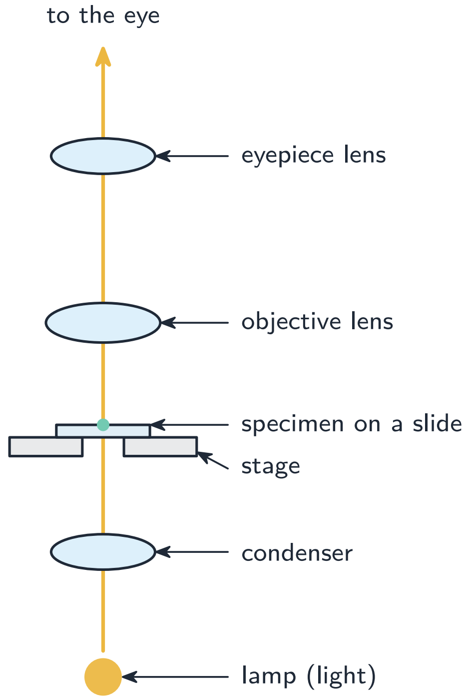
You must be able to:

- use the magnification equation to find magnification, image size, or actual size (convert to the same unit first)
- convert between millimetre (mm), micrometre (µm) and nanometre (nm)
- calibrate an eyepiece graticule with a **stage micrometer 载物台测微尺**, then measure a cell
- define magnification and resolution, and explain why the electron microscope shows more detail

1 Worked examples

Study these first. Each one shows the **method 方法** for a question type used later — examiners give marks for the working, not only the final number.

> ### ■ Magnification, image size and actual size
> A **light microscope 光学显微镜** forms an enlarged image of a thin **specimen 标本**. How many times larger the image is depends on the magnification.



A light microscope forms a magnified image of the specimen

These three quantities are linked by one equation:

$$\text{magnification} = \frac{\text{size of image}}{\text{actual size of object}}$$

Rearrange it to find whichever value is missing:

$$\text{actual size} = \frac{\text{size of image}}{\text{magnification}}, \qquad \text{size of image} = \text{magnification} \times \text{actual size}.$$

The image size and actual size **must be in the same unit** before you divide. Cells are tiny, so work in small units:

$$1\ \text{mm} = 1000\ \mu\text{m}, \qquad 1\ \mu\text{m} = 1000\ \text{nm}, \qquad 1\ \text{mm} = 1\,000\,000\ \text{nm}.$$

Example. A **transmission electron micrograph** 透射电子显微照片 shows a mitochondrion 60 mm long at a magnification of $\times 30\,000$. Its actual length is

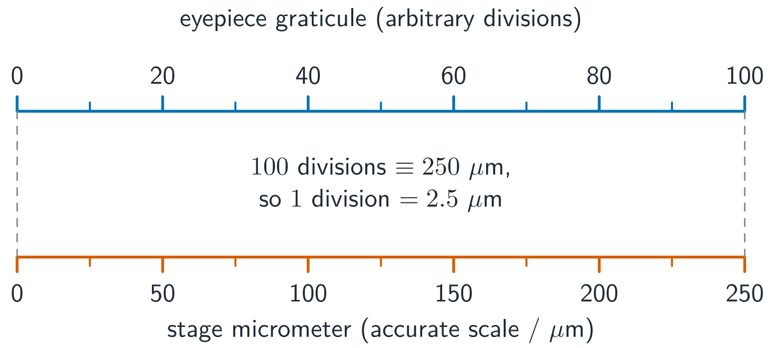
$$\frac{60\ \text{mm}}{30\,000} = 0.0020\ \text{mm} = 2.0\ \mu\text{m}.$$

Reverse example. A cell of actual width 8 µm is drawn at $\times 400$. The drawing width is $400 \times 8\ \mu\text{m} = 3200\ \mu\text{m} = 3.2\ \text{mm}$.

Tip: when a question says "to 3 significant figures", keep the full value until the last step, then round.

■ Calibrating an eyepiece graticule

An **eyepiece graticule** is a scale inside the eyepiece. Its divisions have **no fixed size** — the real length of one division changes with the objective lens. A **stage micrometer** is a tiny ruler on a slide with **known** divisions. You use it to find the real size of one graticule division.



Calibrating the eyepiece graticule against the stage micrometer

Method: line the two scales up, count how many graticule divisions match a known length on the stage micrometer, then divide.

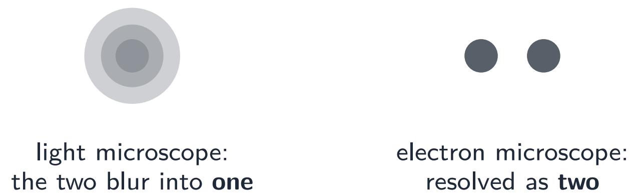
Example. In the figure above, 100 graticule divisions line up with 250 µm on the stage micrometer. So

$$1 \text{ graticule division} = \frac{250\ \mu\text{m}}{100} = 2.5\ \mu\text{m}.$$

A cell now measured at 20 graticule divisions has an actual width of $20 \times 2.5 = 50$ µm. **Recalibrate** whenever you change the objective lens.

■ Magnification versus resolution

- **Magnification** is how many times larger the image is than the object.
- **Resolution** is the smallest distance between two points that can still be seen as **separate**. It sets how much *detail* you can see.



A light microscope blurs two very close points into one; an electron microscope still resolves them

A light microscope resolves down to about 200 nm; a transmission electron microscope resolves to about 0.5 nm. Making an image bigger **without** better resolution just gives a larger blur ("empty magnification"). This is why small structures such as **ribosomes** 核糖体 (about 25 nm) are only seen with an electron microscope.

2 Practice

Now apply the methods above.

2.1 Convert each length. [3]

length	convert to
0.005 mm	µm
2 µm	nm
1.5 mm	µm

2.2 A cell of actual width 50 µm is drawn 100 mm wide. Calculate the magnification of the drawing. *(Hint: put both sizes in µm first.)* [2]

2.3 Using the same eyepiece graticule and objective, 100 graticule divisions line up with 1.0 mm on a stage micrometer.

(a) Calculate the actual length of **one** graticule division, in µm. [2]

(b) A nucleus measures 8 graticule divisions across. State its actual width. [1]

3 Exam-style questions

3.1 In a photomicrograph of magnification ×5000, a **chloroplast 叶绿体** measures 25 mm in diameter. The actual diameter of the chloroplast is: [1]

- **A** 0.5 µm
- **B** 5 µm
- **C** 50 µm
- **D** 125 µm

3.2 Which structure can **only** be seen using an electron microscope, not a high-power light microscope? [1]

- **A** cell wall
- **B** chloroplast
- **C** nucleus
- **D** ribosome

3.3 A student lines up an eyepiece graticule with a stage micrometer whose smallest divisions are 0.01 mm. The diagrams show that 40 graticule divisions cover 0.20 mm. The same eyepiece is used to view a blood smear, and a **lymphocyte 淋巴细胞** measures 2 graticule divisions across.

(a) Calculate the actual length of one graticule division, in µm. [2]

(b) Calculate the diameter of the lymphocyte, in µm. [1]

3.4 Fig. 3.1 is a scanning electron micrograph of a *Plasmodium* ring cell inside a red blood cell. The actual diameter of the ring cell is 2.0 µm. In the image, this diameter measures 80 mm.

(a) Calculate the magnification of the image. Give your answer to 3 significant figures.[2]

(b) The ring cell could not be seen clearly with a light microscope. Use the idea of **resolution** to explain why. [2]

3.5 Define each term. [2]

(a) magnification

(b) resolution

Solutions

2.1 0.005 mm = 5 µm; 2 µm = 2000 nm; 1.5 mm = 1500 µm.

2.2 Both in µm: image = 100 mm = 100 000 µm. magnification $= \dfrac{100\,000}{50} = \times 2000$.

2.3 (a) $\dfrac{1.0 \text{ mm}}{100} = 0.010$ mm = 10 µm.
(b) $8 \times 10 = 80$ µm.

3.1 **B**. $\dfrac{25 \text{ mm}}{5000} = 0.005$ mm = 5 µm.

3.2 **D**. A ribosome (≈ 25 nm) is far below the ≈ 200 nm resolution of a light microscope; the others are large enough to see.

3.3 (a) 40 divisions = 0.20 mm, so 1 division $= \dfrac{0.20}{40} = 0.005$ mm = 5 µm.
(b) $2 \times 5 = 10$ µm.

3.4 (a) Same unit: image = 80 mm = 80 000 µm. magnification $= \dfrac{80\,000}{2.0} = 40\,000$, i.e. $\times 4.00 \times 10^4$.
(b) The ring cell (2 µm) and its detail are near or below the light microscope's resolution (≈ 200 nm = 0.2 µm); the electron microscope has far higher resolution, so it shows the ring cell as a separate, detailed structure.

3.5 (a) magnification = how many times larger the image is than the actual object.
(b) resolution = the smallest distance between two points that can still be seen as two separate points.

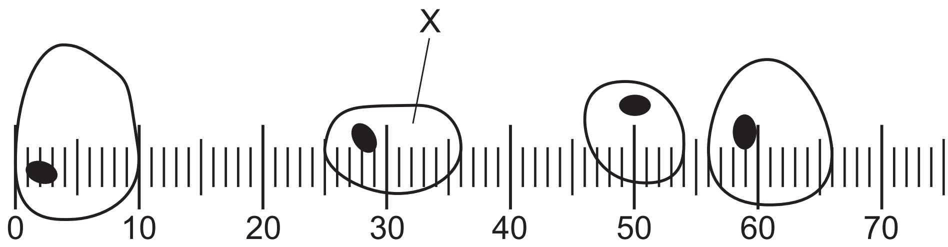
1 In a photomicrograph of magnification ×5000, a chloroplast measures 25 mm in diameter.

What is the actual diameter of the chloroplast?

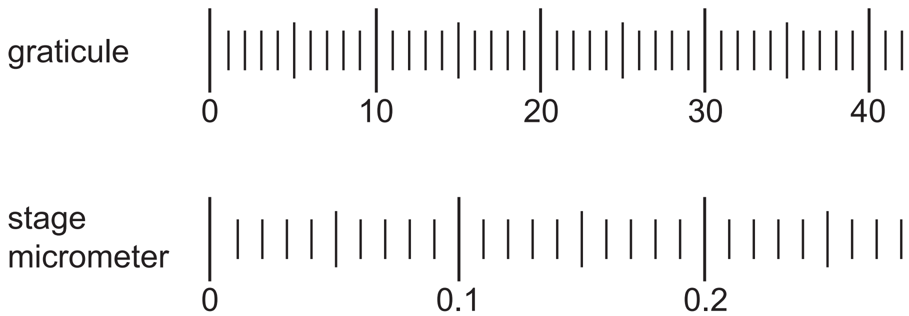
A 0.2 μm **B** 0.5 μm **C** 2 μm **D** 5 μm

A-Level Biology: **w25 12**

1 A student observed some cells using a microscope with an eyepiece graticule.



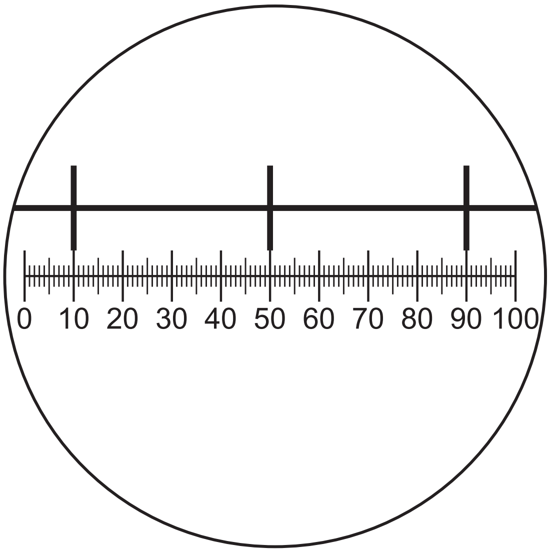
They then replaced the slide containing the cells with a stage micrometer with a millimetre scale, and lined up the eyepiece graticule as shown.



What is the maximum diameter of the cell labelled X?

A 0.0066 μm **B** 66 μm **C** 73 μm **D** 733 μm

1 The diagram shows a stage micrometer, with divisions 0.1 mm apart, viewed through an eyepiece containing a graticule.



The same eyepiece is now used to examine a blood smear.

How many graticule divisions will cover the diameter of a lymphocyte of 10 μm?

A 1 **B** 4 **C** 10 **D** 20

1 Which structures are visible in an appropriately stained plant cell using a high power (×400) light microscope?

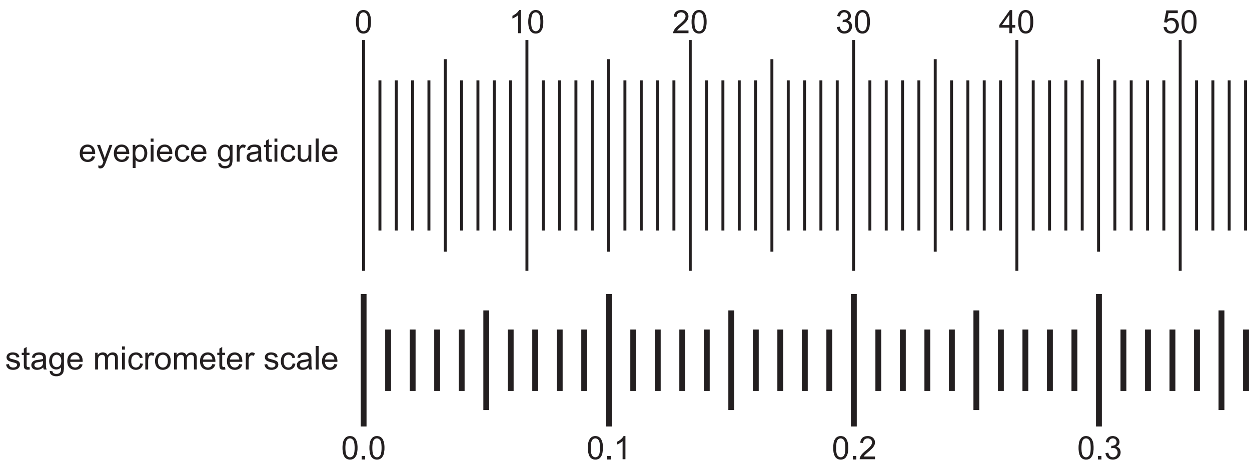
	centrioles	mitochondria	starch grains
A	✓	✗	✓
B	✓	✗	✗
C	✗	✓	✗
D	✗	✓	✓

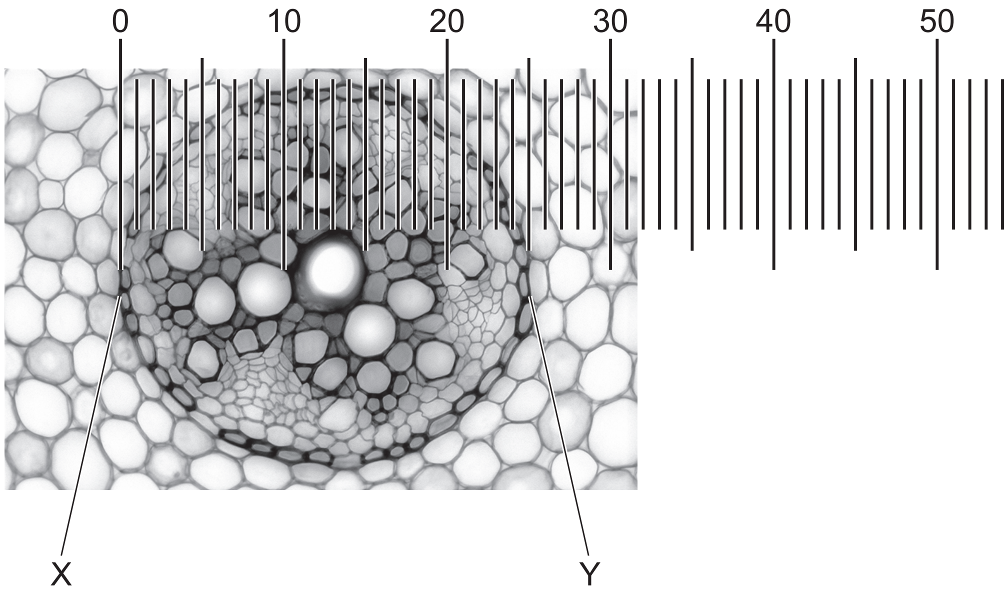
key
✓ = visible
✗ = **not** visible

2 The images show an eyepiece graticule and a stage micrometer scale viewed through a microscope.

The smallest divisions of the stage micrometer scale are 0.01 mm.

The images also show a photomicrograph of a transverse section through a plant root using the same eyepiece graticule and the same magnification.





What is the actual width of the vascular tissue in the plant root between X and Y?

A 17 µm **B** 25 µm **C** 170 µm **D** 250 µm

2 **K1** is a slide of a stained transverse section through a root.

(a) **(i)** Draw a large plan diagram of the region on **K1** indicated by the shaded area in Fig. 2.1. Use a sharp pencil.

Use **one** ruled label line and the label **T** to identify a tissue involved in transport of substances throughout the plant.

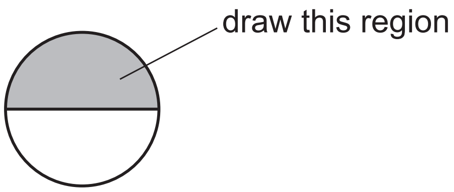


Fig. 2.1

[5]

(ii) Observe the cells in the centre of the root on **K1**.

Select a group of **four** adjacent cells.

Each cell must touch at least **one** of the other cells.

Make a large drawing of this group of **four** cells.

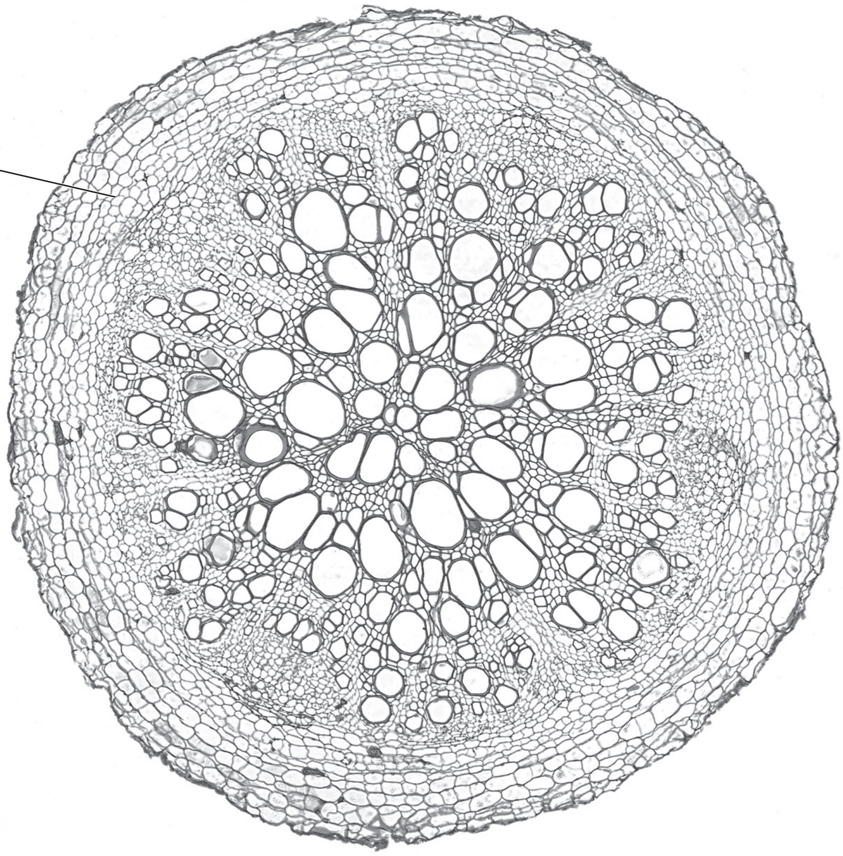
[4]

(b) Fig. 2.2 is a photomicrograph of a stained transverse section through the root of a different plant to **K1**.

One difference between the section in Fig. 2.2 and the section on **K1** has been labelled.

Identify **three** other observable differences between the section in Fig. 2.2 and the section on **K1**.

Draw **three** label lines on Fig. 2.2 to label the **three** differences you have identified. You should complete the labels to describe the differences you observe.



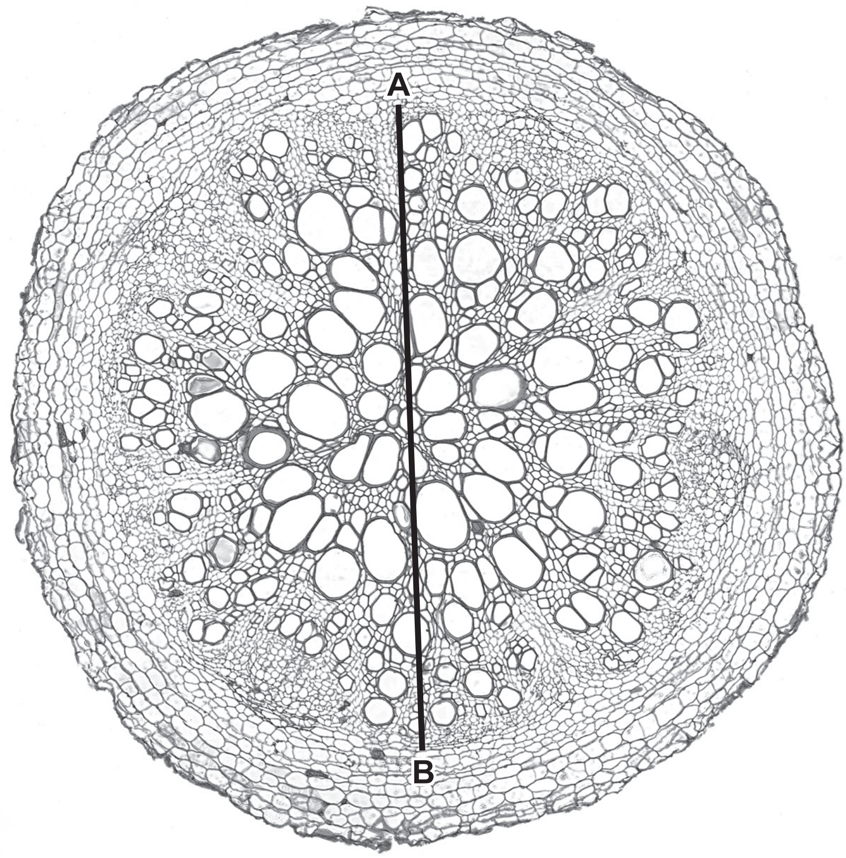
magnification ×35

Fig. 2.2

[4]

(c) A student was asked to find the area of the vascular tissue in a transverse section of root.

The student grew one plant for three weeks and took a section from one of the roots. This section is shown in Fig. 2.3.



magnification ×35

Fig. 2.3

The vascular tissue is the central region of the section.

Assume that the vascular tissue is a circle. The line **A–B** is the diameter of the vascular tissue.

(i) Calculate the actual area of the vascular tissue.

Use the formula: area = πr^2, where π = 3.14.

actual area of the vascu sue = ... mm^2

[4]

(ii) The student wrote a hypothesis which stated that:

The area of vascular tissue in a root section changes as the plant grows.

Suggest modifications to the method used in **(c)** to investigate this hypothesis.

....

....

....

....

....

....

....

.... [3]

[Total: 20]

2 **L1** is a slide of a stained transverse section through a plant organ.

(a) **(i)** Draw a large plan diagram of the region on **L1** indicated by the shaded area in Fig. 2.1. Use a sharp pencil.

Use **one** ruled label line and label to identify **one** vascular bundle.

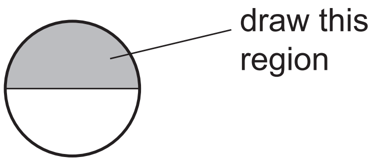


Fig. 2.1

[5]

(ii) Observe the xylem vessel elements in the organ on **L1**.

Select a line of **four** adjacent xylem vessel elements.

Each xylem vessel element must touch at least **one** other xylem vessel element.

- Make a large drawing of this line of **four** xylem vessel elements.
- Use **one** ruled label line and label to identify the wall of **one** xylem vessel element.

[5]

(iii) Identify the plant organ on **L1** and give a reason for your answer.

....

.... [1]

(b) Fig. 2.2 is a photomicrograph of a stained transverse section of the same organ from a different plant to **L1**.

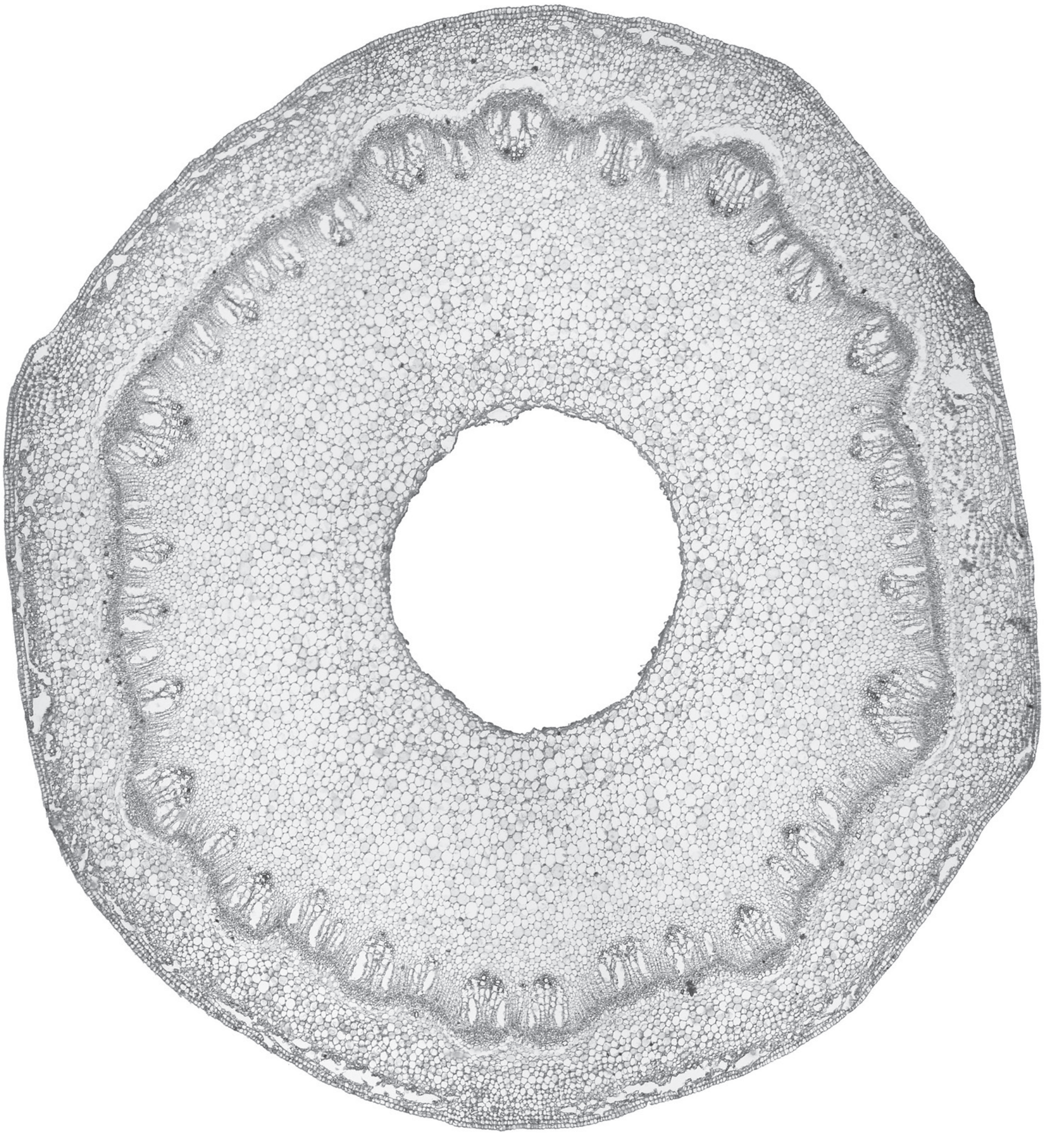


Fig. 2.2

Identify **two** observable differences, other than colour, between the section on **L1** and the section in Fig. 2.2.

Record these **two** observable differences in Table 2.1.

Table 2.1

feature	L1	Fig. 2.2
1		
2		

[2]

(c) Fig. 2.3 shows a photomicrograph of a stage micrometer scale that is being used to calibrate an eyepiece graticule.

One division, on either the stage micrometer scale or the eyepiece graticule, is the distance between two adjacent lines.

The length of one division on the stage micrometer in Fig. 2.3 is 1.0 mm.

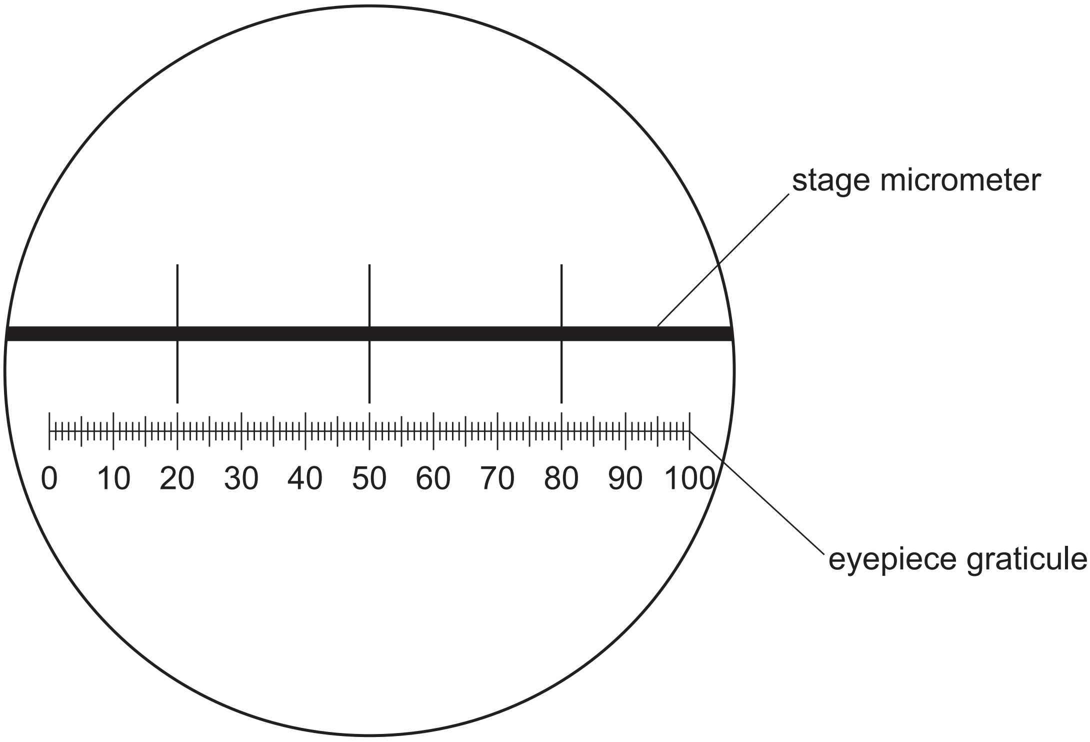


Fig. 2.3

(i) Calculate the actual length of **one** eyepiece graticule unit shown in Fig. 2.3.

Give your answer in micrometres (μm).

Show your working.

actual length = ... μm [2]

Fig. 2.4 is the same photomicrograph as that shown in Fig. 2.2. This was taken with the same microscope and the same lenses used to take the photomicrograph in Fig. 2.3. The eyepiece graticule has been placed across the width of the tissue.

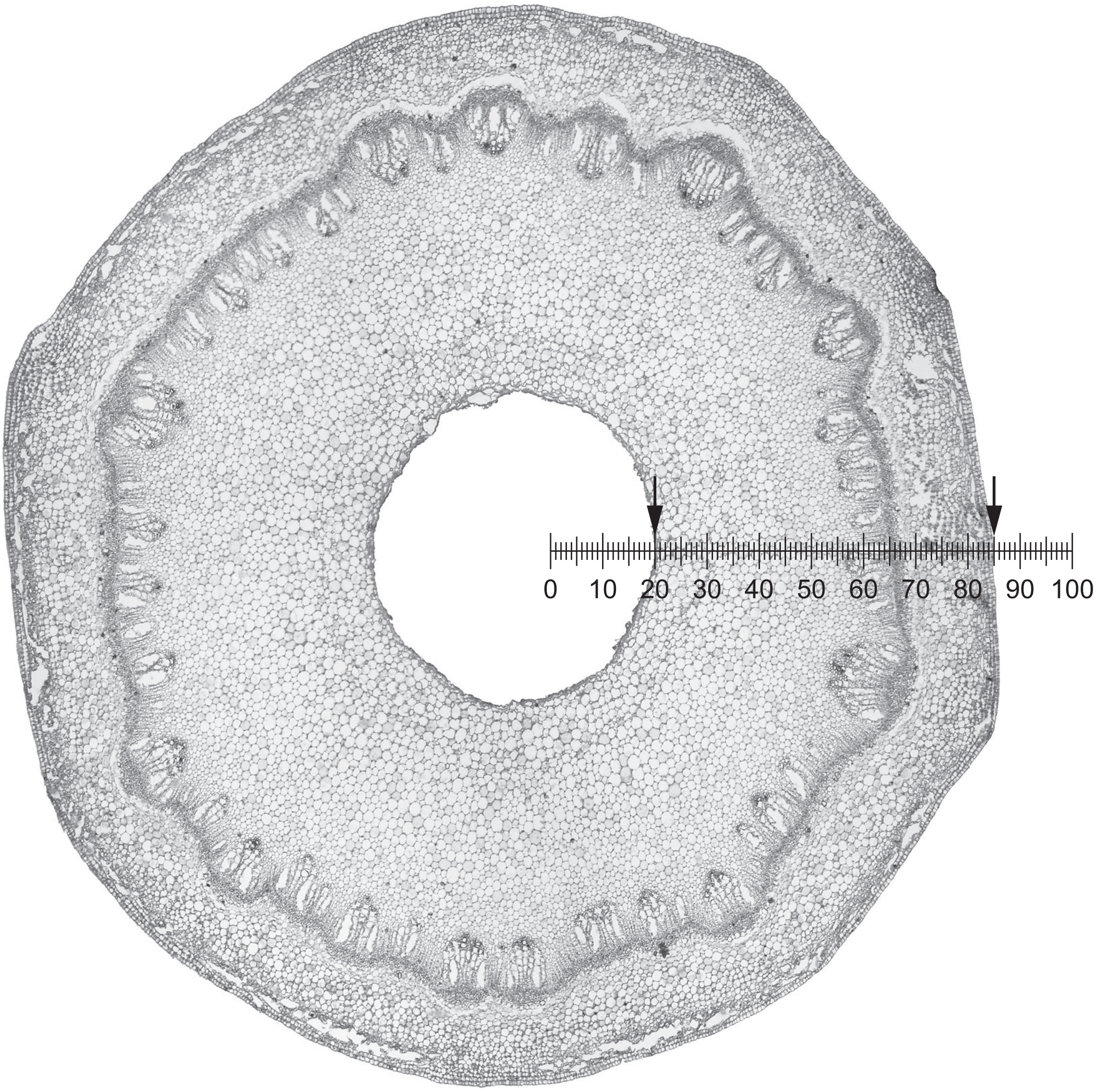


Fig. 2.4

(ii) Use your calibration of one eyepiece graticule unit from **(c)(i)** to calculate the actual width of the tissue between the arrows on Fig. 2.4.

Show your working and use appropriate units.

actual width of the tissue between rrows ....

[2]

(iii) The width of the tissue in Fig. 2.4 varies. Suggest how you could more accurately calculate the width of the tissue.

....

.... [1]

[Total: 19]

1.2 Cells as the basic units of living organisms

Name: ______________ Class: __________ Date: ____________ **Total: 22 marks**

KEY WORDS organelle 细胞器 • cell wall 细胞壁 • prokaryotic 原核 • cell surface membrane 细胞膜 • prokaryotic cell 原核细胞

Objective

Build the skills to answer exam questions on **cells as the basic units of living organisms** — identifying **organelles** 细胞器, comparing plant, animal and **prokaryotic** 原核 cells, and describing viruses.

You must be able to:

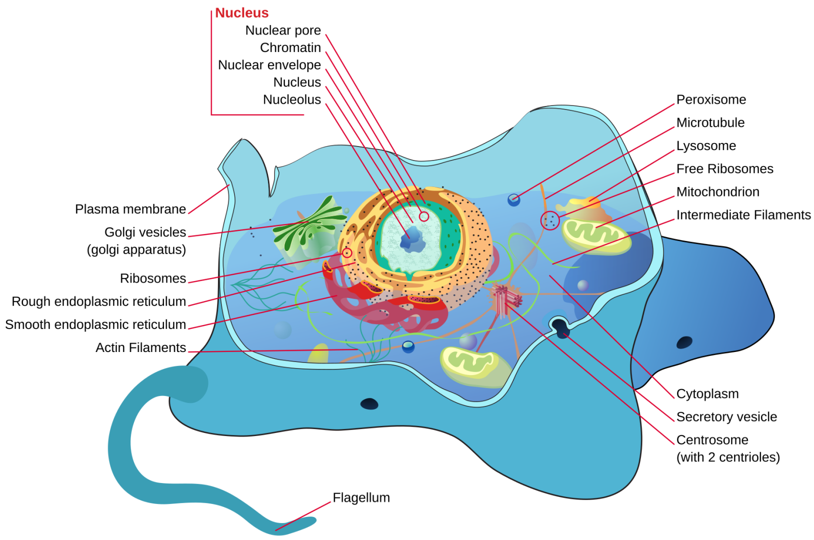
- name organelles from their structure and give their function
- compare a typical plant cell with a typical animal cell
- compare a **prokaryotic cell** with a **eukaryotic cell** 真核细胞
- state that a virus is non-cellular, with a nucleic acid core and a protein **capsid** 衣壳

1 Worked examples

Study these first. Each shows the **method** 方法 for a question type used later.

■ Identifying an organelle from its features

Match the clues — shape, membranes, contents — to one organelle, then give its job. Learn to recognise each organelle in the diagram below.

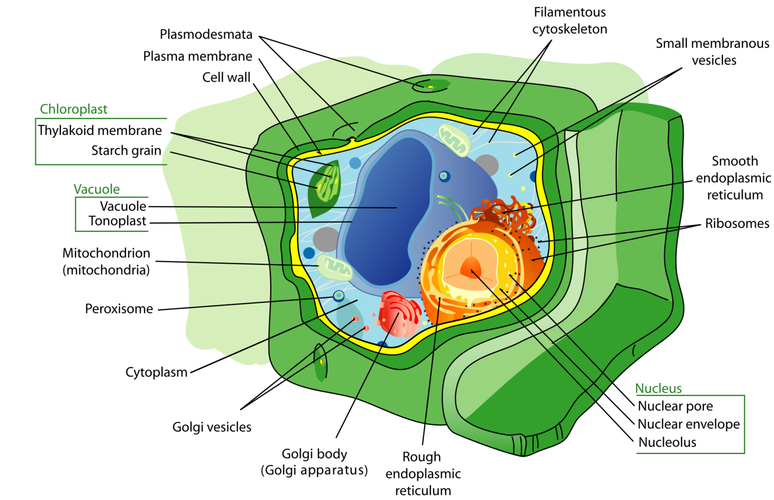


A generalised animal cell — recognise each organelle by its shape and position

Example. *"This organelle is oval, has a folded inner membrane, and contains small circular DNA and 70S ribosomes."* → It is a **mitochondrion 线粒体**. Its function is **aerobic respiration 有氧呼吸** — releasing energy as ATP. (The folded inner membrane and own circular DNA are the give-away clues.)

■ Answering a "compare" question

"Compare" means give points that mention **both** sides, and include at least one **similarity**.



A plant cell — note the features an animal cell does not have

Example — plant vs animal cell. Write paired statements:

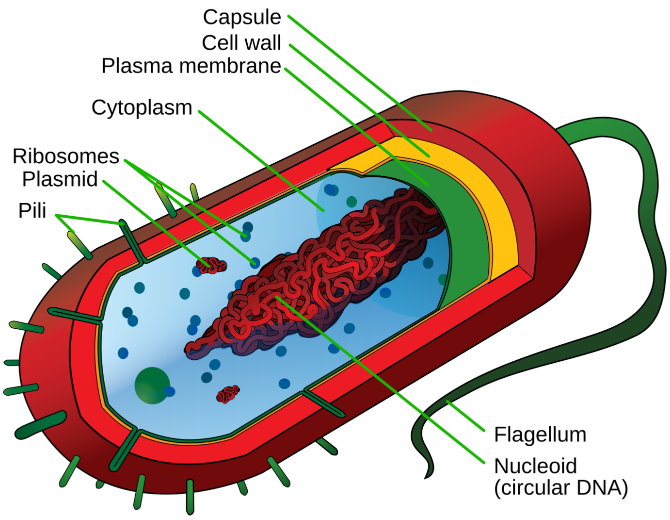
- a plant cell has a **cellulose 纤维素** cell wall; an animal cell has none.
- a plant cell has **chloroplasts 叶绿体**; an animal cell has none.
- a plant cell has one large permanent **vacuole 液泡**; an animal cell has only small,

temporary ones.

- **both** have a cell surface membrane, cytoplasm, a nucleus and mitochondria.

■ Comparing prokaryotic and eukaryotic cells

A **prokaryotic cell** (a bacterium) has no nucleus and no membrane-bound organelles.



A prokaryotic cell: circular DNA lies free in the cytoplasm; 70S ribosomes; no nucleus

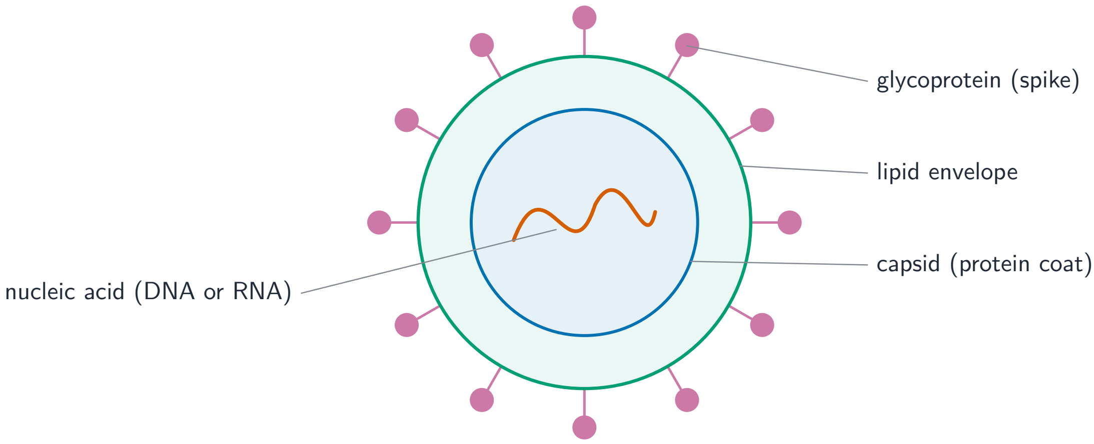
The key differences examiners reward:

feature	prokaryotic cell	eukaryotic cell
nucleus	none (DNA free in cytoplasm)	true nucleus with envelope
DNA	circular, no **histones** 组蛋白	linear, wound on histones
ribosomes	70S	80S (in the cytoplasm)
membrane-bound organelles	absent	present (mitochondria, ER, Golgi)
size	1–5 µm	10–100 µm

Both have a cell surface membrane, cytoplasm, ribosomes and DNA. (A prokaryote also has a wall, but of **peptidoglycan** 肽聚糖, not cellulose.)

■ Viruses are non-cellular

A virus is **not** a cell. It has only a **nucleic acid** 核酸 core (DNA *or* RNA) inside a protein **capsid**; some also have an outer phospholipid **envelope** 包膜.



A generalised virus: nucleic acid core, protein capsid, and (in some) a lipid envelope

It has no cytoplasm, no organelles and no ribosomes, so it cannot release energy or make proteins on its own.

2 Practice

2.1 Name the organelle that carries out each function. [4]

function	**organelle**
makes and transports proteins (has ribosomes on it)	
packs and modifies proteins into vesicles	
site of photosynthesis	
breaks down old organelles and waste	

2.2 State **three** structures found in a plant cell that are **not** found in a typical animal cell. [3]

2.3 Give the size (S value) of the ribosomes found in (a) the cytoplasm of a eukaryotic cell, and (b) a prokaryotic cell. [2]

3 Exam-style questions

3.1 Which structures are found in **both** a prokaryotic cell and a eukaryotic cell? [1]

- **A** cell surface membrane, cytoplasm, ribosomes
- **B** mitochondria, nucleus, ribosomes
- **C** chloroplasts, cell wall, vacuole
- **D** nuclear envelope, Golgi body, lysosomes

3.2 An organelle has a **double membrane** and contains small **circular DNA**. Which organelle could it be? [1]

- **A** lysosome
- **B** mitochondrion
- **C** ribosome
- **D** smooth endoplasmic reticulum

3.3 Which feature is present in a prokaryotic cell but **not** in a eukaryotic cell? [1]

- **A** 70S ribosomes only
- **B** a cell surface membrane
- **C** a Golgi body
- **D** linear DNA wound on histones

3.4 A student views an electron micrograph of an animal cell.

(a) One organelle is described as *"a stack of flat membrane sacs near the nucleus"*. Name this organelle and state its function. [2]

(b) Another organelle has *"sheets of membrane covered with ribosomes"*. Name it and state what it makes. [2]

3.5 The diagram of the prokaryotic cell above shows several features. Compare the structure of a prokaryotic cell with that of a eukaryotic cell. Give **two** differences and

one similarity. [3]

3.6 Describe the structure of a virus. [3]

Solutions

2.1 rough endoplasmic reticulum; Golgi body (Golgi apparatus); chloroplast; lysosome.

2.2 Any three of: cellulose cell wall; chloroplasts; large permanent vacuole (tonoplast); plasmodesmata.

2.3 (a) 80S; (b) 70S.

3.1 A. A cell surface membrane, cytoplasm and ribosomes occur in all cells; the others are eukaryote-only.

3.2 B. Mitochondria (and chloroplasts) have a double membrane and their own circular DNA.

3.3 A. Prokaryotes have only 70S ribosomes; the cell surface membrane is in both, and a Golgi body and histone-wound linear DNA are eukaryote features.

3.4 (a) Golgi body / Golgi apparatus; modifies and packages proteins/lipids into vesicles for secretion.
(b) rough endoplasmic reticulum; makes (and transports) proteins.

3.5 Two differences, e.g. prokaryote has no nucleus while eukaryote has a true nucleus; prokaryote has 70S ribosomes while eukaryote has 80S; prokaryote has no membrane-bound organelles while eukaryote does. One similarity, e.g. both have a cell surface membrane / cytoplasm / ribosomes / DNA.

3.6 A nucleic acid core, either DNA or RNA; surrounded by a protein coat called a capsid; some have an outer phospholipid envelope / it is non-cellular with no organelles.

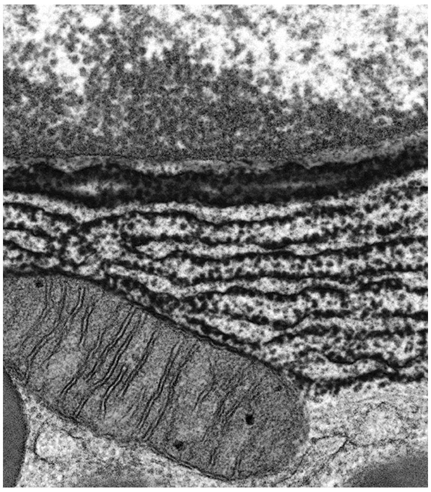
3 A cell in the human body is specialised for synthesis and secretion of lipids.

Which row shows the organelles required by the cell for synthesis **and** secretion of lipids?

	mitochondria	smooth endoplasmic reticulum	vesicles
A	✓	✓	✓
B	✓	✗	✗
C	✗	✓	✓
D	✗	✓	✗

key
✓ = required
✗ = **not** required

4 The photomicrograph shows part of a cell.



Which row is correct?

	this cell will contain 70S ribosomes	this could be part of a plant cell	the organelles shown could be used to make antibodies
A	✓	✓	✓
B	✓	✗	✗
C	✗	✓	✗
D	✗	✗	✓

key
✓ = correct
✗ = **not** correct

2 Which structures will be present in a cell that causes cholera?

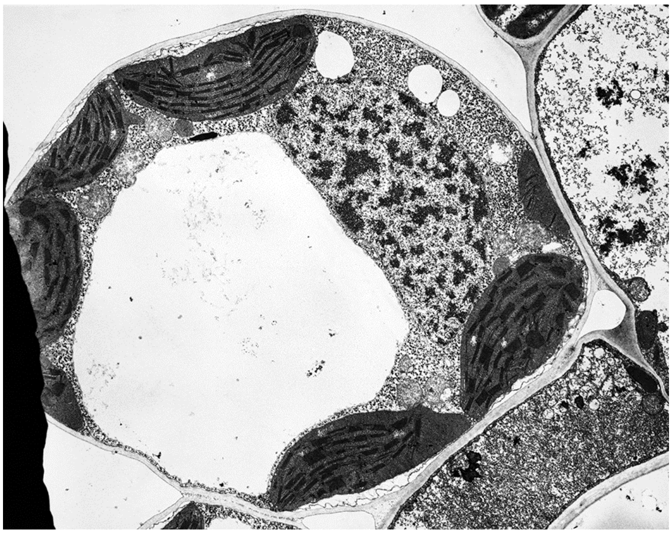
1 circular DNA

2 cytoplasmic DNA

3 70S ribosomes

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

5 The electron micrograph shows a section through a cell.



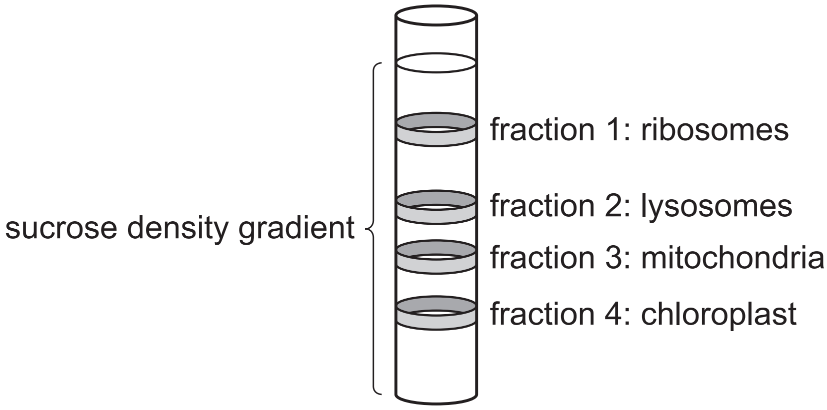
What would be present in this type of cell?

	mitochondria	peptidoglycan cell wall	histone proteins
A	✓	✓	✗
B	✓	✗	✓
C	✗	✓	✗
D	✗	✗	✓

key
✓ = present
✗ = **not** present

2 Cell structures can be isolated by centrifuging the cells in a sucrose density gradient. This breaks up the cells and separates the cell structures into fractions.

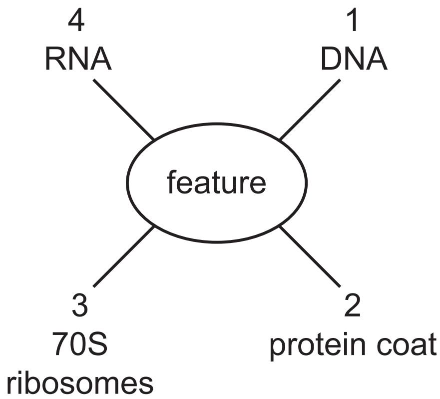
The diagram shows the positions of some of these fractions in a sucrose density gradient.



Which fractions contain cell structures that carry out protein synthesis?

A 1, 2 and 3 **B** 1, 3 and 4 **C** 1 only **D** 2, 3 and 4

7 Which features shown in the diagram can be present in viruses?



A 1, 2 and 3 **B** 1, 2 and 4 **C** 1, 3 and 4 **D** 2, 3 and 4

A-Level Biology: **w25 14**

3 It is thought that some organelles in eukaryotic cells evolved from free-living prokaryotes.

Which organelles have features that suggest they evolved from free-living prokaryotic ancestors?

A chloroplasts and mitochondria

B chloroplasts and Golgi bodies

C mitochondria and smooth endoplasmic reticulum

D Golgi bodies and smooth endoplasmic reticulum

4 A student completed a table showing the structures that are found in four different types of cells.

cell structure	cell Q	cell R	cell S	cell T
cell surface membrane	✓	✓	✓	✓
cellulose cell wall	✓	✓	✗	✓
chloroplast	✓	✗	✗	✗
mitochondrion	✓	✓	✗	✓
nucleus	✓	✓	✗	✗

key
✓ = present
✗ = **not** present

How many of these types of cells can be found in plants?

A 1 **B** 2 **C** 3 **D** 4

1 The wall of the small intestine is highly folded to form villi. Between the villi are infoldings known as crypts of Lieberkühn.

Fig. 1.1 is a diagram of a section through a single villus and a crypt of Lieberkühn.

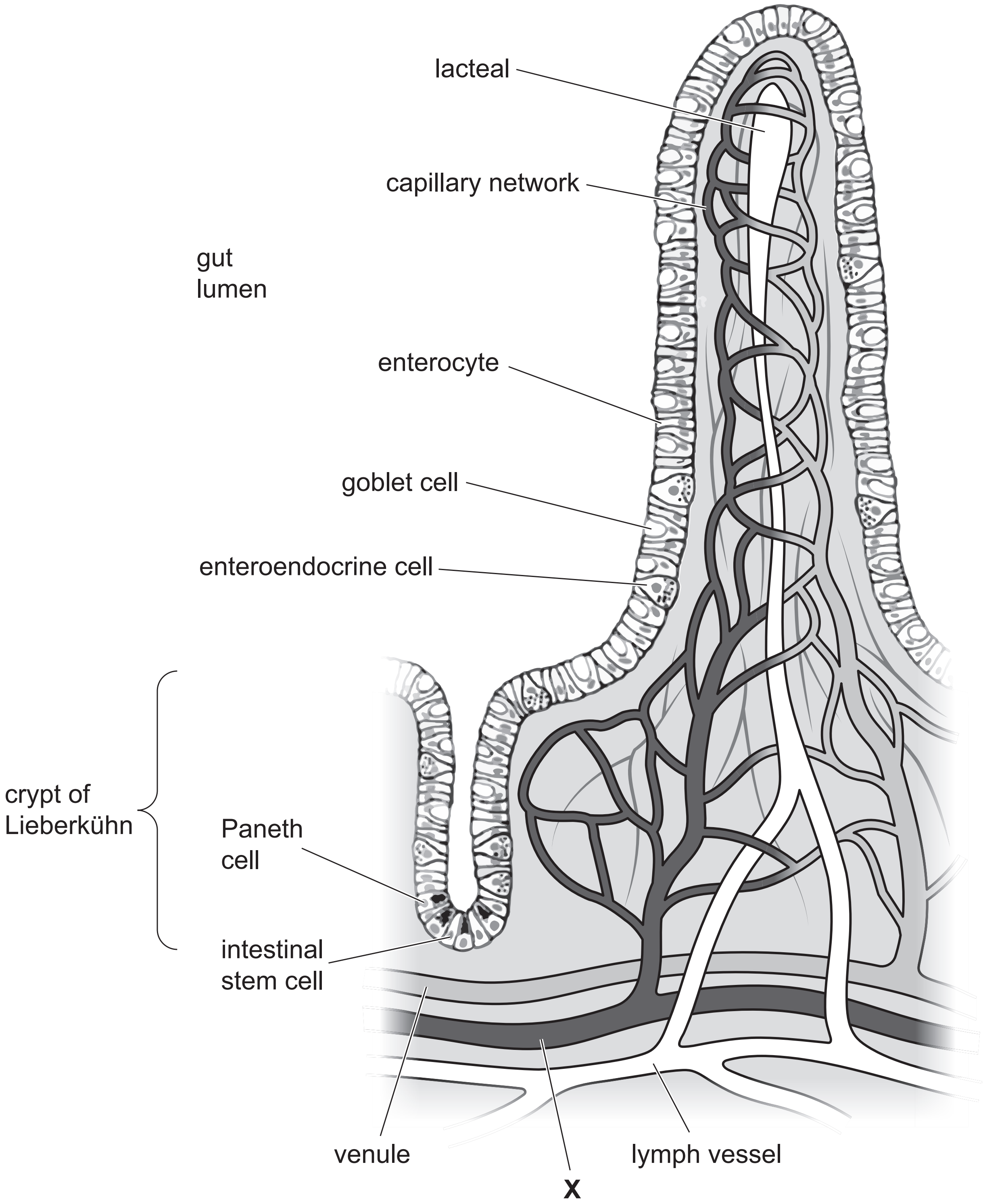


Fig. 1.1

Fig. 1.1 shows that the epithelium of the villus contains mainly goblet cells and cells known as enterocytes. Both cell types have microvilli on the apical surface (surface facing the gut lumen).

Goblet cells are involved in the production of mucus.

Enterocytes are adapted for the absorption of the soluble products of digestion. These products enter the circulatory system.

(a) A student incorrectly stated that an enterocyte has many **cilia** on its apical surface.

Explain the difference between a cilium and a microvillus.

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(b) Suggest **one** role of the mucus produced by the goblet cells of the villus.

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(c) In Fig. 1.1, blood vessel **X** delivers blood to the capillary network of the villus, where tissue fluid is formed. Some of the fluid passes back into the capillaries and then into the venule.

(i) Blood vessel **X** receives blood from an artery.

Name the type of blood vessel represented by **X**.

.... [1]

(ii) Describe the formation of tissue fluid in the capillary network of the villus.

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(d) In response to the presence of compounds in the gut lumen, enteroendocrine cells synthesise and release peptides (short chains of amino acids) that are cell-signalling molecules. One of these cell-signalling molecules is known as GLP-1.

GLP-1 initiates a number of responses in different body cells. Some of these responses include:

- the increase in release of the hormone insulin from cells in the pancreas
- the decrease in release of acid from cells in the stomach.

Outline, **in sequence**, the main stages involved in the process of cell signalling by GLP-1.

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(e) Paneth cells, which are secretory cells, are located between intestinal stem cells at the base of the crypt of Lieberkühn, as shown in Fig. 1.1.

A Paneth cell has a very different appearance to an intestinal stem cell.

Fig. 1.2 is a transmission electron micrograph of a Paneth cell.

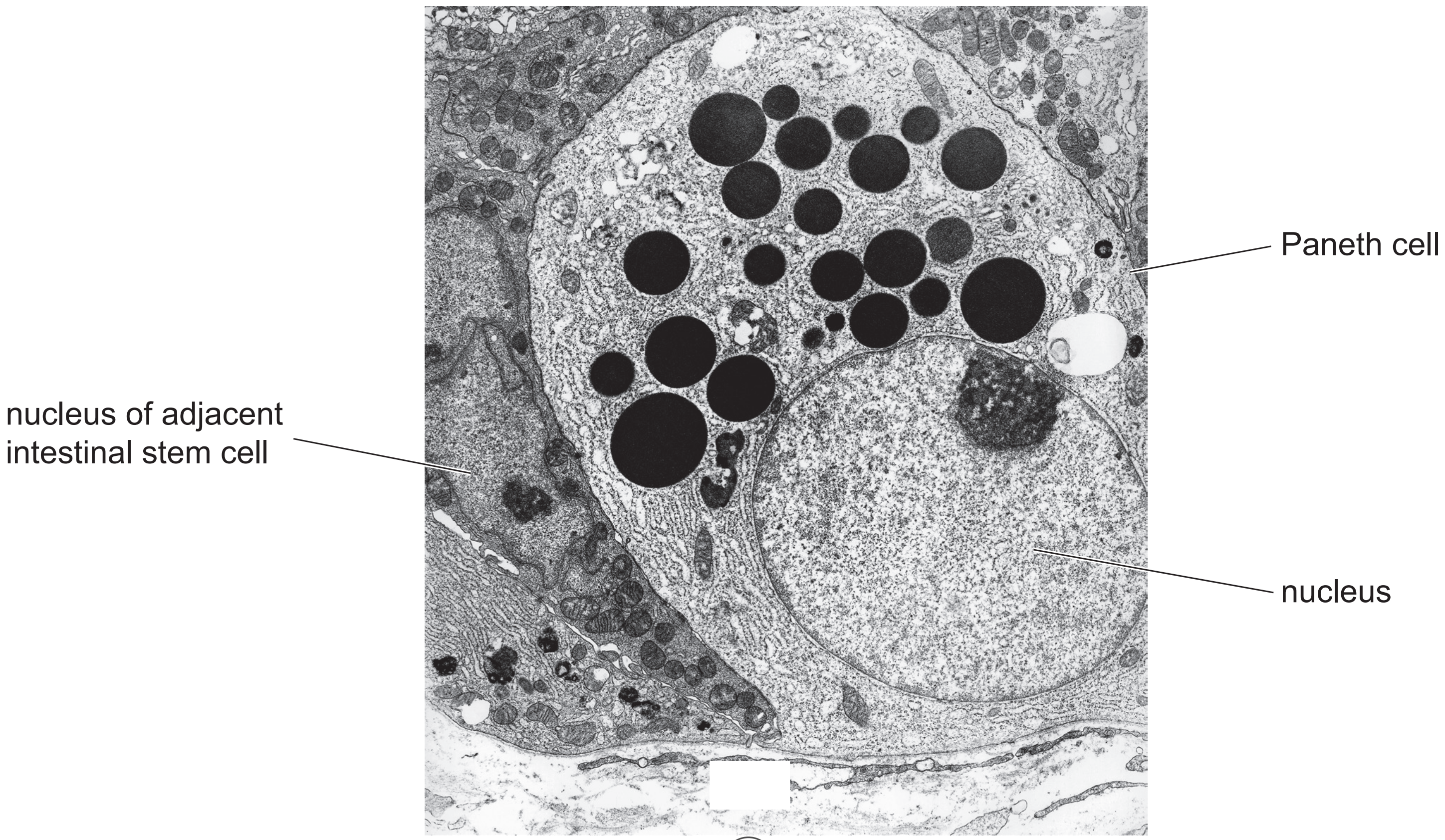

Fig. 1.2

(i) Paneth cells are formed following the mitotic division of an intestinal stem cell during a cell cycle.

Complete the cell cycle shown in Fig. 1.3 by naming, **in sequence**, the stages of mitosis.

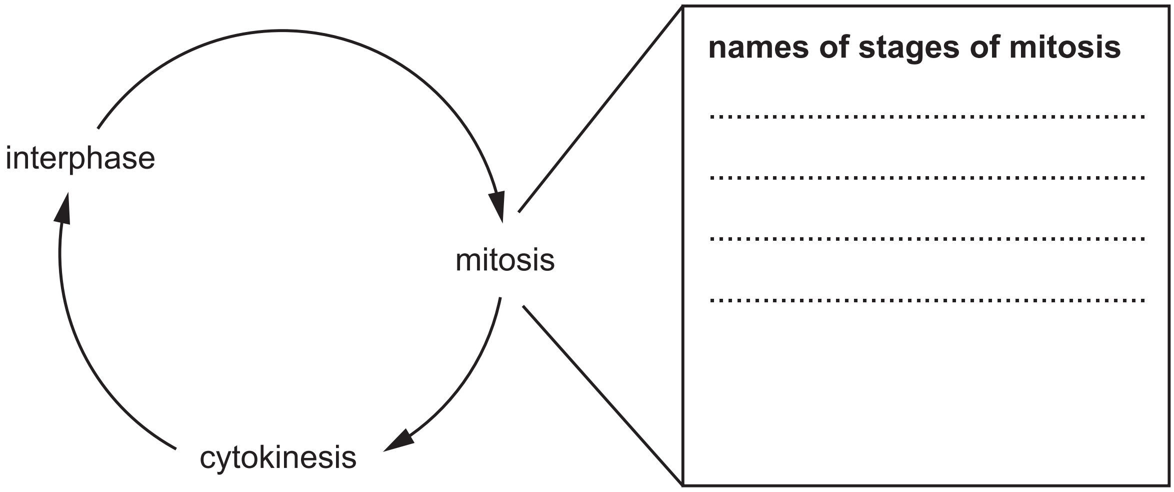

Fig. 1.3

[1]

(ii) One of the functions of a Paneth cell is to synthesise and secrete peptides and proteins that act against pathogens in the gut lumen.

State **and** explain the evidence, **visible in Fig. 1.2**, which suggests that a Paneth cell:

- is a secretory cell
- synthesises many peptides and proteins.

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(iii) Explain why a Paneth cell has a very different appearance to an intestinal stem cell.

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[Total: 14]

1 There are similarities and differences between the structure of a typical plant cell and a typical animal cell.

(a) The nucleus of plant cells and animal cells contains chromosomes. In interphase of the cell cycle, individual chromosomes are present but cannot be seen. The chromosome material is known as chromatin.

(i) Changes occur in interphase, which result in a difference between the chromatin in the G1 phase compared with the chromatin in the G2 phase.

State **and** explain the difference in chromatin in the G1 phase compared with chromatin in the G2 phase.

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(ii) Describe the features of a nucleus, **other than** containing chromatin.

You may use the space below the lines for a diagram.

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[3]

(b) Starch, cellulose and pectins are polysaccharides found in plant cells but **not** in animal cells.

Pectins are complex polysaccharides that are found in the cell wall.

(i) Describe the structural features of starch that are **different** from the structural features of cellulose.

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(ii) Cell wall pectins can vary in different plant cell types and in different stages of cell development. Pectin molecules are released from cells as basic structures and then modified within the cell wall by adding side chains.

RG-I is a pectin molecule with a variable structure. The basic structure is a repeated disaccharide made from two different monosaccharides. RG-I has three different side chains that can be added in different positions.

Monoclonal antibodies (mAbs) are used to investigate the structure, location and role of cell wall pectins.

Suggest **and** explain why scientists need to use a number of different monoclonal antibodies when investigating a pectin such as RG-I.

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[Total: 12]