

2 The cell as the basic unit of life



Think about...

2.1 Chemicals of life

2.2 Discovery and early studies of cells

2.3 Microscopes: tools for studying cells

2.4 Structure of cells

2.5 Levels of body organization

Recall Think about...

Concept map



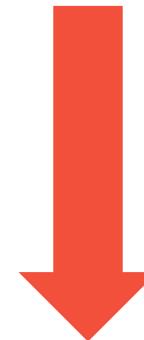
Meat from a laboratory



nutrient solution

+

cells from cow
muscle tissues



divide
and grow

a piece of meat

Think about...



Cells are too small to be seen with the naked eye. What tool can we use to view them when selecting them?

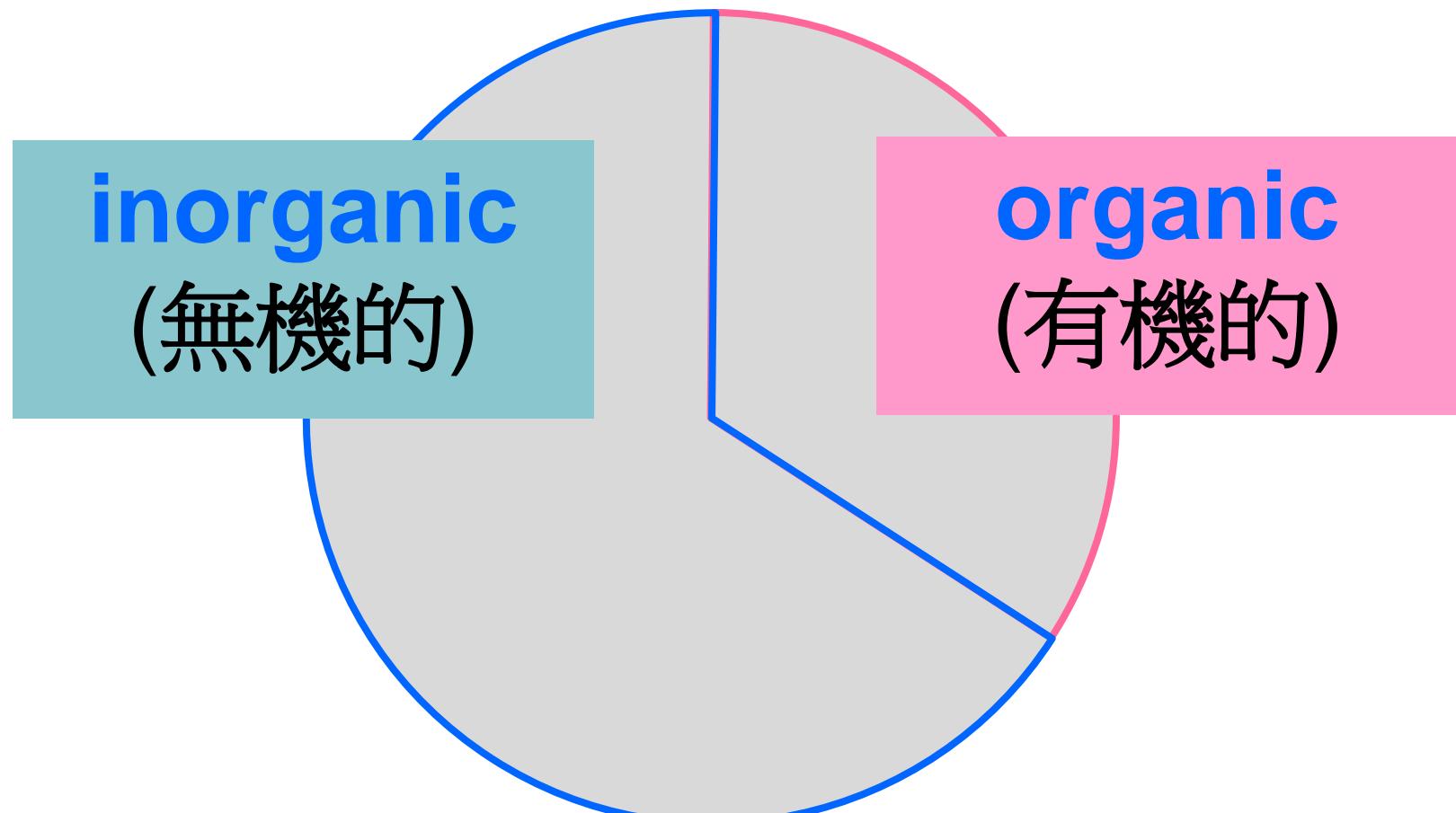
Think about...



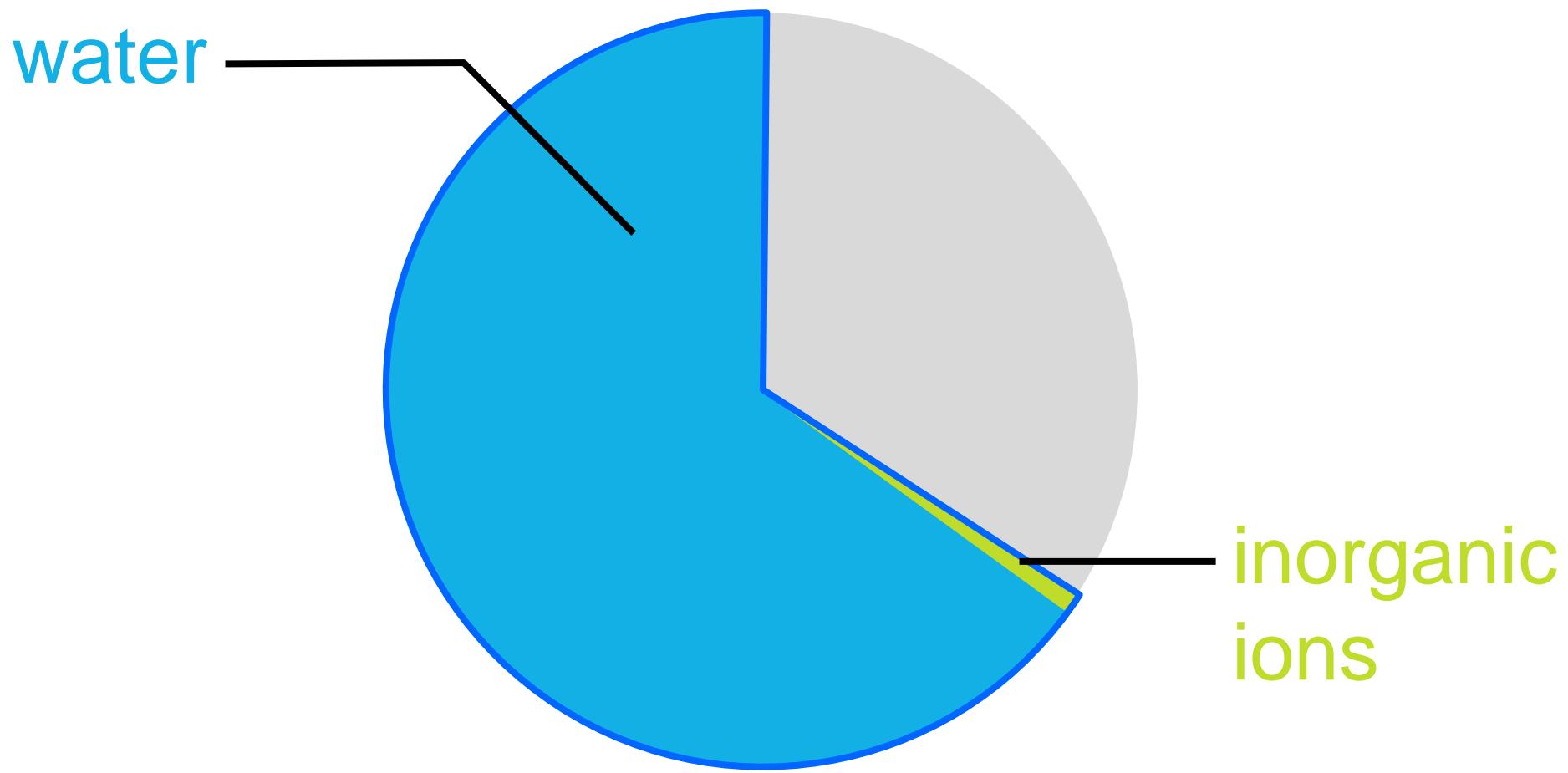
To produce new cells, what materials have to be supplied?

2.1 Chemicals of life

chemical constituents of organisms



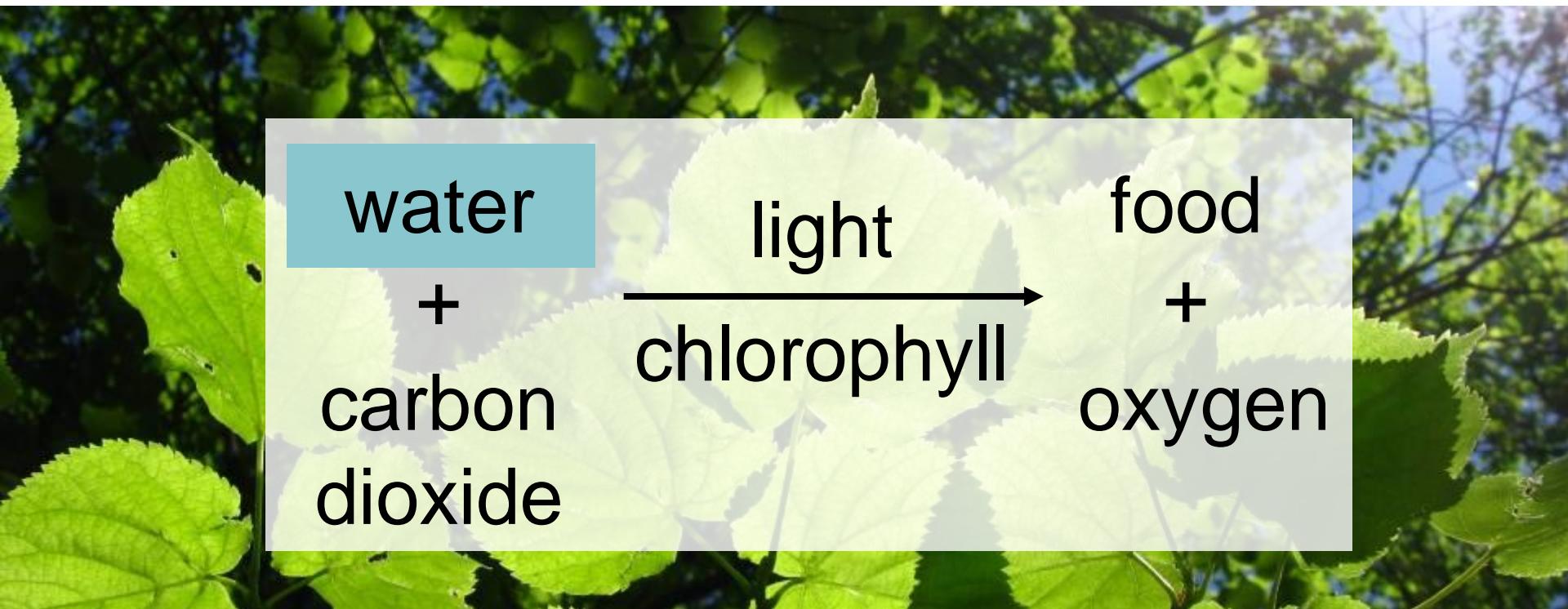
A Inorganic chemical constituents of organisms



Water

1 As a reactant (反應物)

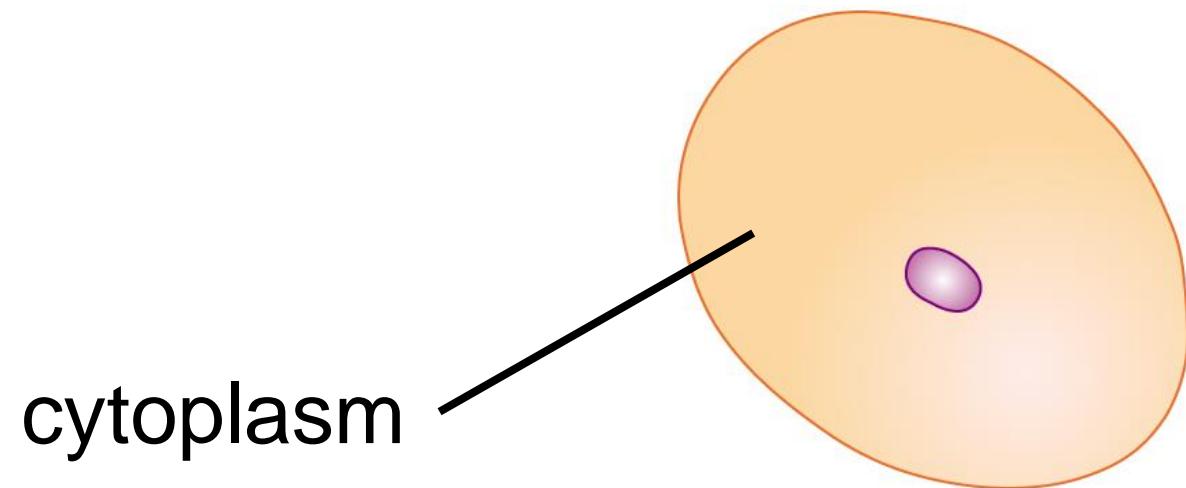
e.g. in **photosynthesis**



Water

2 As a medium for chemical reactions

provide an aqueous medium for chemical reactions in cells



Water

3 As a medium of transport



inorganic ions
dissolved in water

Water

4 As a cooling agent (冷卻劑)



Water

5 Provides support



turgid (膨脹) cells
press against each
other



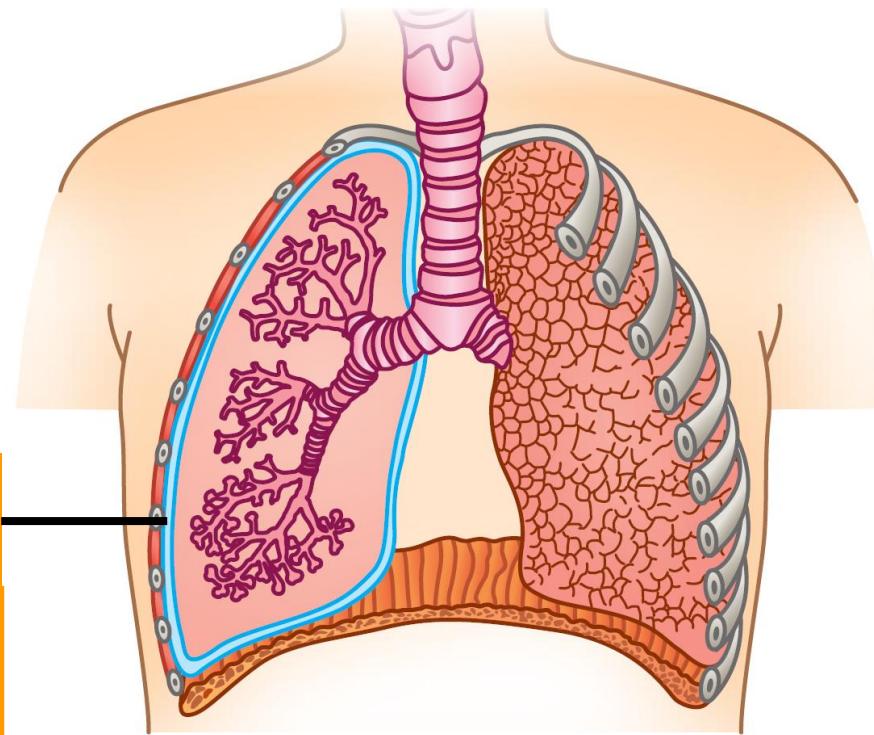
stem stays upright

Water

6 As a component of lubricant

pleural fluid (胸膜液)

reduces friction
during breathing



Inorganic ions

i) Nitrate (硝酸鹽)

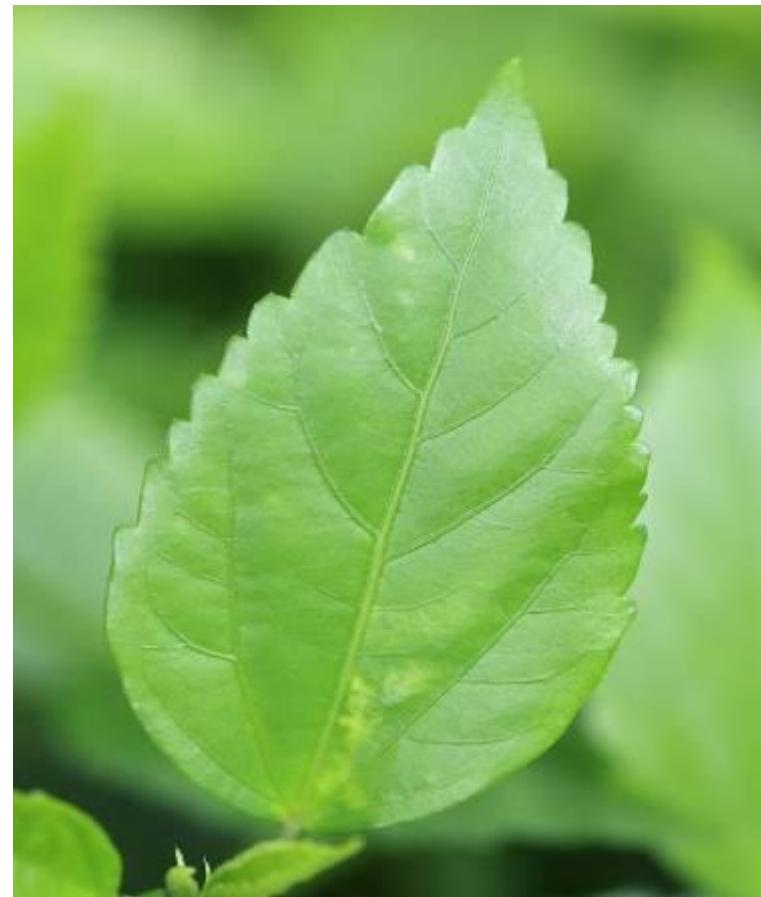
- a source of **nitrogen** (氮)



Inorganic ions

ii) Magnesium (鎂)

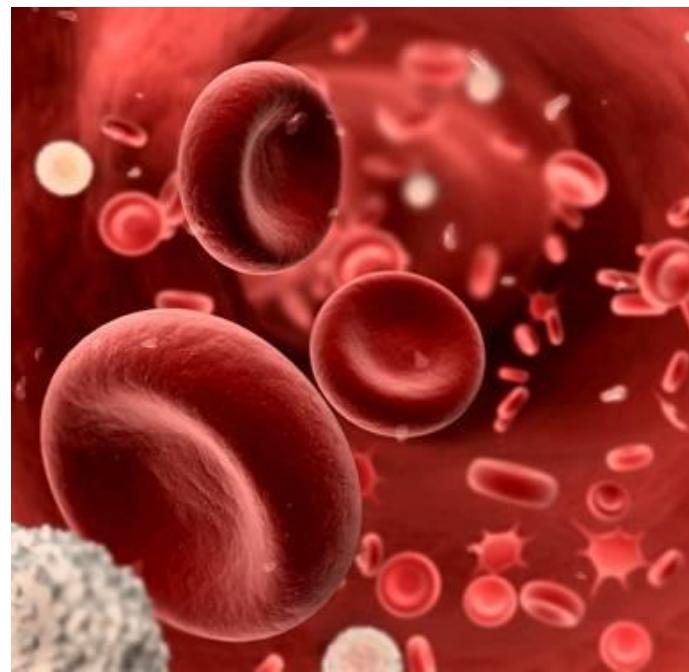
- component of **chlorophyll** (葉綠素) in leaves
- activates some **enzymes** (酶)



Inorganic ions

iii) Iron (鐵)

- component of **haemoglobin** (血紅蛋白) in red blood cells
- activates some **enzymes**



Inorganic ions

iv) Calcium (鈣)

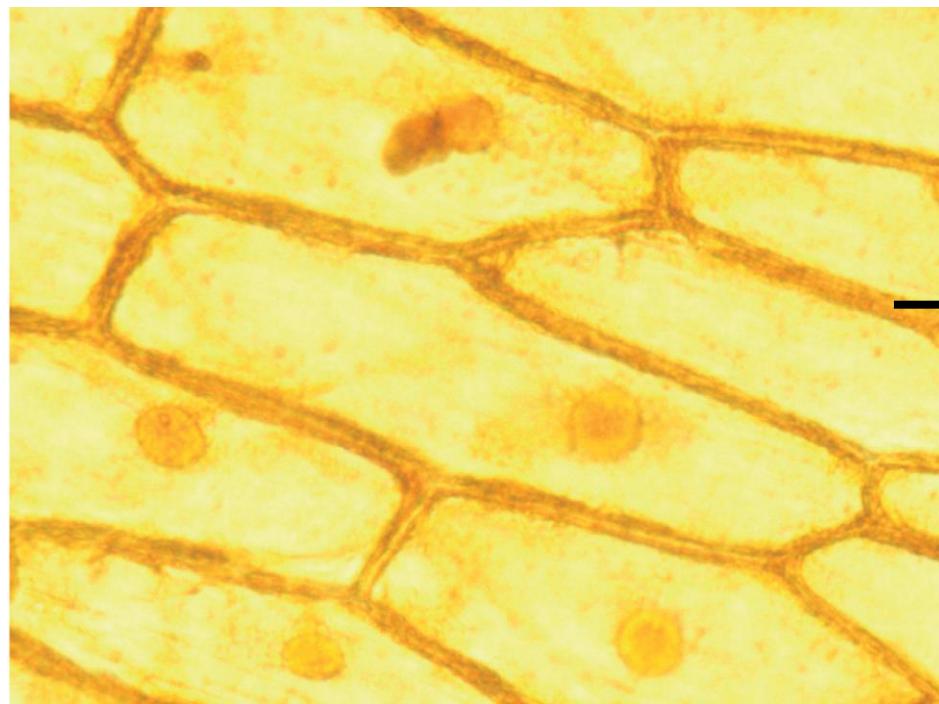
- component of **bones** and **teeth**
- for **blood clotting**, **muscle contraction** and **sending messages** in nervous system



Inorganic ions

iv) Calcium (鈣)

- strengthens cell walls in plants



— cell wall

Inorganic ions

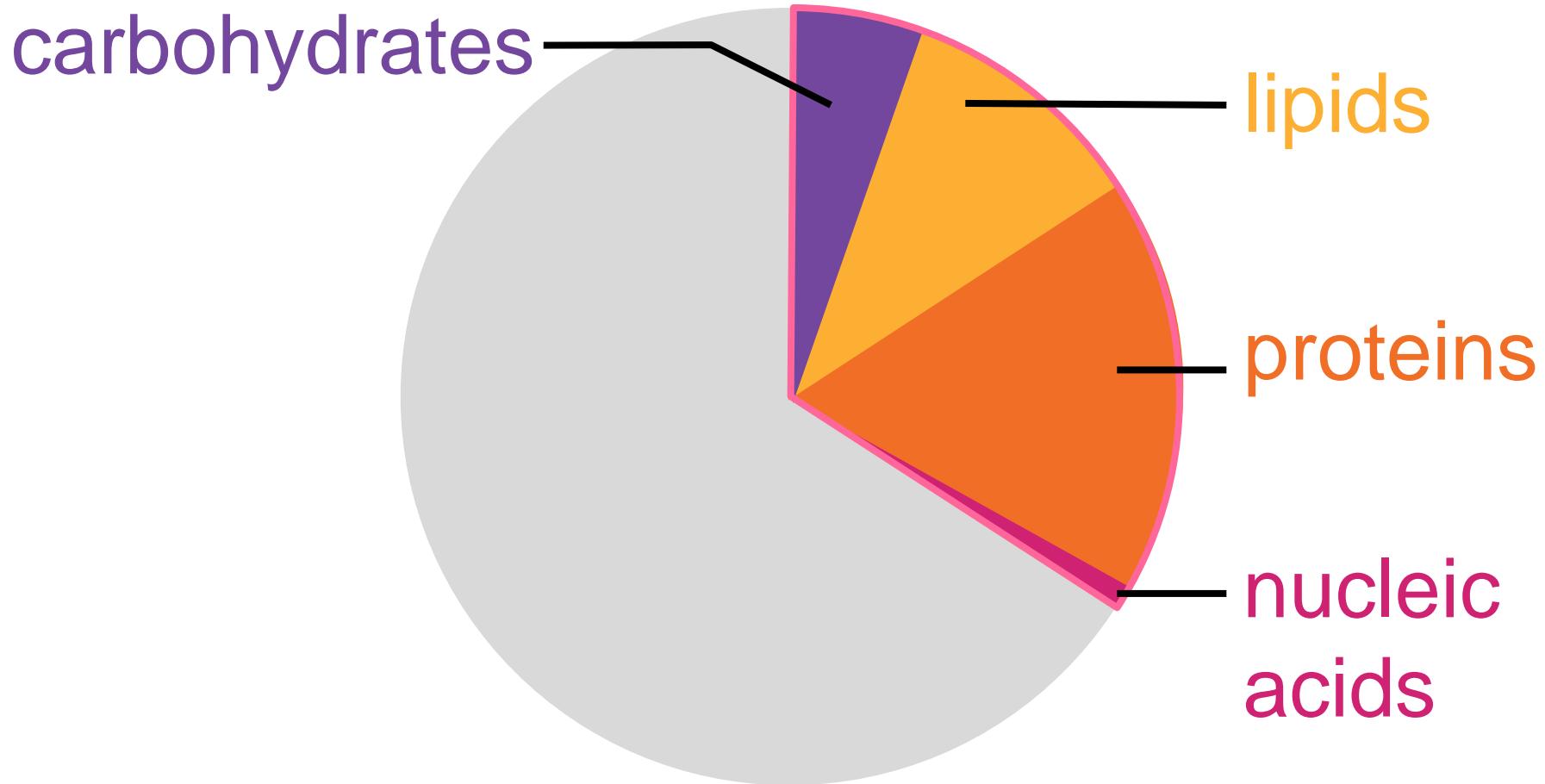
v) Phosphate (磷酸鹽)

- component of **bones** and **teeth**
- component of **phospholipids**
(磷脂) in cell membranes and
nucleic acids (核酸)



B

Organic chemical constituents of organisms



B Organic chemical constituents of organisms

- called **biomolecules** (生物分子)
- all contain the element **carbon**

Carbohydrates contain carbon, hydrogen and oxygen

Glucose (葡萄糖)

Starch (澱粉)

Glycogen (糖原)

Cellulose (纖維素)

examples

Carbohydrates

Glucose

Starch

Glycogen

Cellulose

main energy source for
cells



Carbohydrates

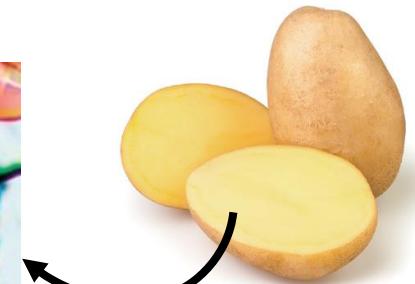
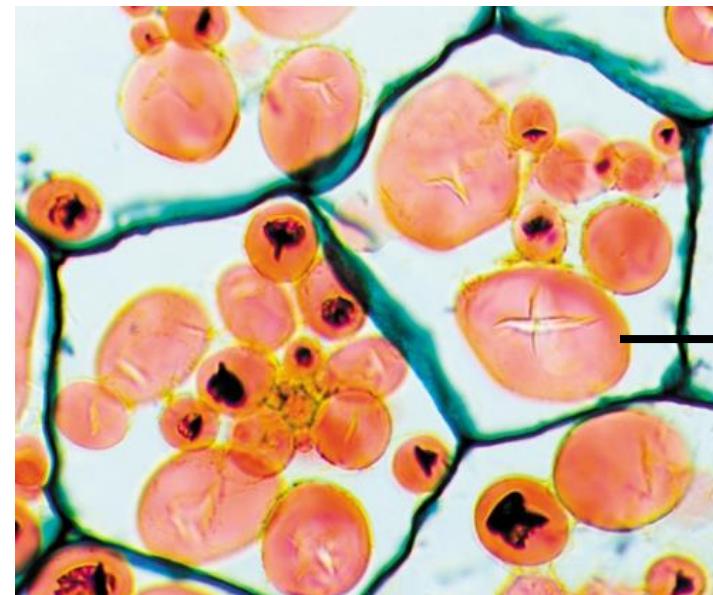
Glucose

Starch

Glycogen

Cellulose

energy reserve in plants



starch
granule

Carbohydrates

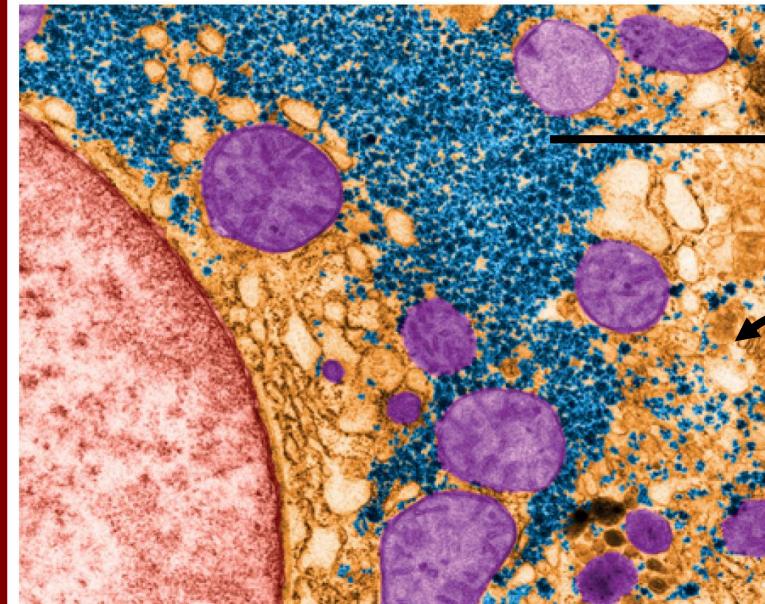
Glucose

Starch

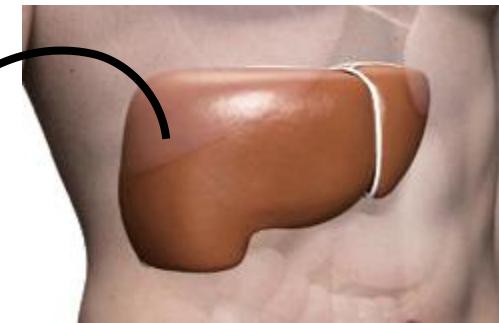
Glycogen

Cellulose

energy reserve in
animals



glycogen
granule



Carbohydrates

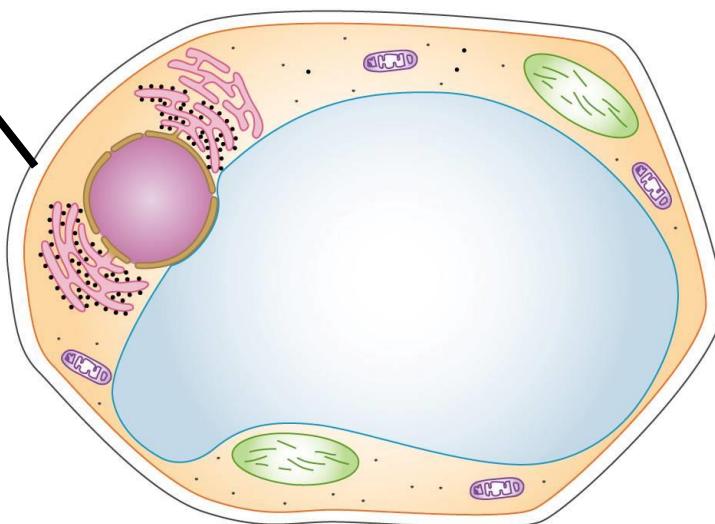
Glucose

Starch

Glycogen

Cellulose

major component of **plant**
cell walls



Lipids contain carbon, hydrogen and oxygen;
a higher H:O ratio than carbohydrates

Triglycerides (甘油三酯)

examples

Phospholipids (磷脂)

Lipids

Triglycerides
(fats and oil)

Phospholipids

as **energy reserve**



Lipids

Triglycerides
(fats and oil)

Phospholipids

**adipose tissues
reduce heat loss**

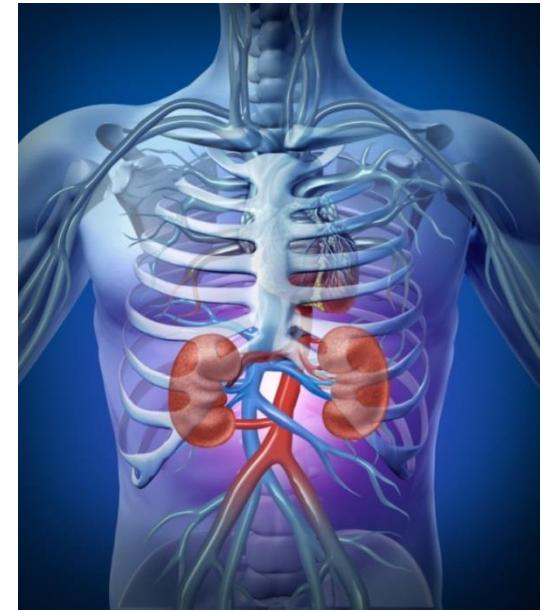


Lipids

Triglycerides
(fats and oil)

Phospholipids

adipose tissues
protect internal
organs

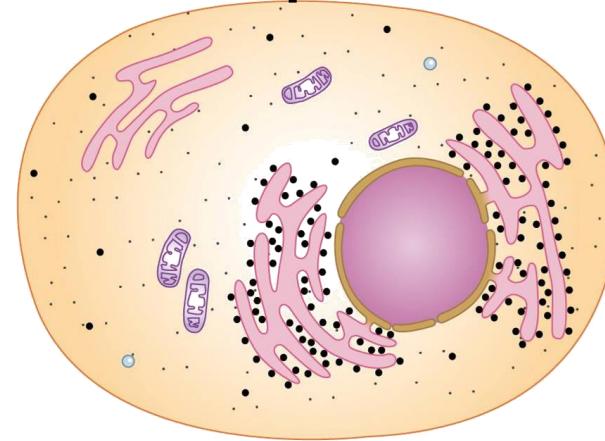


Lipids

Triglycerides
(fats and oil)

Phospholipids

major component of
cell membranes
(细胞膜)

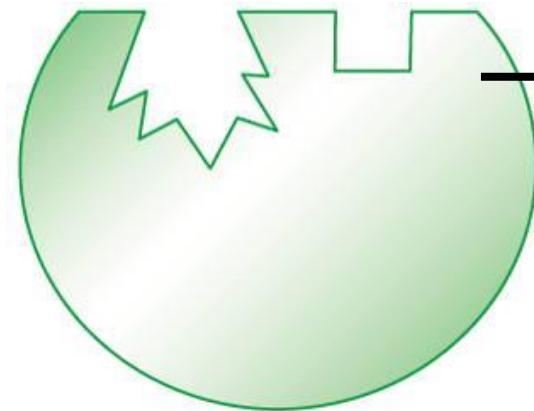


Proteins contain carbon, hydrogen, oxygen and nitrogen, some contain sulphur

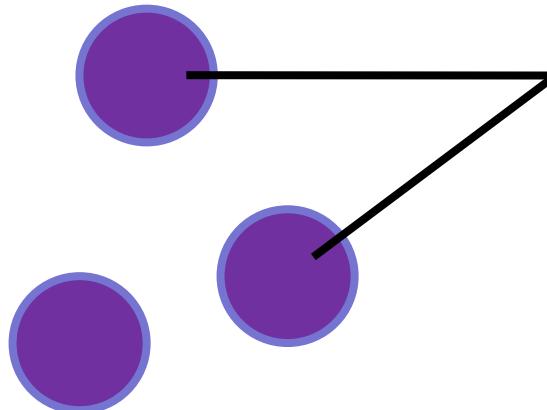
- make up **body tissues**



Proteins

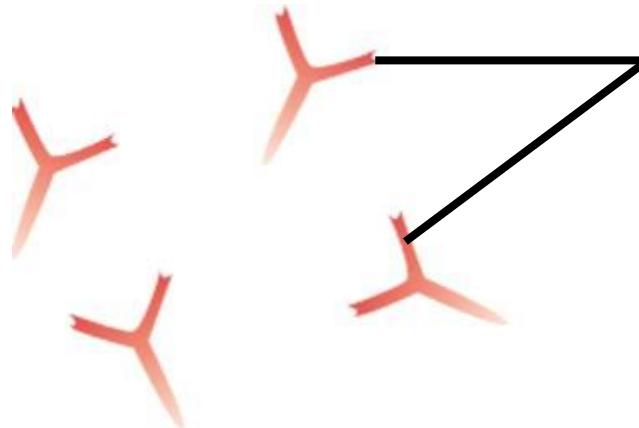


— as **enzymes** to regulate chemical reactions in organisms

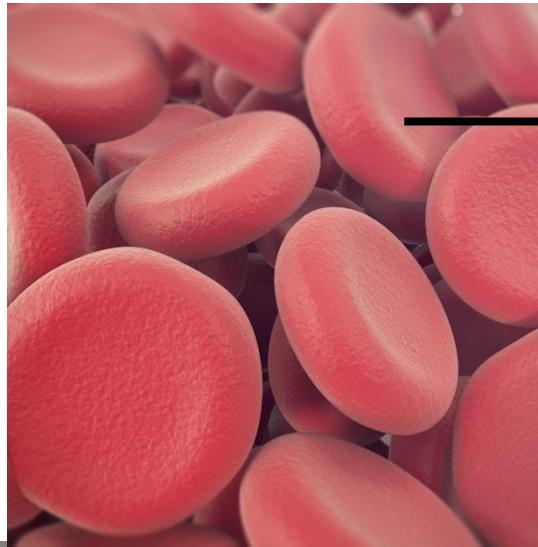


as **hormones** (激素) to regulate body processes

Proteins



as **antibodies** (抗體) to help protect the body against pathogens (病原體)



transport of substances
(e.g. **haemoglobin** carries oxygen)

Nucleic acids contain carbon, hydrogen, oxygen, nitrogen, phosphorus

DNA

RNA

examples

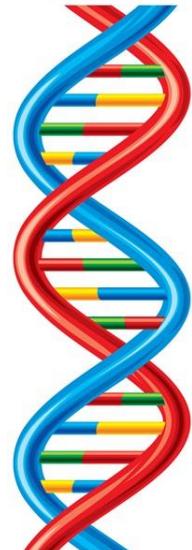
Nucleic acids

DNA

Deoxyribonucleic acid

carries **genetic information**

- controls activities of cells
- determines features of organisms



Nucleic acids

DNA

RNA

Ribonucleic acid

involved in synthesis of
proteins

Key learning

1 The inorganic chemical constituents include **water** and **inorganic ions** such as nitrate, magnesium, iron, calcium and phosphate.

Key learning

2 The organic chemical constituents:

Carbohydrates

Example	Function
<ul style="list-style-type: none">• Glucose	<ul style="list-style-type: none">• The main energy source for cells

Key learning

2 The organic chemical constituents:

Carbohydrates

Example	Function
<ul style="list-style-type: none">• Starch	<ul style="list-style-type: none">• An energy reserve in plants

Key learning

2 The organic chemical constituents:

Carbohydrates

Example	Function
<ul style="list-style-type: none">• Glycogen	<ul style="list-style-type: none">• An energy reserve in animals

Key learning

2 The organic chemical constituents:

Carbohydrates

Example	Function
<ul style="list-style-type: none">• Cellulose	<ul style="list-style-type: none">• A major component of plant cell walls

Key learning

2 The organic chemical constituents:

Lipids

Example	Function
<ul style="list-style-type: none">• Triglycerides (fats and oil)	<ul style="list-style-type: none">• An energy reserve in organisms

Key learning

2 The organic chemical constituents:

Lipids

Example	Function
<ul style="list-style-type: none">• Triglycerides (fats and oil)	<ul style="list-style-type: none">• Fats stored in adipose tissues <p>reduce heat loss</p> <p>in animals</p>

Key learning

2 The organic chemical constituents:

Lipids

Example	Function
<ul style="list-style-type: none">• Triglycerides (fats and oil)	<ul style="list-style-type: none">• Fats stored in adipose tissues <p>protect internal organs in animals</p>

Key learning

2 The organic chemical constituents:

Proteins

Example	Function
<ul style="list-style-type: none">• Structural proteins	<ul style="list-style-type: none">• Make up body tissues

Key learning

2 The organic chemical constituents:

Proteins

Example	Function
<ul style="list-style-type: none">• Enzymes	<ul style="list-style-type: none">• Regulate chemical reactions

Key learning

2 The organic chemical constituents: Proteins

Example	Function
<ul style="list-style-type: none">• Hormones	<ul style="list-style-type: none">• Help regulate body processes

Key learning

2 The organic chemical constituents: Proteins

Example	Function
<ul style="list-style-type: none">• Antibodies	<ul style="list-style-type: none">• Help protect the body against pathogens

Key learning

2 The organic chemical constituents:

Proteins

Example	Function
• Haemoglobin	• Carries oxygen

Key learning

2 The organic chemical constituents:

Nucleic acids

Example	Function
<ul style="list-style-type: none">• Deoxyribonucleic acid (DNA)	<ul style="list-style-type: none">• Carries genetic information

Key learning

2 The organic chemical constituents:

Nucleic acids

Example	Function
<ul style="list-style-type: none">• Ribonucleic acid (RNA)	<ul style="list-style-type: none">• Involved in the synthesis of proteins

2.2 Discovery and early studies of cells

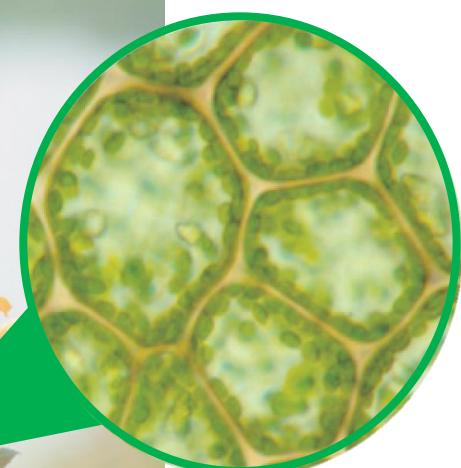
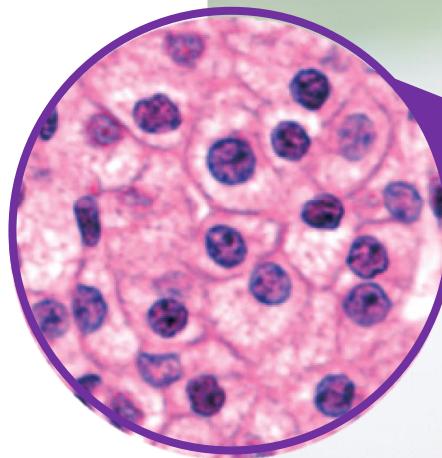
cells = basic unit of life



A Discovery of cells

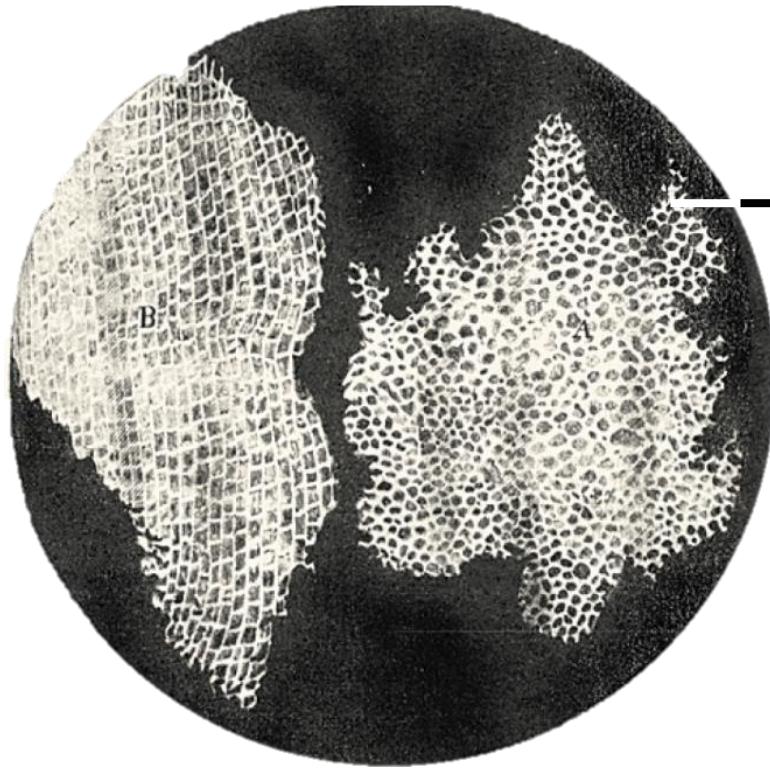
Cells cannot be seen
with naked eye

How were
they
discovered?



A Discovery of cells

In 1665, Robert Hooke examined a thin slice of cork (木栓) under microscope:

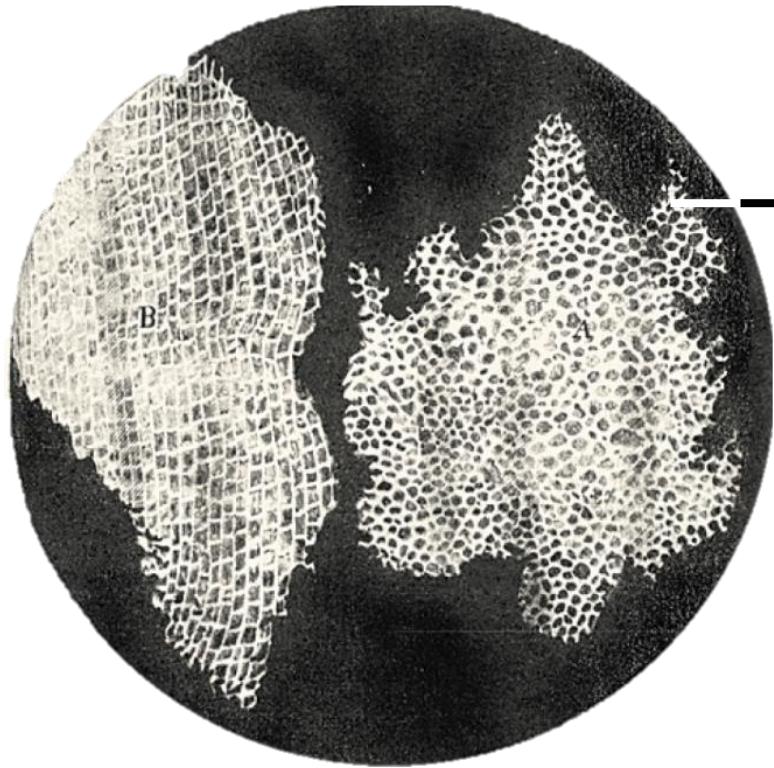


— many **small irregular boxes**

Hooke named them '**cells**'

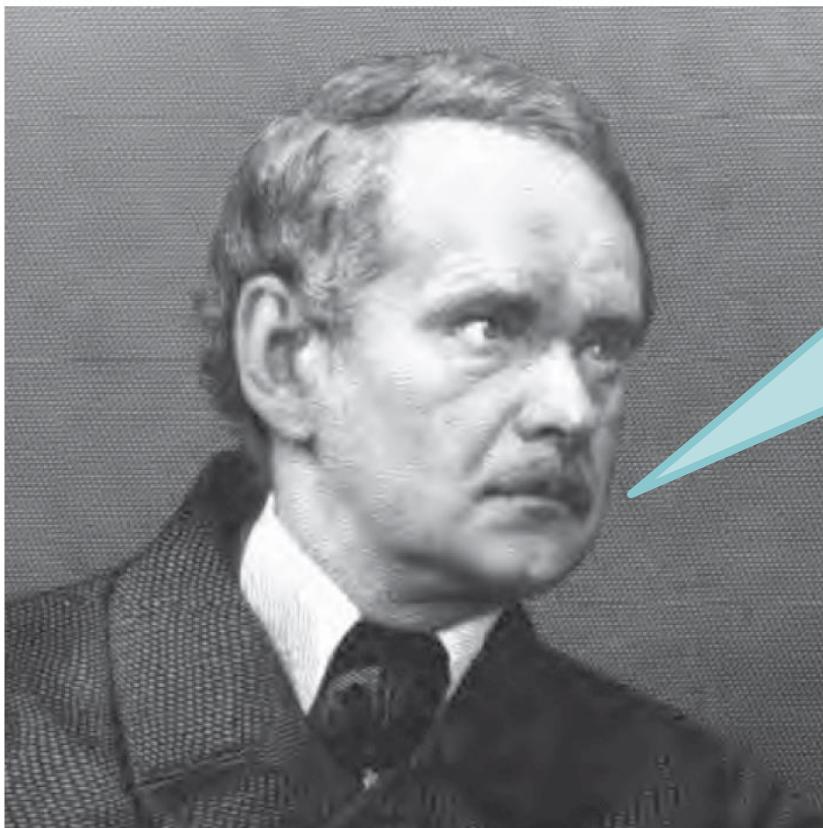
A Discovery of cells

In 1665, Robert Hooke examined a thin slice of cork (木栓) under microscope:



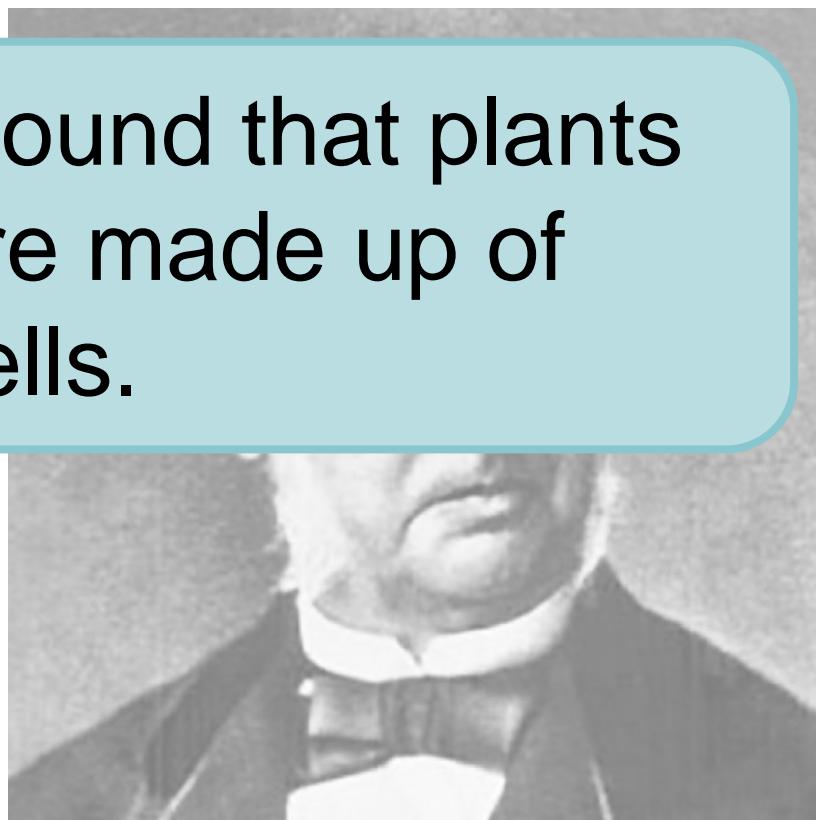
— actually, they were only the **cell walls** of dead cork cells

B The Cell Theory



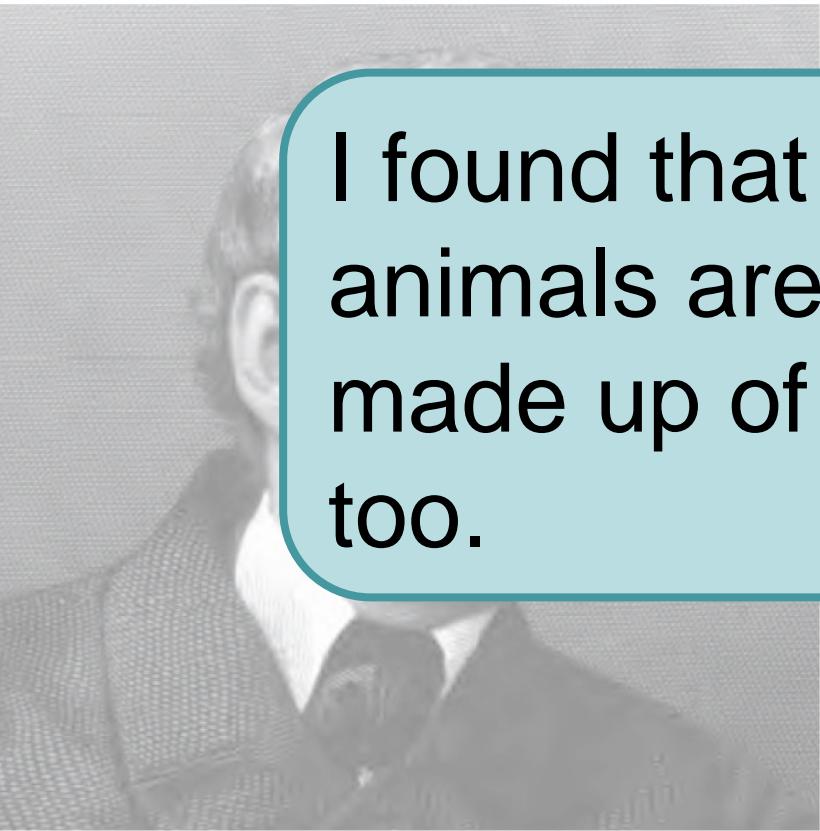
Matthias Schleiden

I found that plants
are made up of
cells.



Theodor Schwann

B The Cell Theory

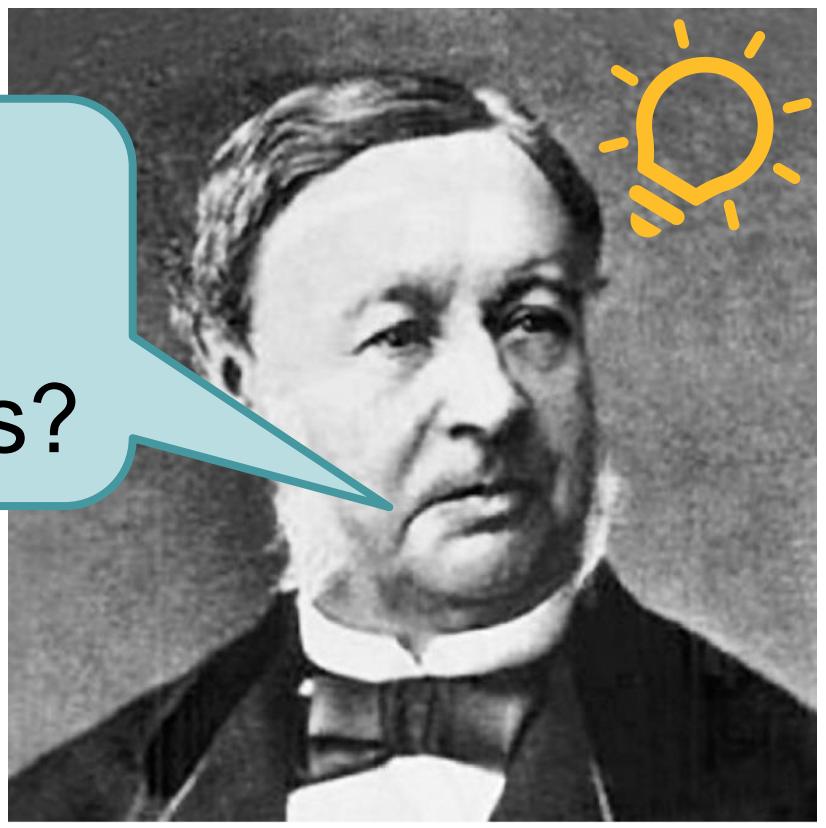
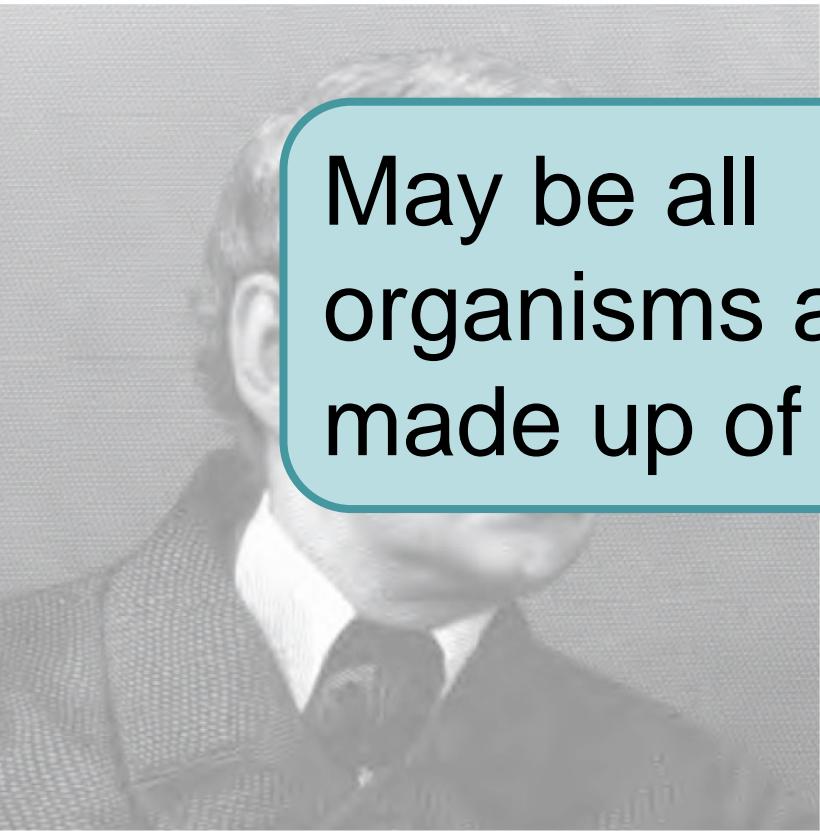


I found that animals are made up of cells too.

Matthias Schleiden

Theodor Schwann

B The Cell Theory



May be all
organisms are
made up of cells?

Matthias Schleiden

Theodor Schwann

B The Cell Theory

In 1839, Schwann proposed the **Cell Theory** (細胞學說)



Theodor Schwann

B The Cell Theory

1 All organisms are **made up of one or more cells.**



B The Cell Theory

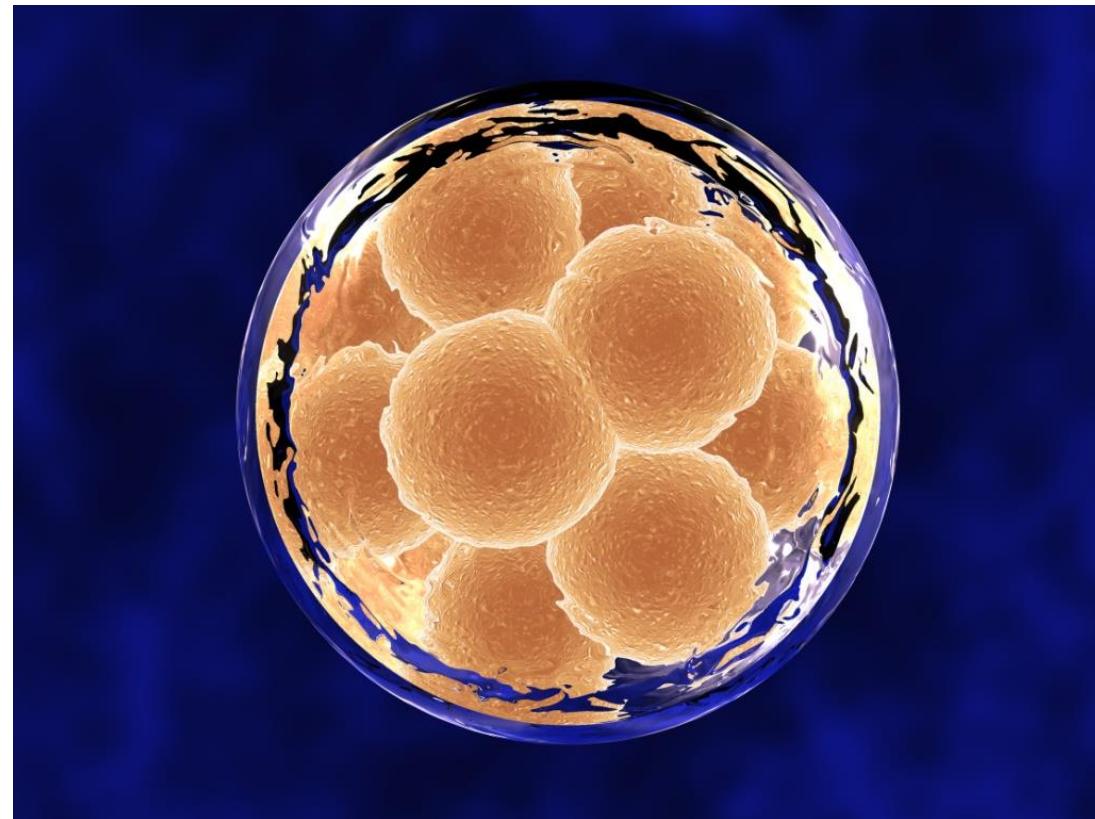
2 The cell is the **basic unit of life**.

a single
cell



B The Cell Theory

3 All cells come **from pre-existing cells.**



Some major events in cell biology and the development of microscopes

1590

**Development of the
first light microscope**

by Hans Janssen
and his son



magnification:
3–9 times

Some major events in cell biology and the development of microscopes

1590

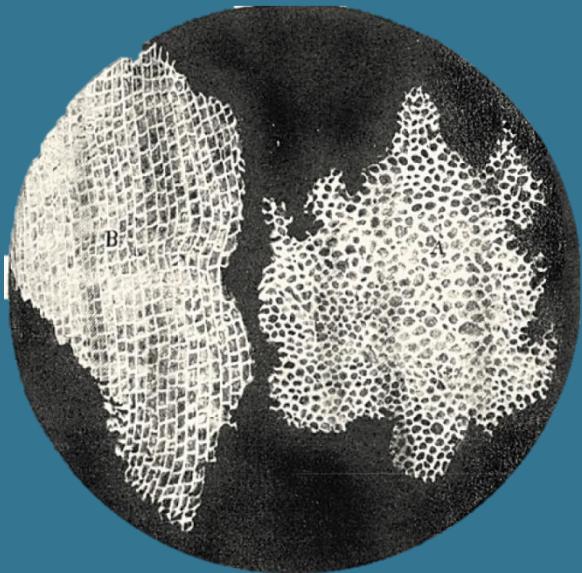
Development of the
first light microscope



magnification:
3–9 times

1590

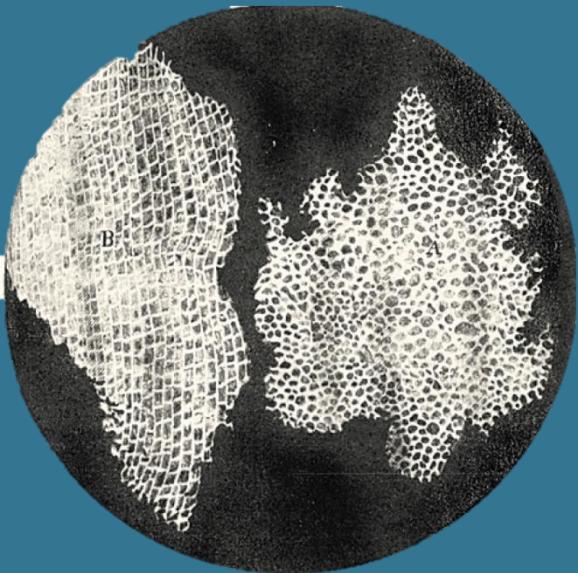
Robert Hooke
examined a thin slice of
cork



magnification:
~50 times

1665

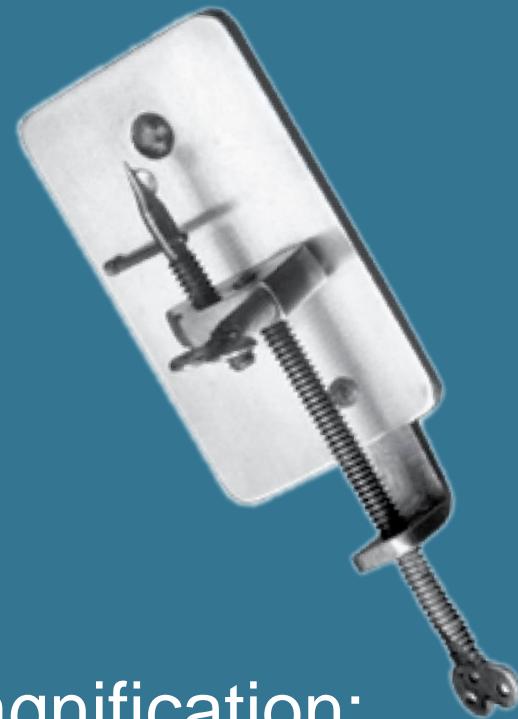
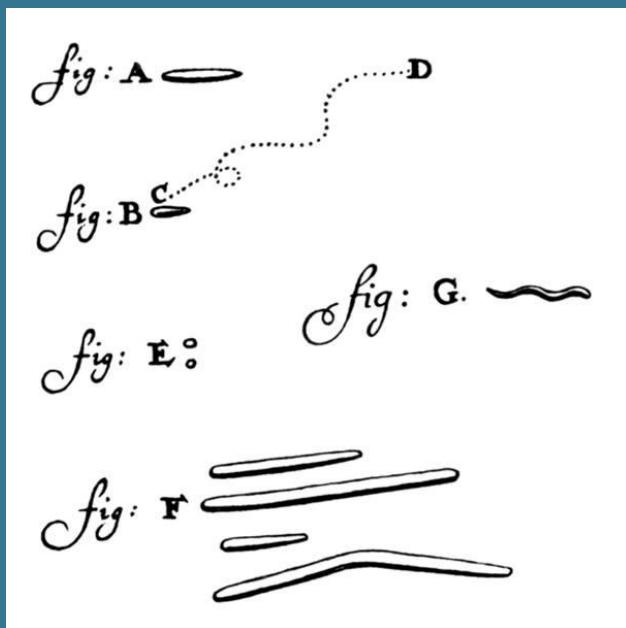
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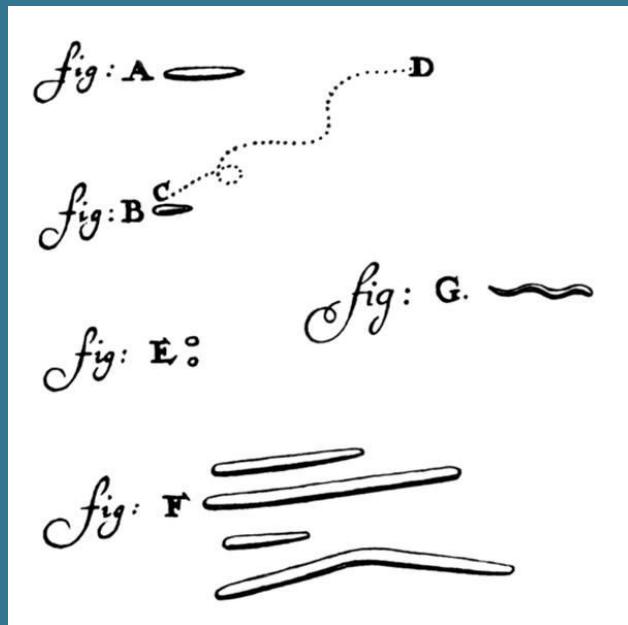
First observation of living cells under a microscope by Antoni van Leeuwenhoek



magnification:
~200 times

1674

First observation of living cells under a microscope by Antoni van Leeuwenhoek



magnification:
~200 times

1674

**Discovery of the
nucleus by Robert
Brown**



1839

**Formulation of the
Cell Theory by
Theodor Schwann**

1831

**Discovery of the
nucleus by Robert
Brown**



1839

**Formulation of the
Cell Theory by
Theodor Schwann**

1831

The first modern
light microscope
was invented

magnification:
1600 times



Discovery of
mitochondria with
improved microscope

1886

The first modern
light microscope

was invented



magnification:
1600 times



Discovery of
mitochondria with
improved microscope

1886

The first electron microscope was invented



1950

Discovery of ribosomes using an electron microscope

Some major events in cell biology and the development of microscopes

- All these major discoveries in cell biology were made possible by the **improvement of microscopes**

**Scientific knowledge advances
with improvement in technology**

Key learning

1 The development of microscopes led to the **discovery of cells** and the formulation of **the Cell Theory**.

Key learning

- With improved microscopes,
more details of the cells were observed.

Key learning

- 2 The Cell Theory states that:
- all organisms are made up of
one or more cells.
 - the cell is the **basic unit of life**.
 - all cells come from
pre-existing cells.

2.3 Microscopes: tools for studying cells

A

Types of microscopes

- Light microscopes
- Electron microscopes

Light microscopes

- use **light** to form images
- magnification: up to $\times 1600$
- produce **coloured** images



Light microscopes

Advantages:

- **live specimens** can be observed
- specimens can be **prepared easily**



Electron microscopes

- use **electron beams** to form images
- produce **black and white** images
- examples: transmission electron microscopes (透射電子顯微鏡), scanning electron microscopes (掃描電子顯微鏡)

Electron microscopes

i) Transmission electron microscope (TEM)

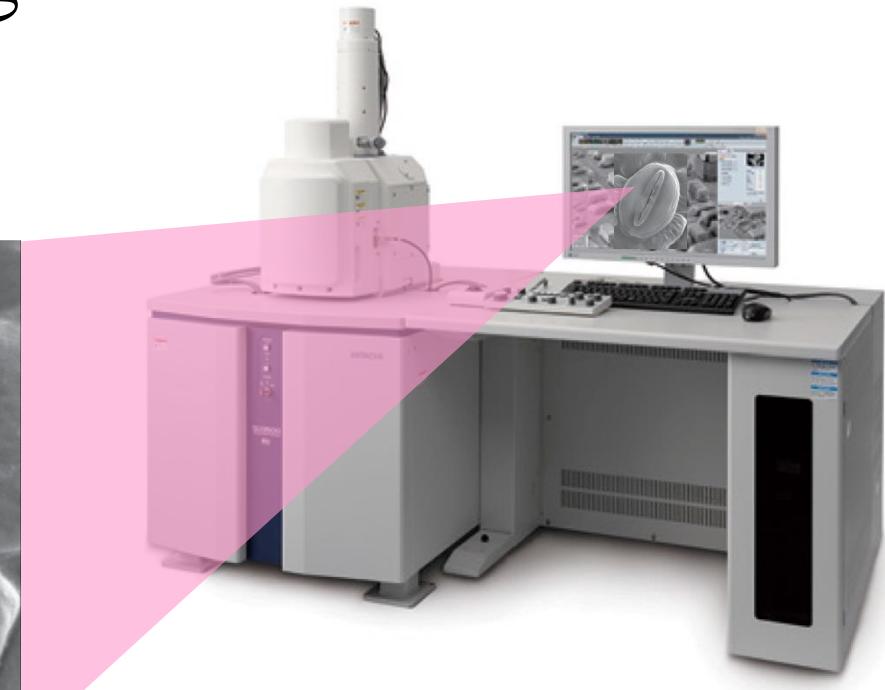
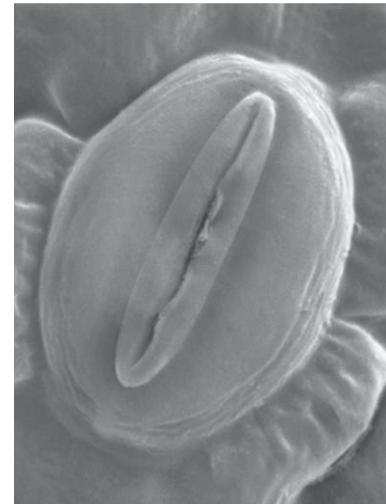
- **2-D images showing internal structures**



Electron microscopes

ii) Scanning electron microscope (SEM)

- **3-D images showing external structures**



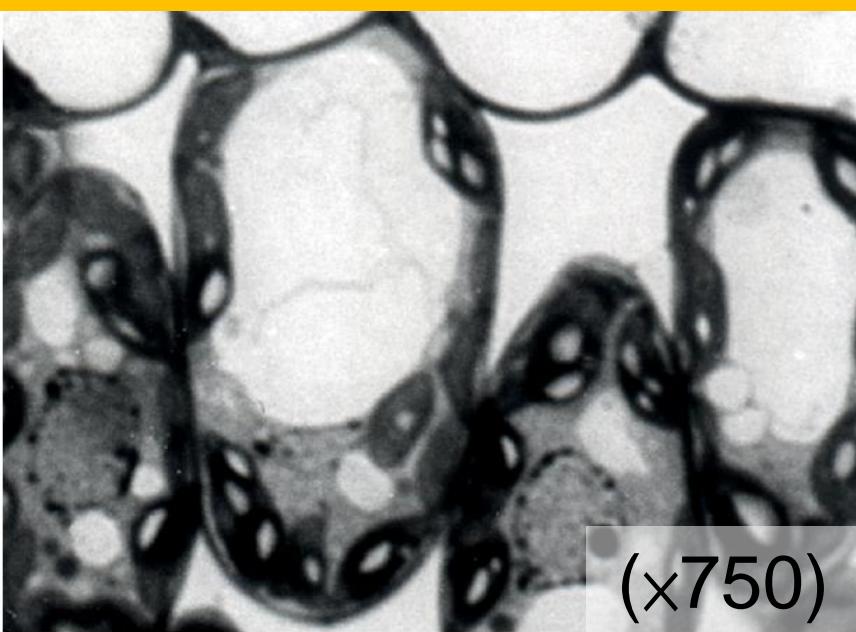
Electron microscopes

Advantage:

- produce images with **higher magnifications** and **resolution** (分辨率)

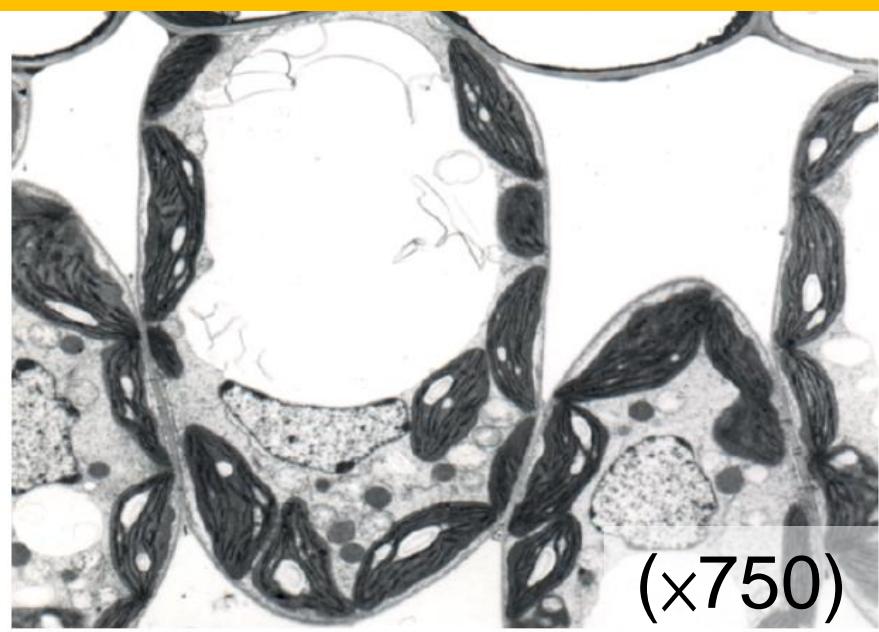
Resolution of images

light microscope



($\times 750$)

electron microscope

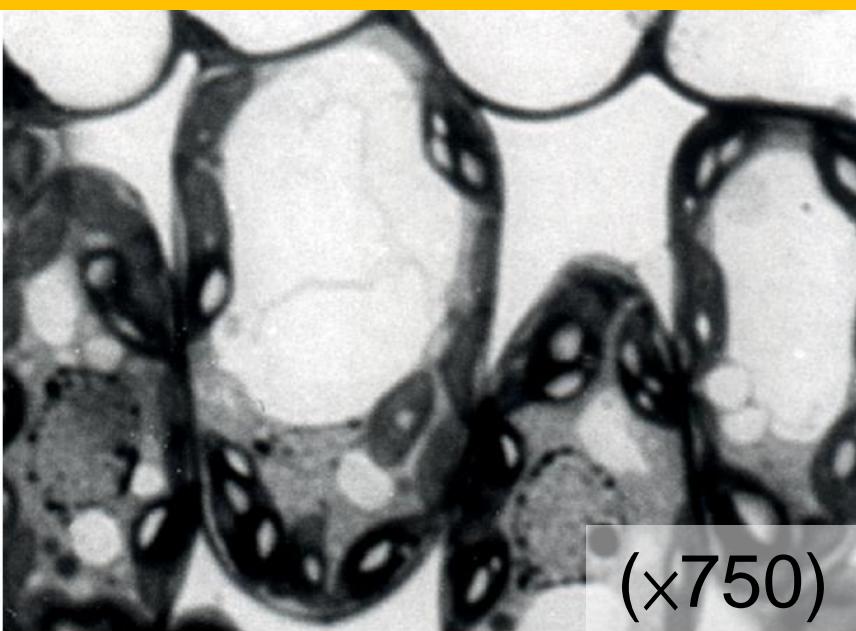


($\times 750$)

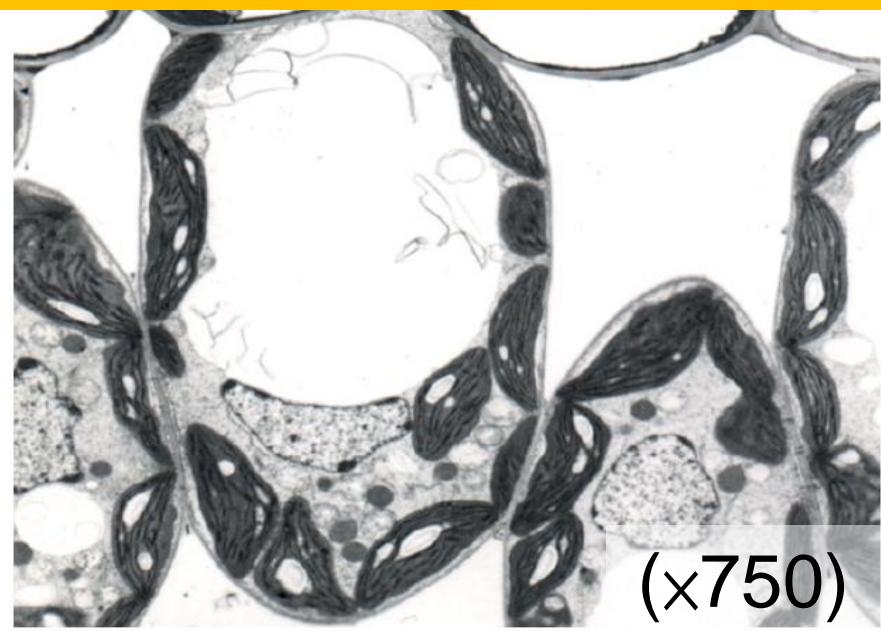
same magnification

Resolution of images

light microscope



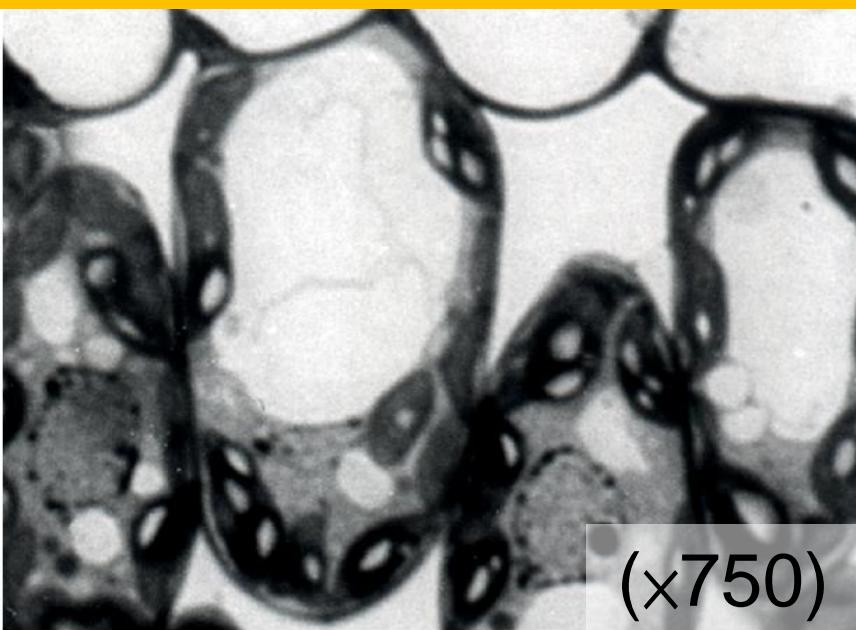
electron microscope



higher resolution

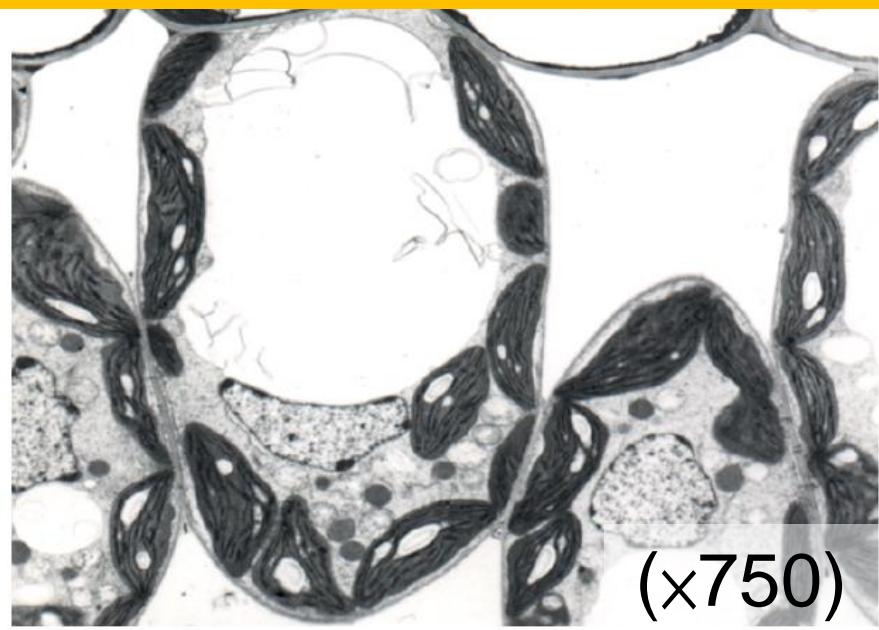
Resolution of images

light microscope



(×750)

electron microscope



(×750)

clearer and with
more details

B

Light microscopes



Compound microscope

(複式顯微鏡)

has two sets of lenses:
eyepiece and **objective**

1 Different parts of a light microscope



Eyepiece (目鏡)

magnifying lens which
the eye can look through



1 Different parts of a light microscope



Body tube (鏡筒)

holds the eyepiece
and nosepiece

1 Different parts of a light microscope



Nosepiece (物鏡轉換器)

we can rotate it to
choose objective
required

Objectives (物鏡)

magnifying lens pointing
to the specimen

1 Different parts of a light microscope



Condenser (聚光器)

focuses light onto the specimen

Diaphragm (光欄)

for adjusting the amount of light reaching the specimen

1 Different parts of a light microscope



Condenser (聚光器)

focuses light onto the specimen

Diaphragm (光欄)

Light source

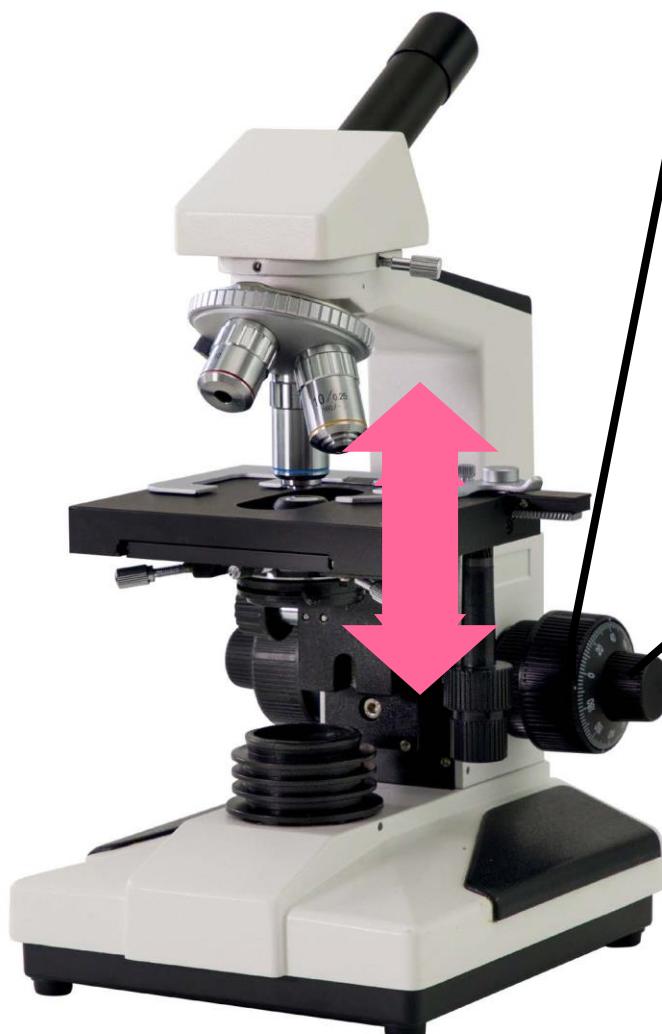
1 Different parts of a light microscope



— Arm

for holding the
microscope

1 Different parts of a light microscope



Coarse adjustment knob
(粗調節器)

raises or lowers the stage
to get a **rough** focus

Fine adjustment knob
(微調節器)

raises or lowers the stage
tube to get a **sharp** focus

1 Different parts of a light microscope



Stage (載物台)

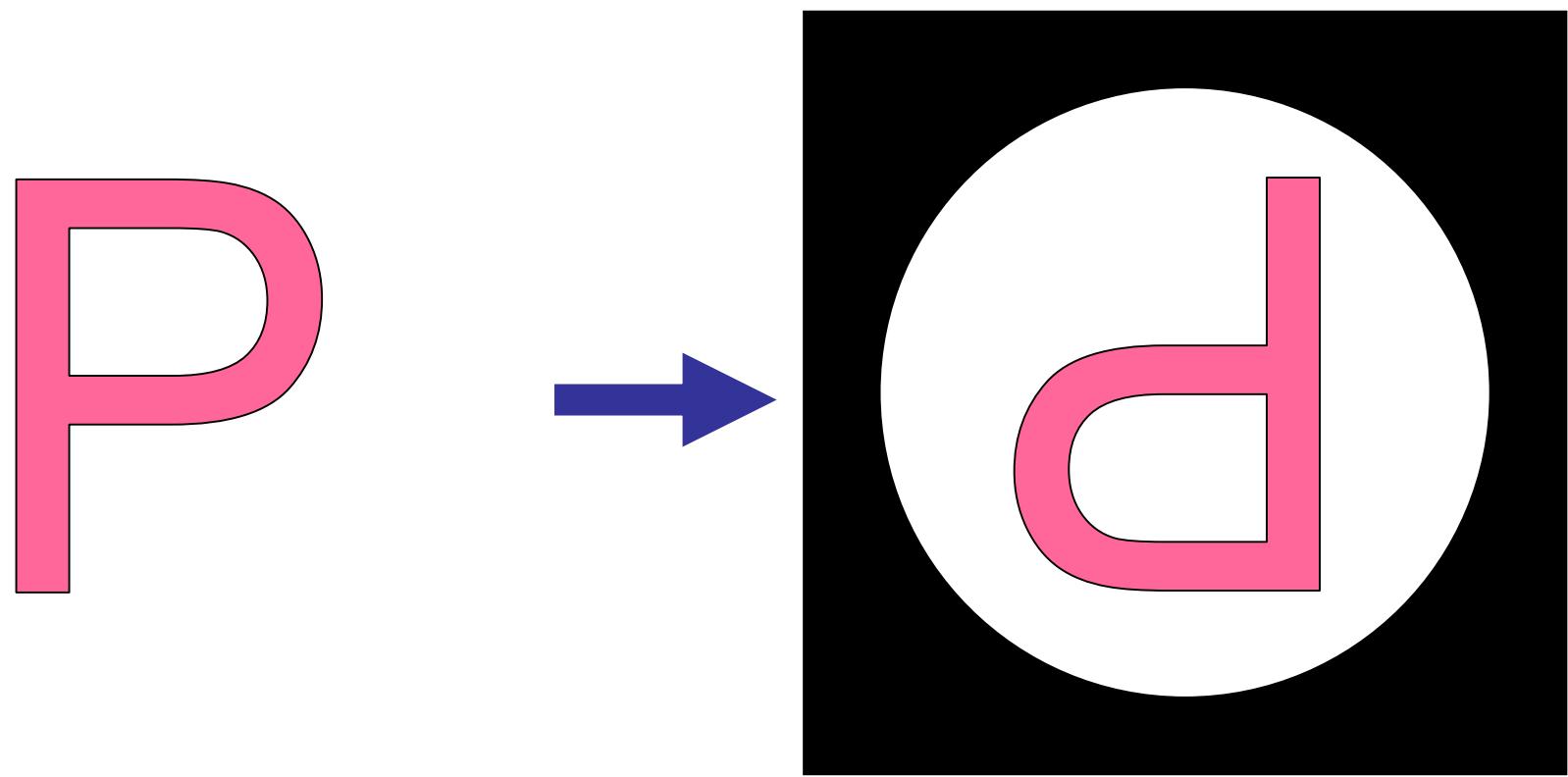
slide is clipped here
for observation

Base

supports the whole
microscope

2 How a light microscope works

The image is **inverted**.



Practical 2.1



Practical 2.1

Observation with a light microscope

Procedure

A Observation at low-power magnification

1 Place a microscope on the bench.

Practical 2.1

2



low-power
eyepiece

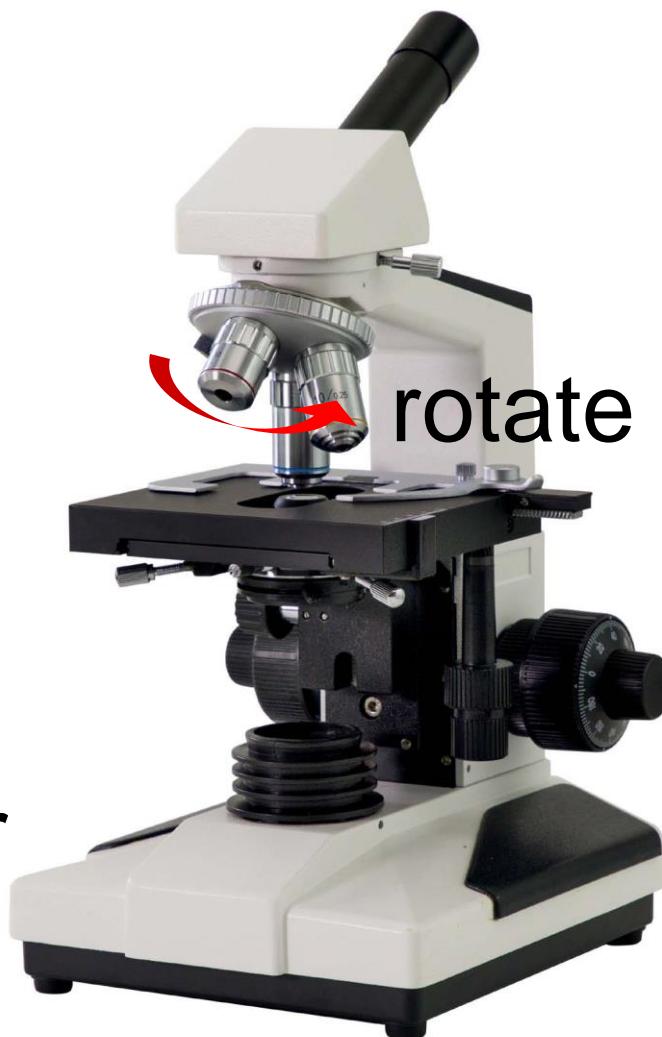


Practical 2.1

2



low-power
objective



Practical 2.1

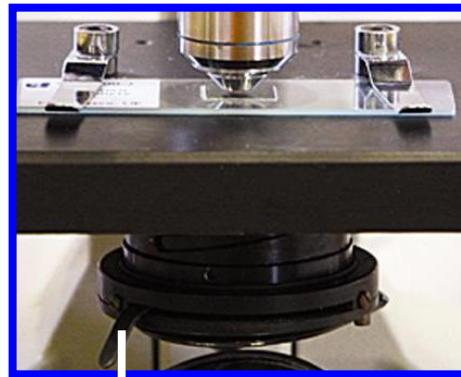
3

turn on the light
source



Practical 2.1

3 look through the eyepiece



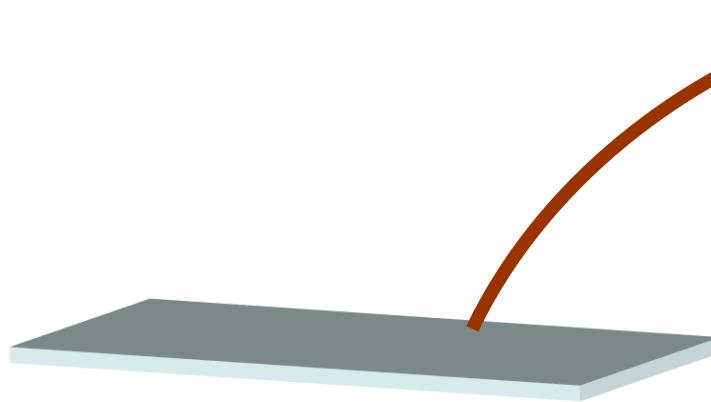
adjust the diaphragm



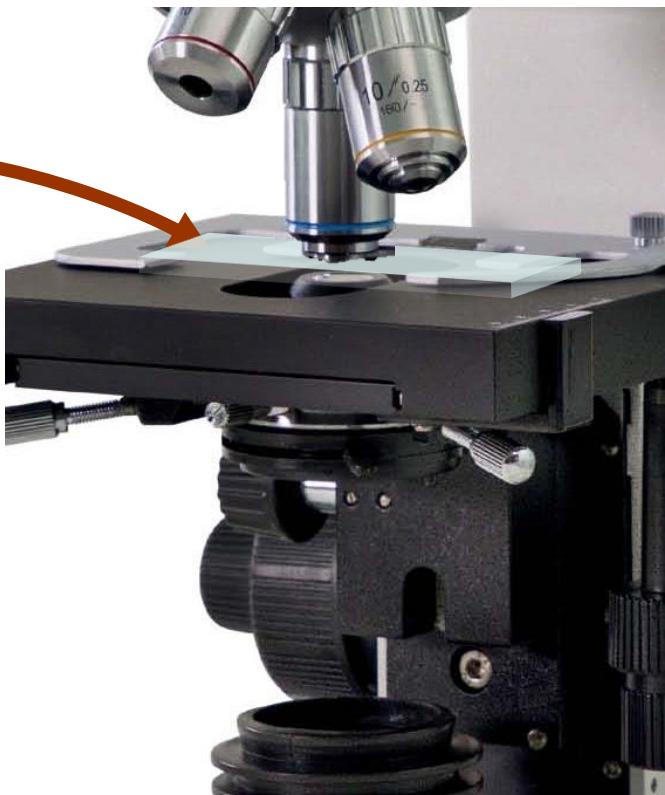
Practical

2.1

4



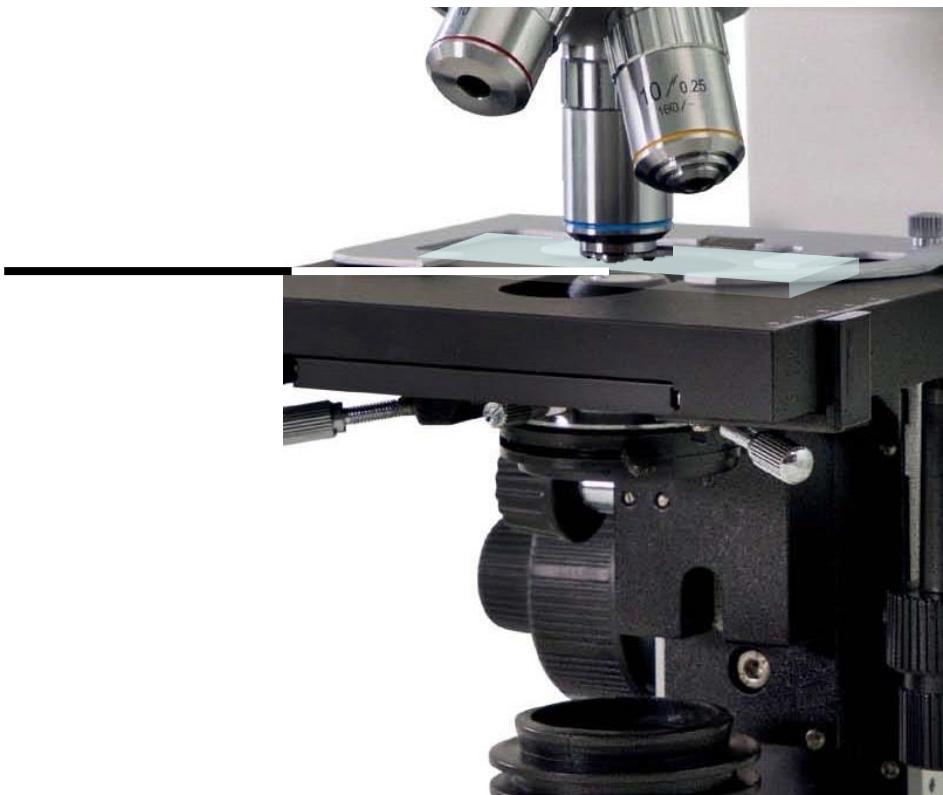
prepared slide of
onion epidermal cells



Practical 2.1

4

make sure the specimen is directly over the hole of the stage



Practical 2.1

5 Focus on the specimen:

a

watch from the side

turn the **coarse adjustment knob** until the objective is **closest** to the slide

stage
raises



Practical 2.1

5 Focus on the specimen:

b

look through the ——————
eyepiece

turn the **coarse
adjustment knob** ——————
until the image is
roughly in focus



Practical 2.1

5 Focus on the specimen:

c

turn the **fine
adjustment knob**
to get a sharp focus —



Practical 2.1

B Observation at high-power magnification

1

focus the specimen
at **low-power**
magnification



Practical 2.1

2

move the part of _____
interest to the centre
of the field of view



Practical 2.1

3

rotate the nosepiece
to select a high-power
objective



Practical 2.1

4

turn the fine
adjustment knob to
get a sharp focus —



Practical 2.1

5

adjust the diaphragm—
if necessary



Practical 2.1

6 If you cannot get a clear image:

- a turn the coarse adjustment knob until the objective **nearly touches** the slide.



- b focus the image by turning the fine adjustment knob.



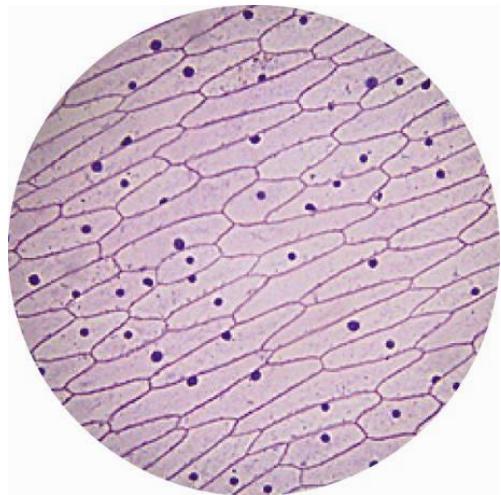
Practical 2.1

7 Compare observations at low-power and high-power magnifications.

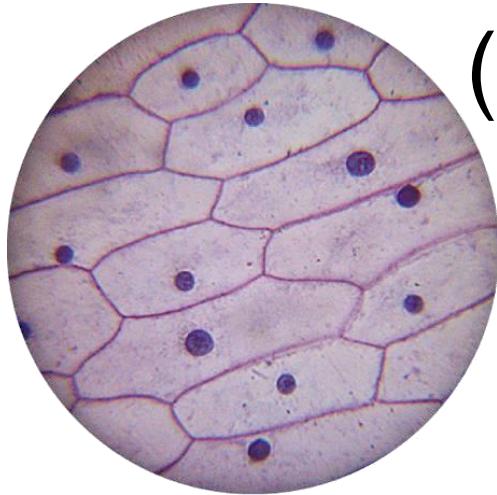
Practical 2.1

Results and discussion

low-power
magnification
($\times 100$)



high-power
magnification
($\times 400$)

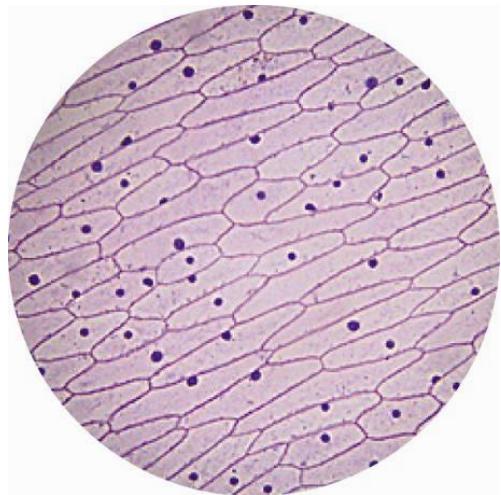


smaller
area
(fewer cells)
observed

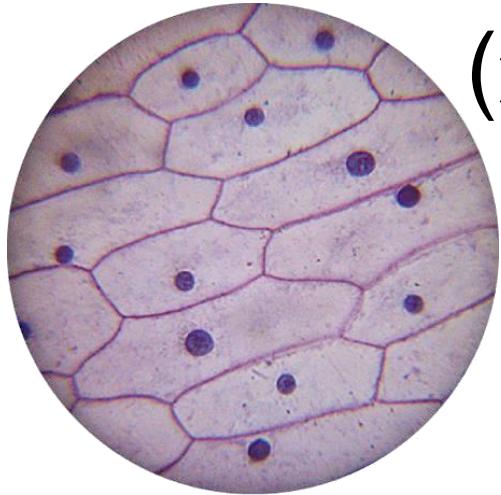
Practical 2.1

Results and discussion

low-power
magnification
($\times 100$)



high-power
magnification
($\times 400$)

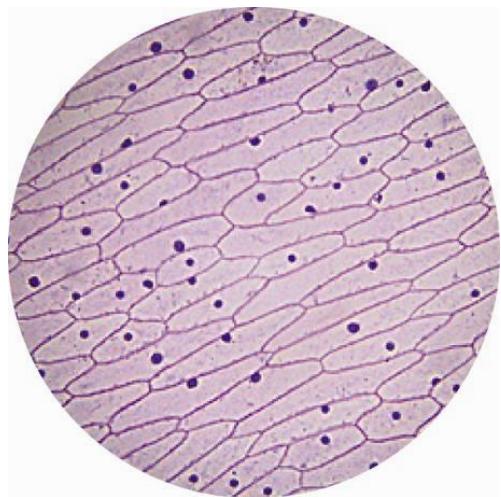


more
details
observed

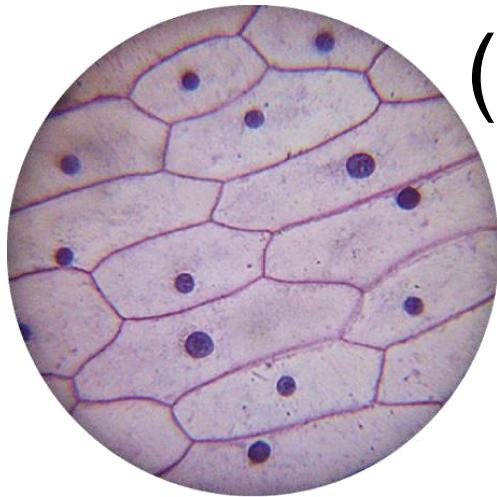
Practical 2.1

Results and discussion

low-power
magnification
($\times 100$)



high-power
magnification
($\times 400$)



dimmer
image

3 Magnification of a light microscope

Total magnification of a microscope

$$= \text{magnification of eyepiece} \times \text{magnification of objective}$$

e.g.

10X eyepiece —————

40X objective —————



3 Magnification of a light microscope

Total magnification of a microscope

$$= \text{magnification of eyepiece} \times \text{magnification of objective}$$

e.g.

10X eyepiece —————

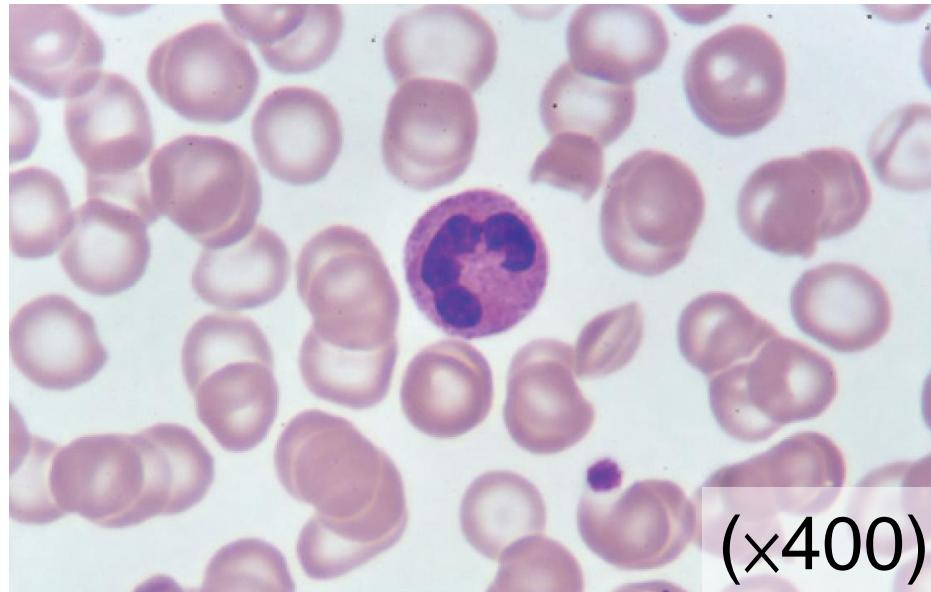
$$\begin{array}{r} \times 40X \text{ objective} \\ \hline = 400X \end{array} —————$$



Calculating the actual size of an object

$$\text{Magnification} = \frac{\text{size of the image}}{\text{size of the object}}$$

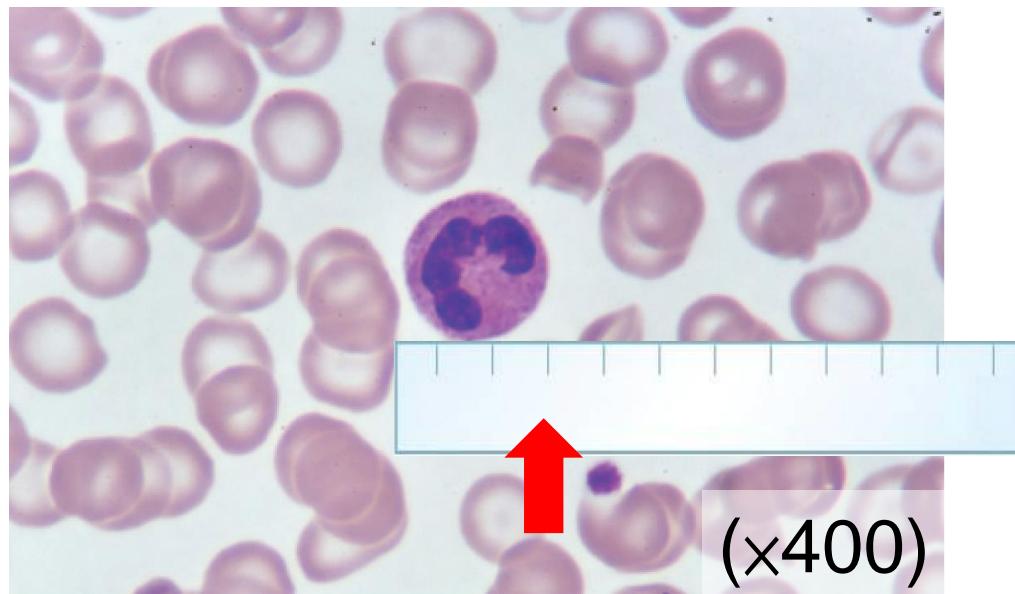
Example:



Calculating the actual size of an object

1

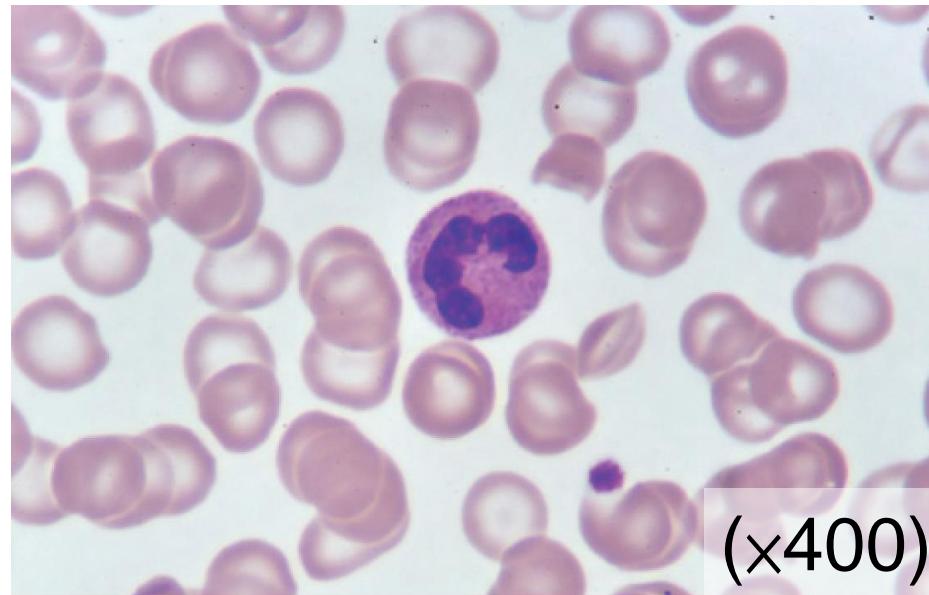
$$\text{Magnification} = \frac{0.6 \text{ cm}}{\text{size of the object}}$$



Calculating the actual size of an object

2

$$400 = \frac{0.6 \text{ cm}}{\text{size of the object}}$$





Calculating the actual size of an object

3

$$400 = \frac{0.6 \text{ cm}}{\text{size of the object}}$$

$$\text{size of the object} = \frac{0.6 \text{ cm}}{400}$$



Calculating the actual size of an object

4

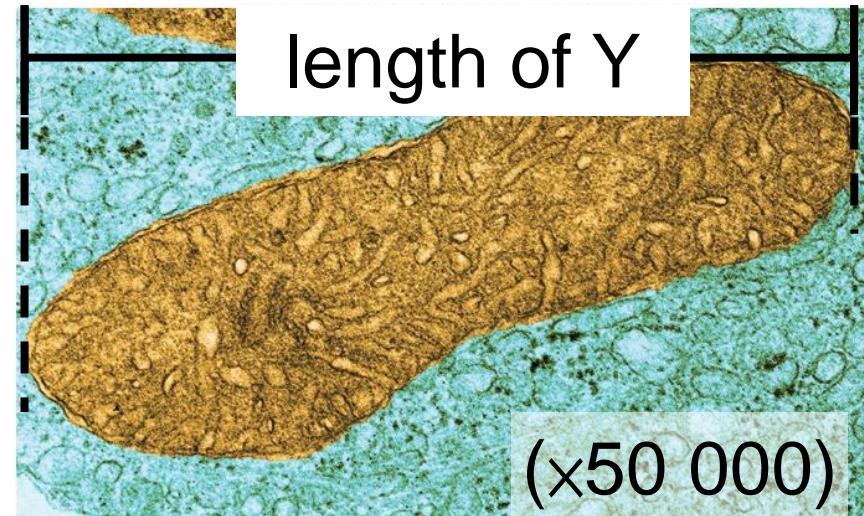
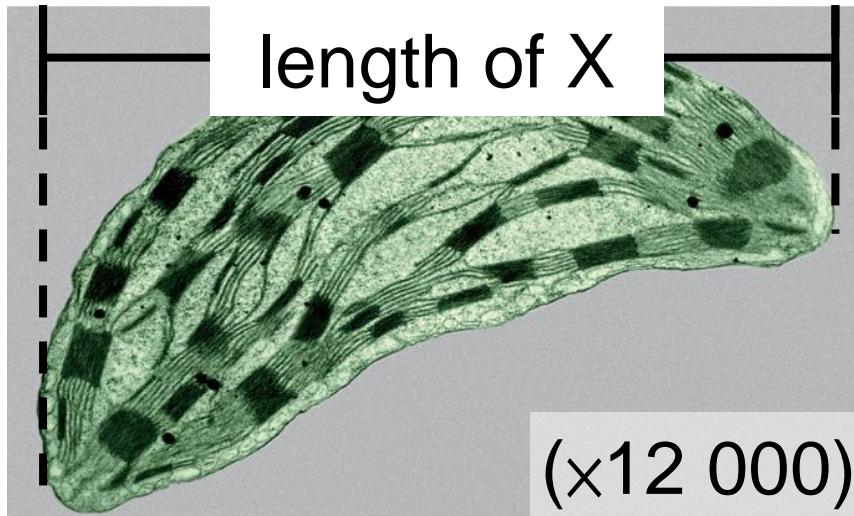
$$400 = \frac{0.6 \text{ cm}}{\text{size of the object}}$$

$$\begin{aligned}\text{size of the object} &= \frac{0.6 \text{ cm}}{400} \\ &= 0.0015 \text{ cm} \\ &= 15 \mu\text{m}\end{aligned}$$

Skill practice

The electron micrographs show two structures found in cells, X and Y. Calculate their actual lengths.

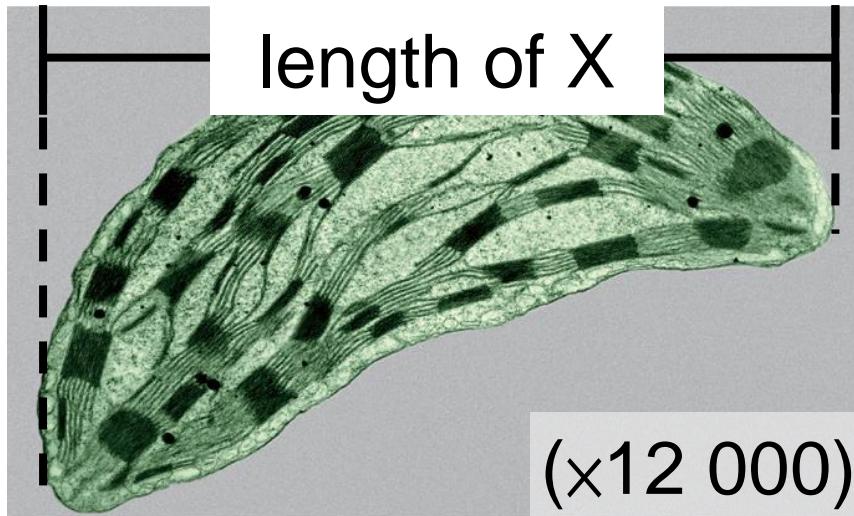
(4 marks)



Skill practice

The electron micrographs show two structures found in cells, X and Y. Calculate their actual lengths.

(4 marks)



length of X in the photomicrograph: 5.45 cm
(1)

actual length of X:

$$= \frac{54.5 \text{ mm}}{12\,000}$$

$$= 4.54 \mu\text{m} \quad (1)$$

Skill practice

The electron micrographs show two structures found in cells, X and Y. Calculate their actual lengths.

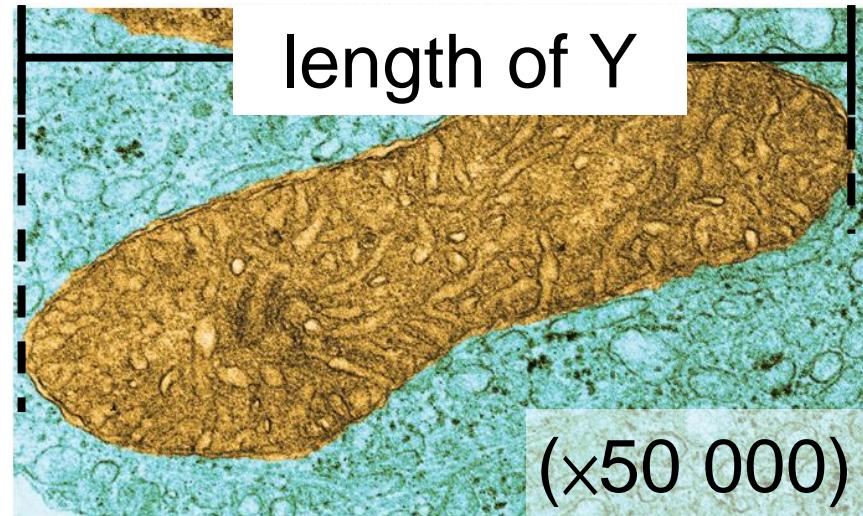
(4 marks)

length of Y in the photomicrograph: 5.6 cm
(1)

actual length of Y:

$$= \frac{56 \text{ mm}}{50\,000}$$

$$= 1.12 \mu\text{m} \quad (1)$$



Key learning

1 **Light** microscopes and **electron** microscopes are commonly used today.

Compared to light microscopes, electron microscopes can produce images with much higher **magnifications** and **resolution**.

Key learning

2 Differences between low-power and high-power magnification:

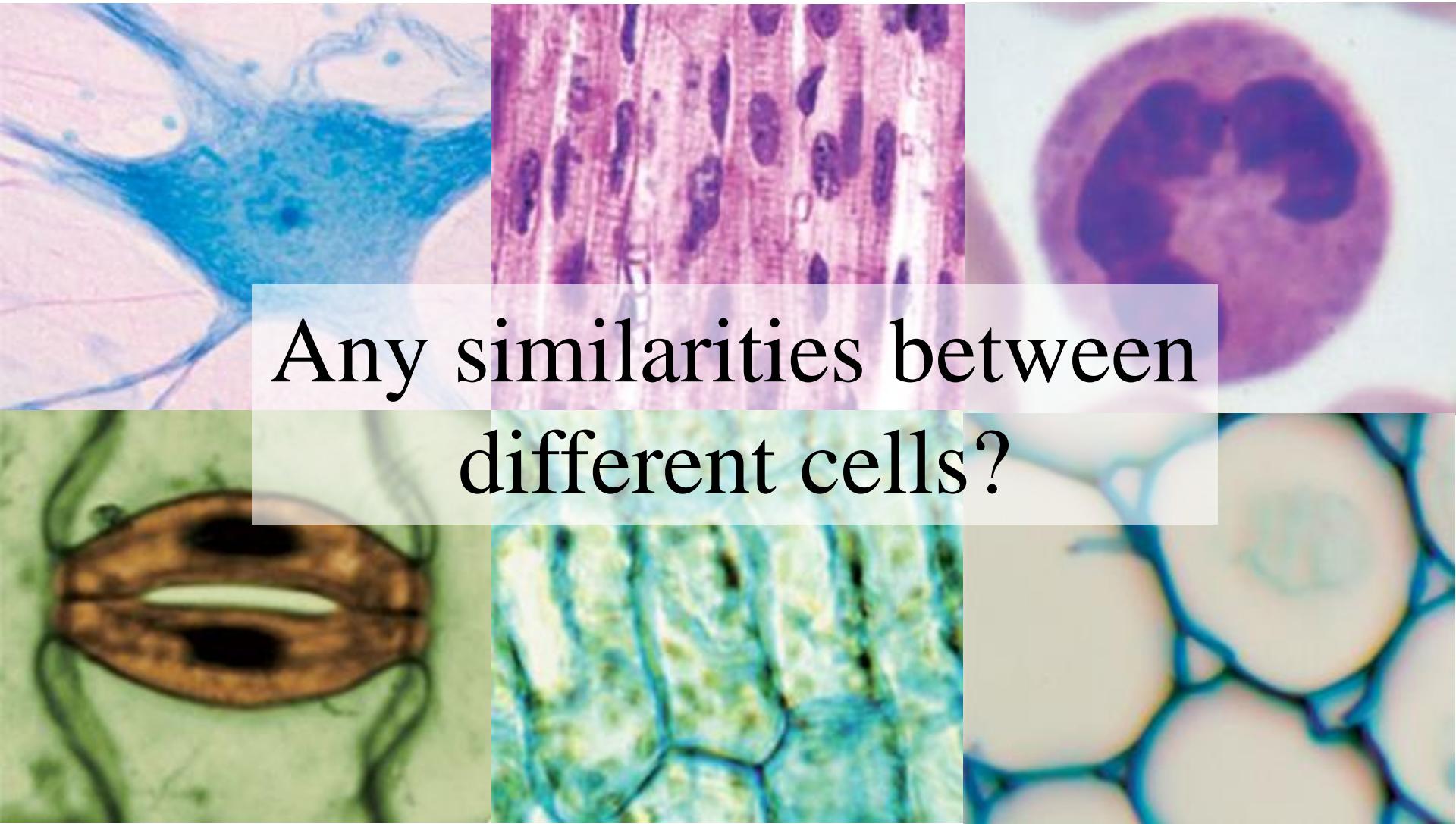
	Low-power magnification	High-power magnification
Area of specimen observed	Larger	Smaller
Details of specimen observed	Less	More
Brightness of image	Brighter	Dimmer

Key learning

3 Total magnification of a compound microscope:

$$= \text{magnification of eyepiece} \times \text{magnification of objective}$$

2.4 Structure of cells



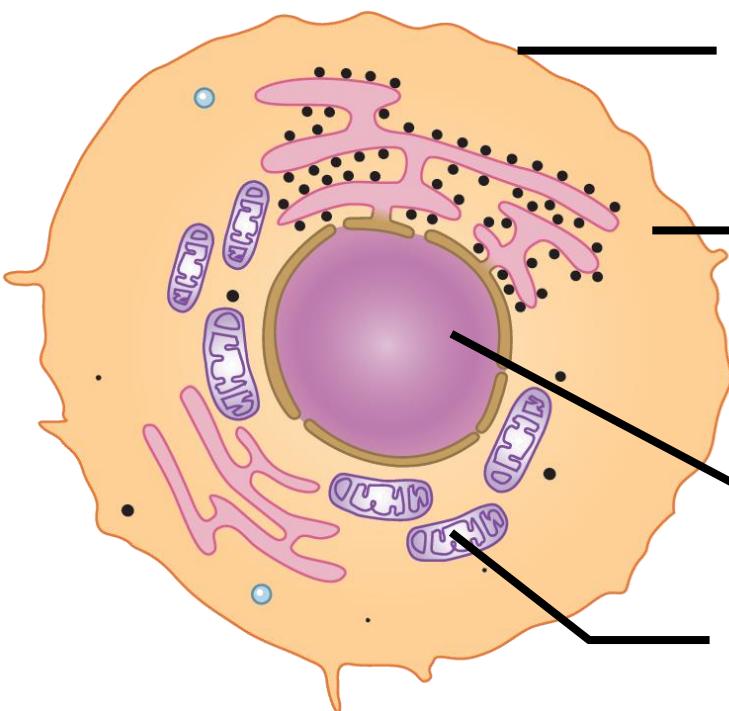
Any similarities between
different cells?

A Animal cells and plant cells

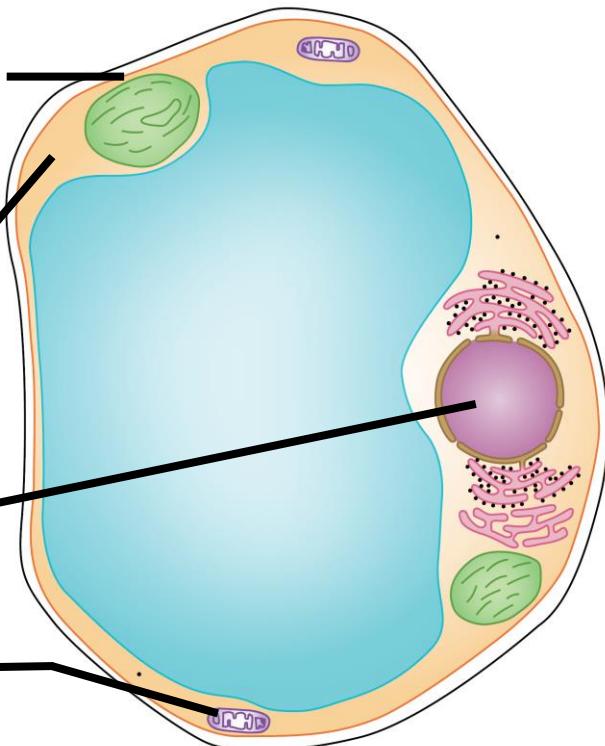
Same basic structure:

- **cytoplasm** (細胞質)
- **cell membrane**
- various **organelles**

Animal cell



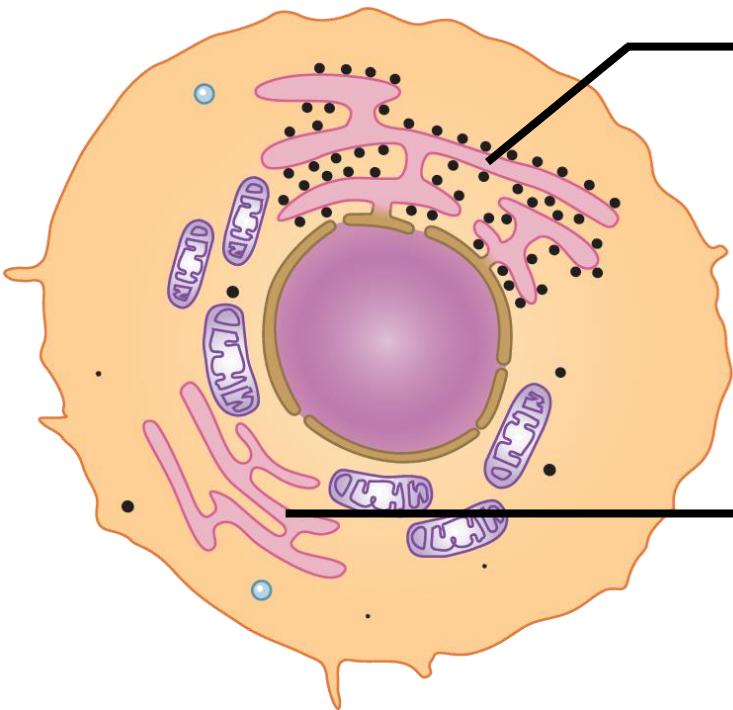
Plant cell

[3D model 2.1](#)

OXFORD

[3D model 2.2](#)

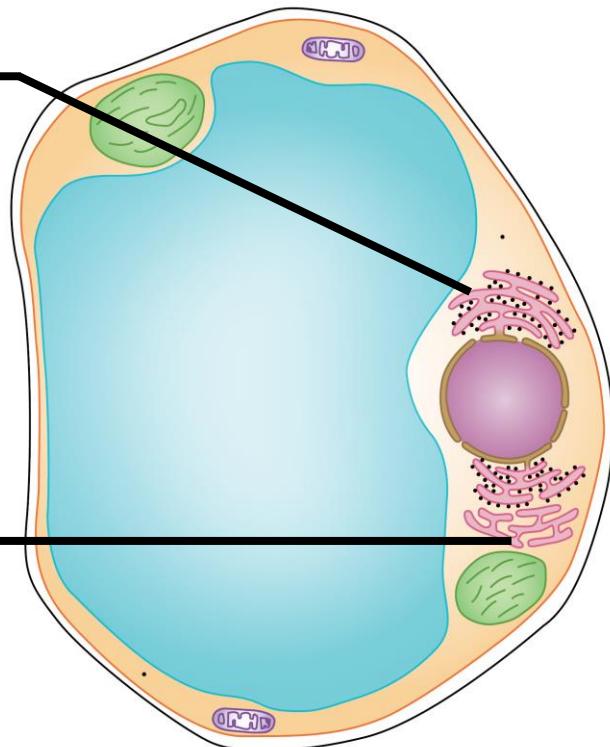
Animal cell



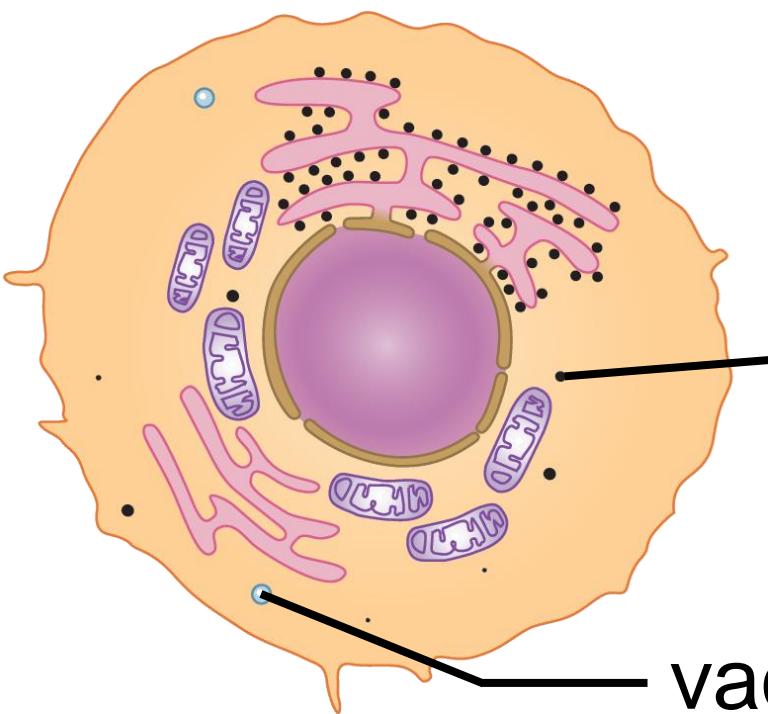
rough
endoplasmic
reticulum
(粗糙內質網)

smooth
endoplasmic
reticulum
(光滑內質網)

Plant cell



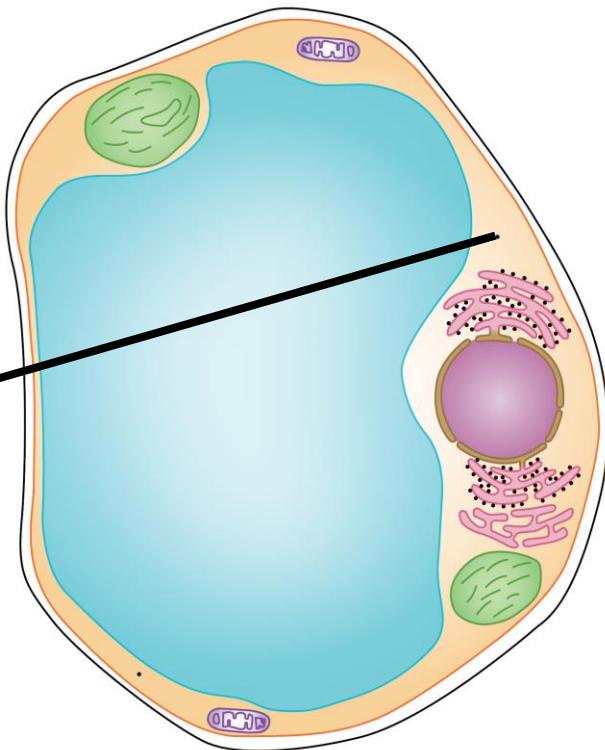
Animal cell



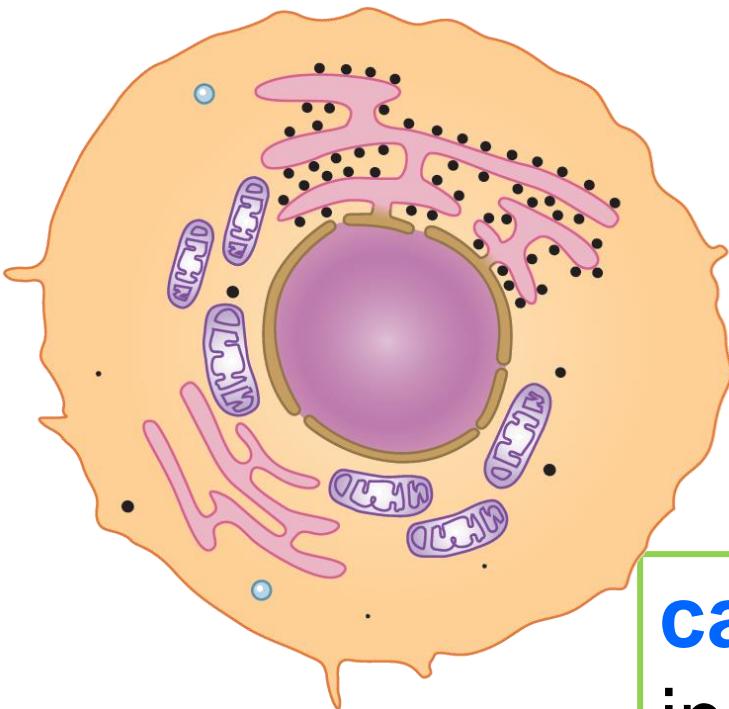
ribosome
(核糖體)

vacuole (液泡)

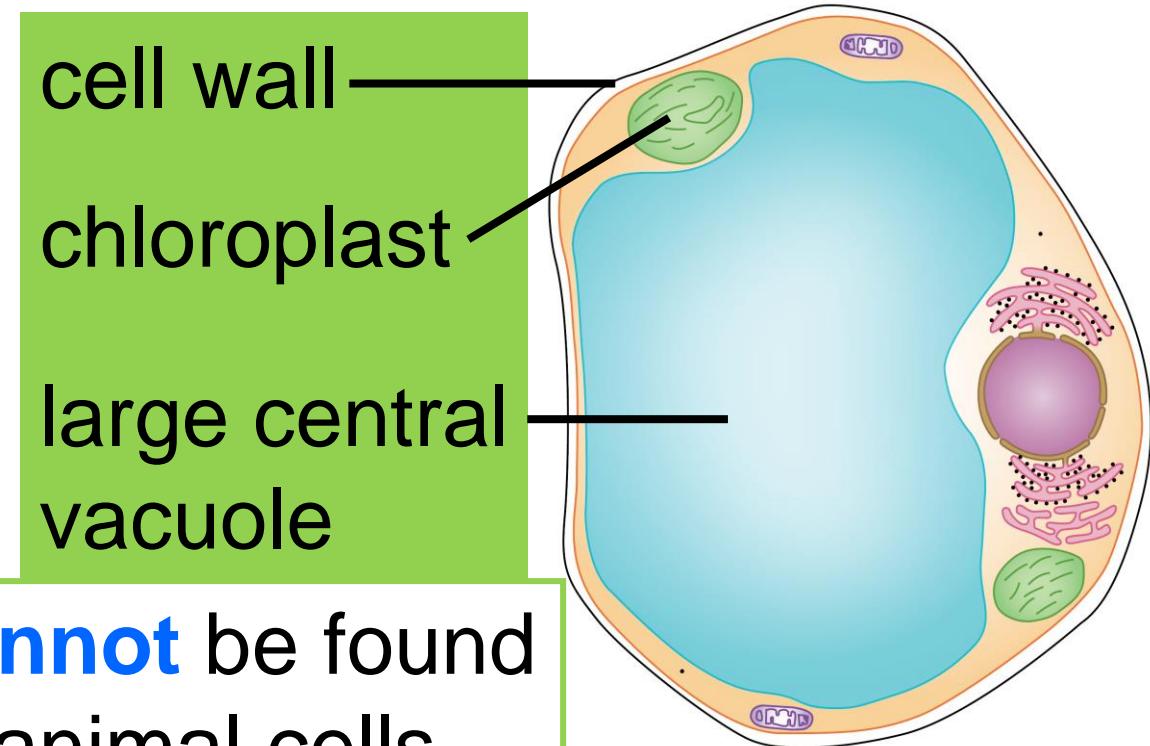
Plant cell



Animal cell



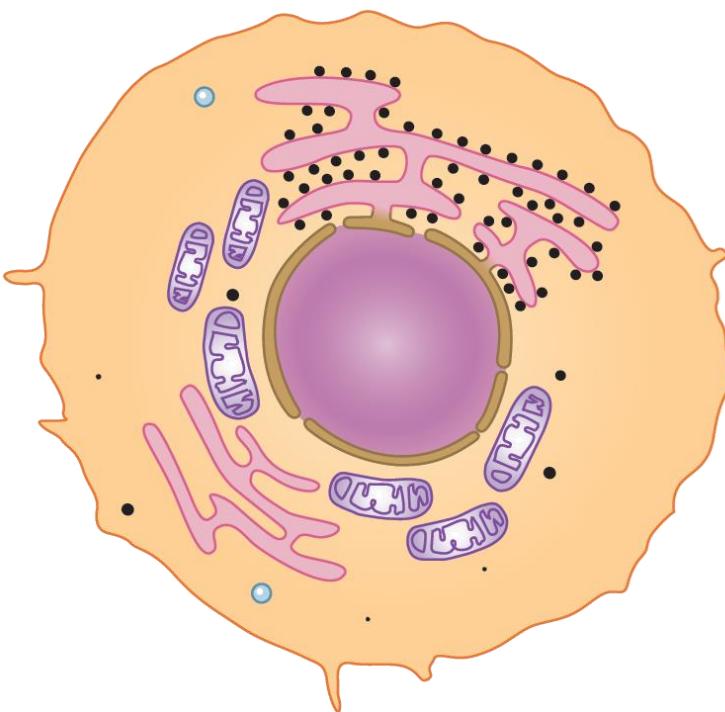
Plant cell



cell wall
chloroplast
large central
vacuole

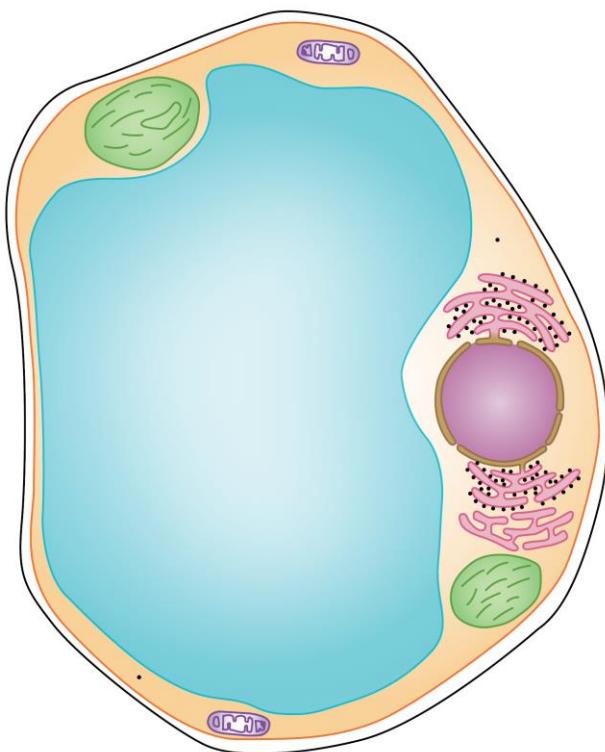
cannot be found
in animal cells

Animal cell

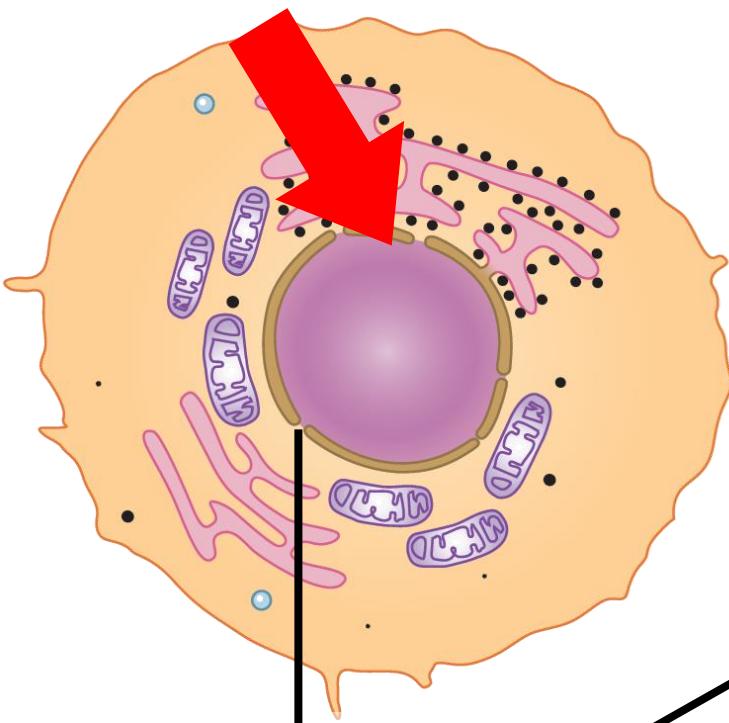


- generally **larger**
- a more **regular** shape

Plant cell

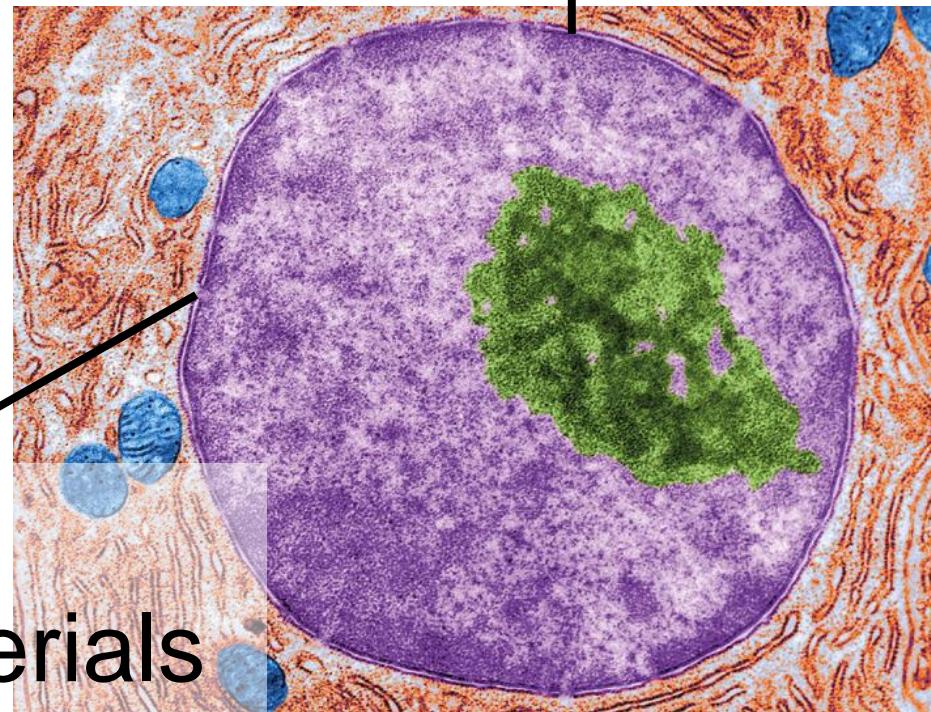


Nucleus

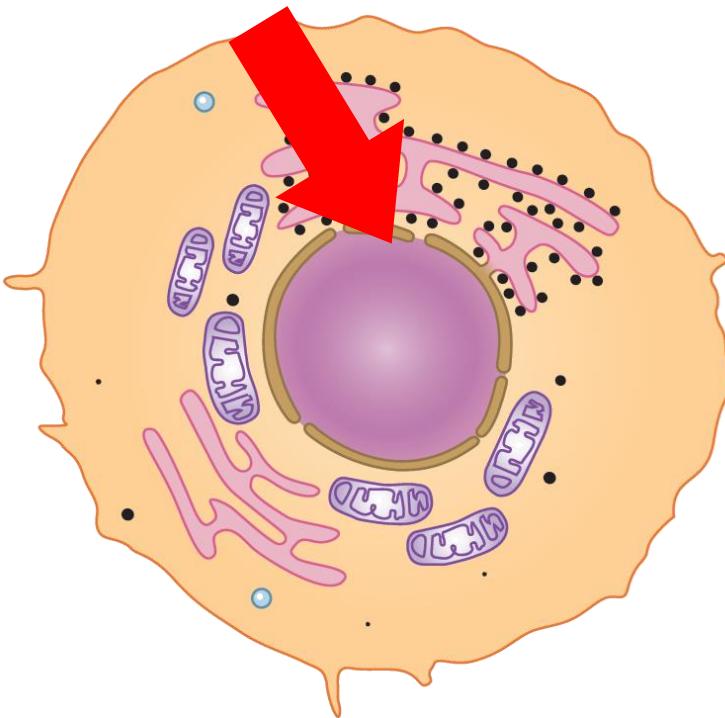


pores for the exchange of materials

- bounded by **nuclear membrane** (核膜)

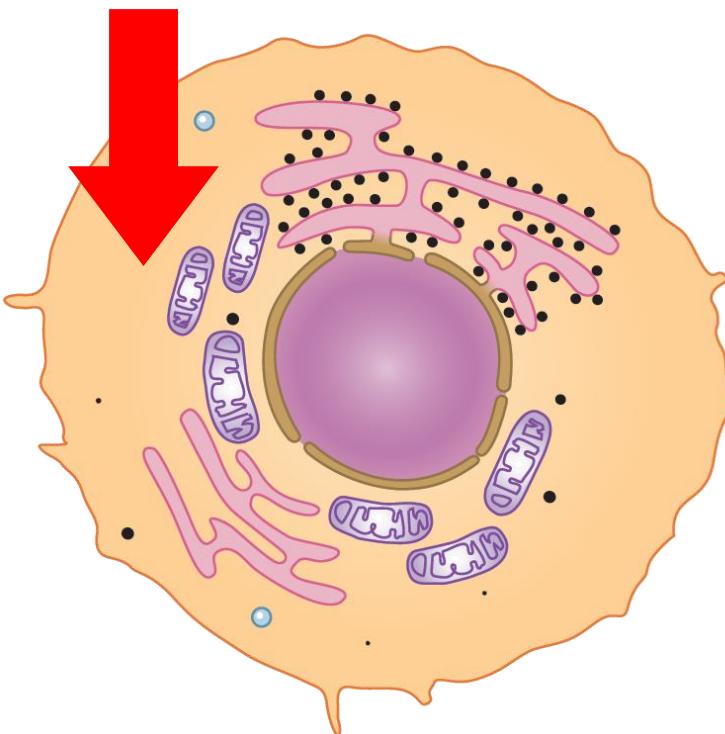


Nucleus



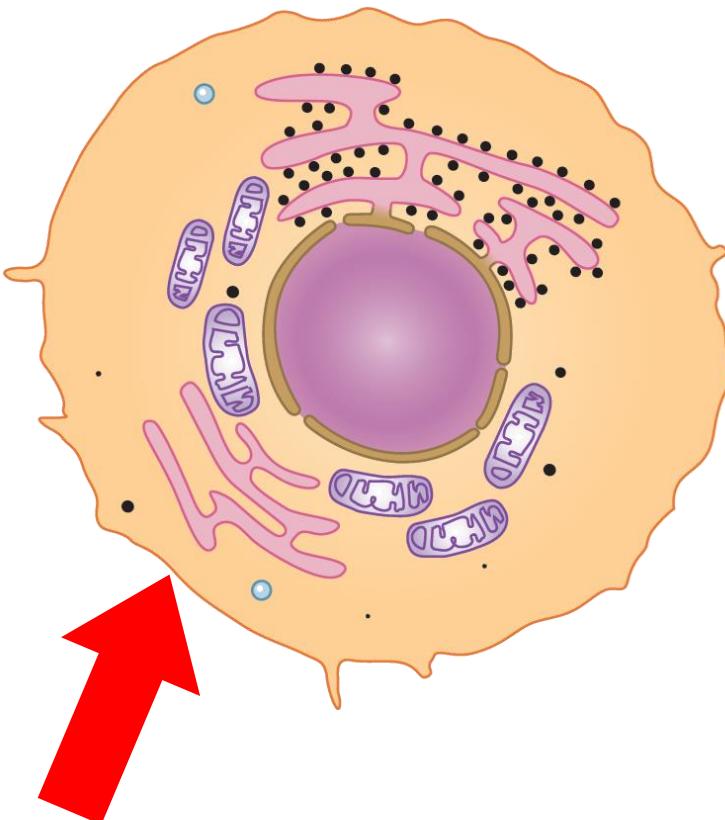
- bounded by **nuclear membrane** (核膜)
- contains **DNA**
- controls activities of the cell

Cytoplasm



- jelly-like fluid
- holds many **organelles**
- site for many **chemical reactions**
- allows movement and transport of materials inside cells

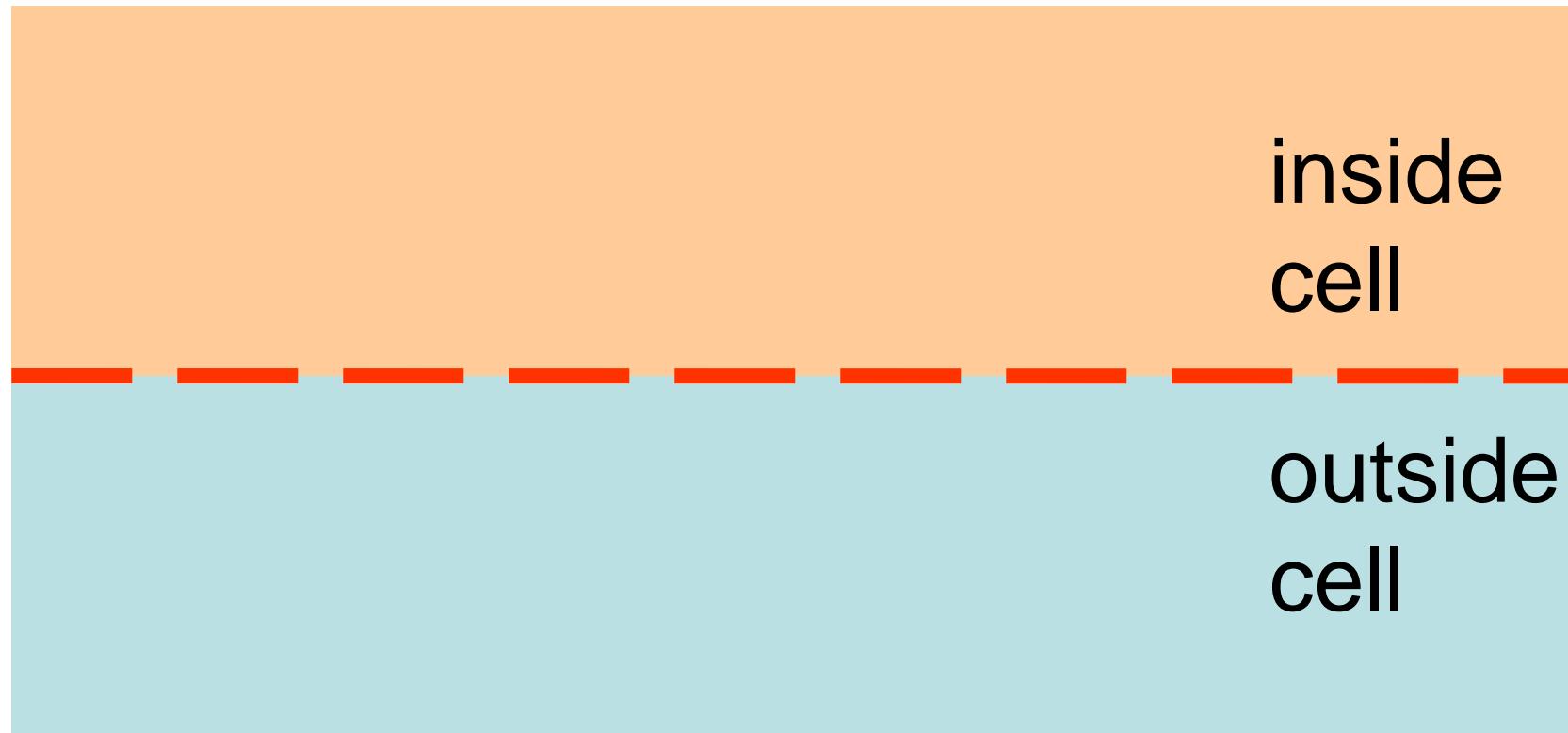
Cell membrane



- thin and **flexible**
- mainly made up of **phospholipids** and **proteins**

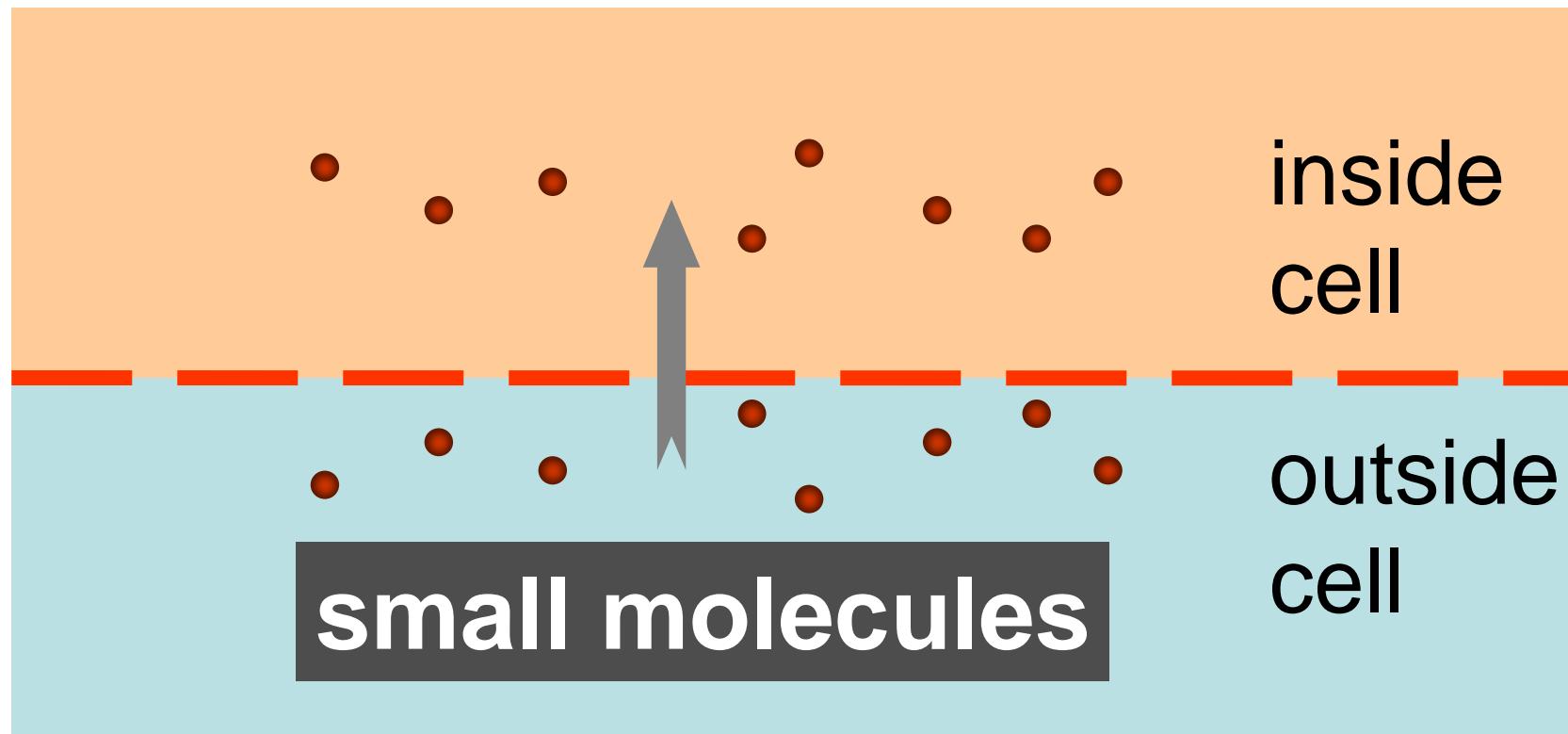
Cell membrane

- separates the cell contents from the outside environment



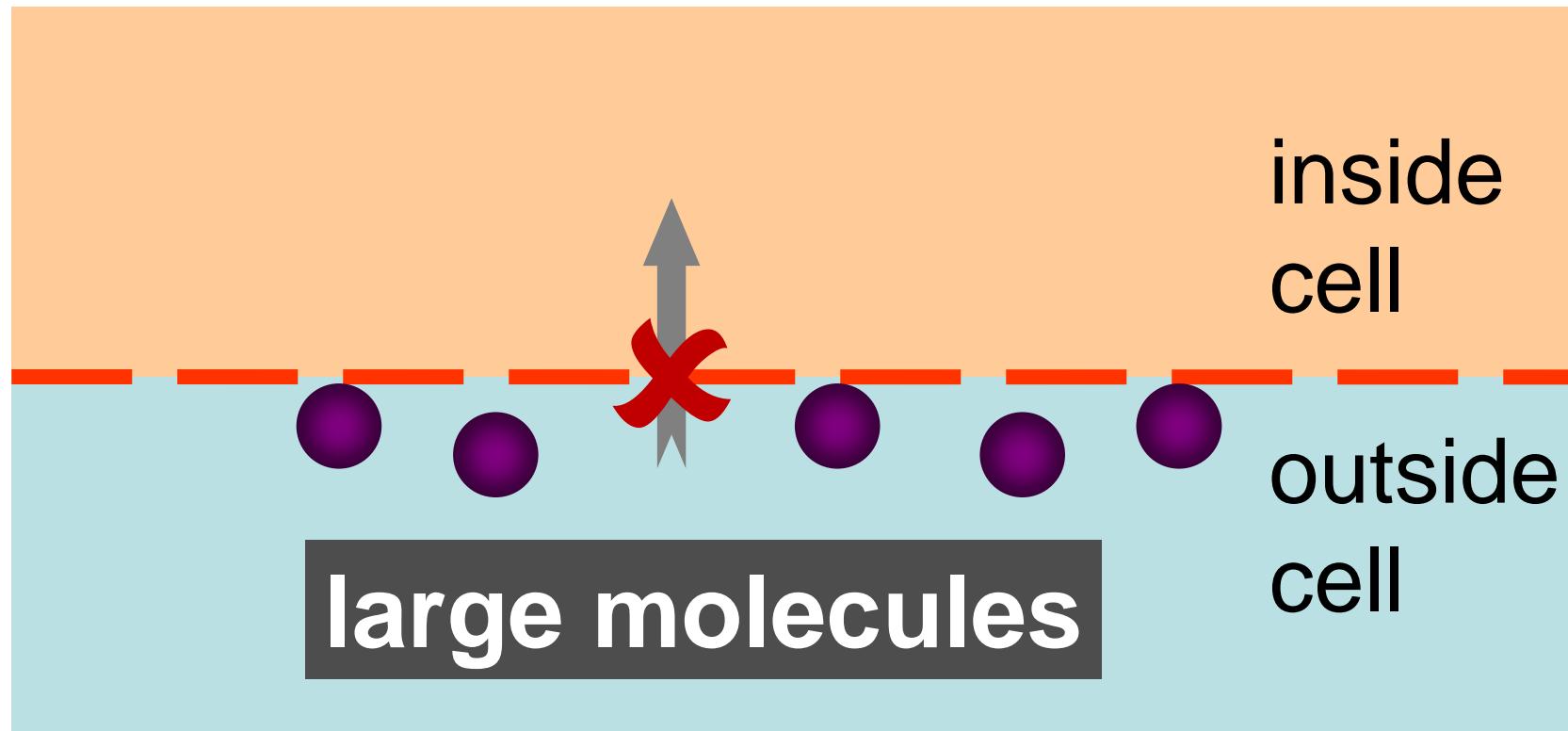
Cell membrane

- differentially permeable (差異透性的)



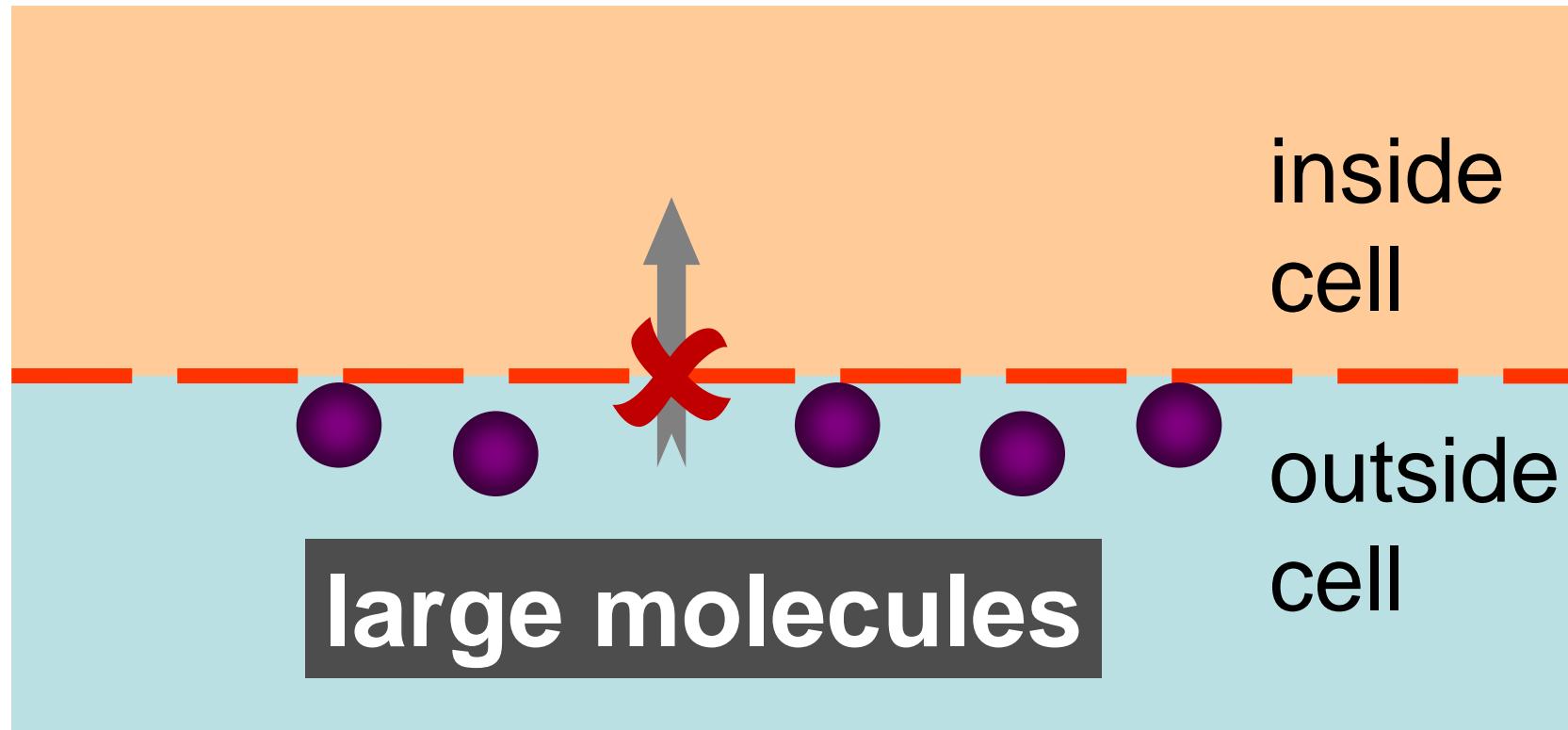
Cell membrane

- **differentially permeable** (差異透性的)

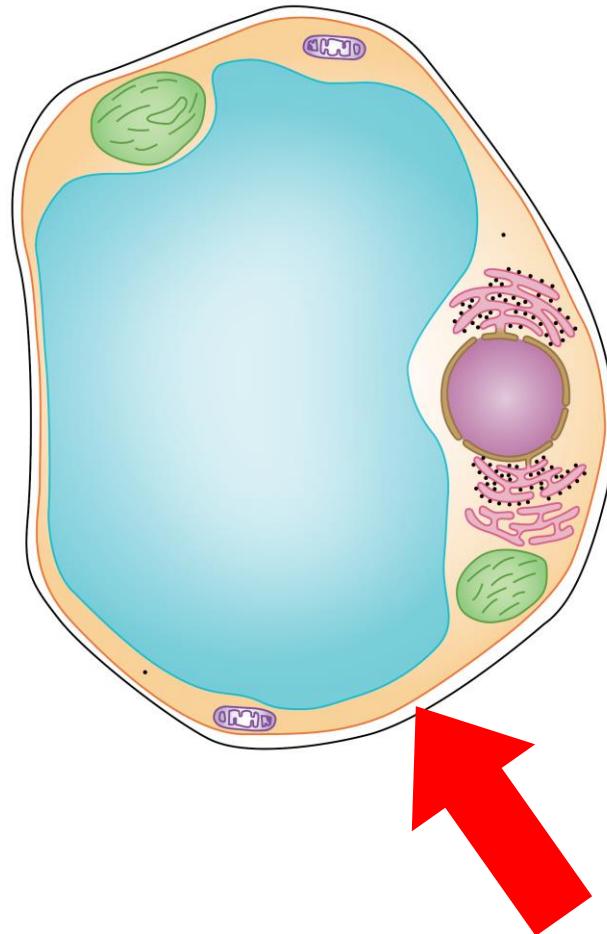


Cell membrane

- **controls the movement** of substances into and out of the cell

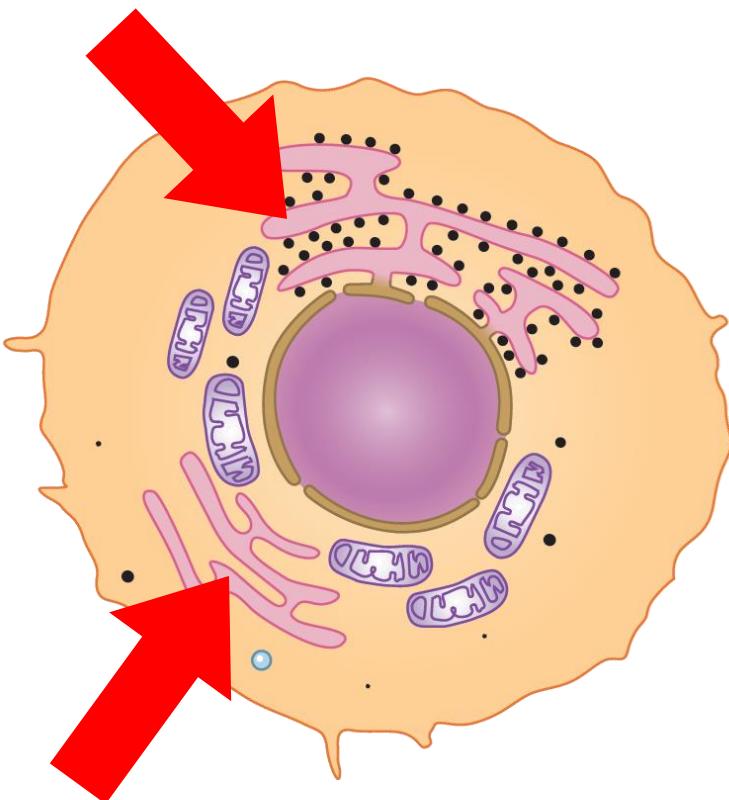


Cell wall



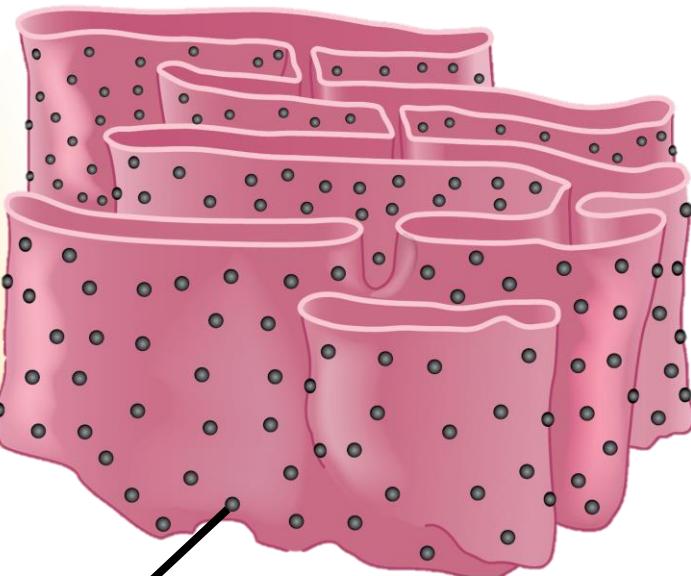
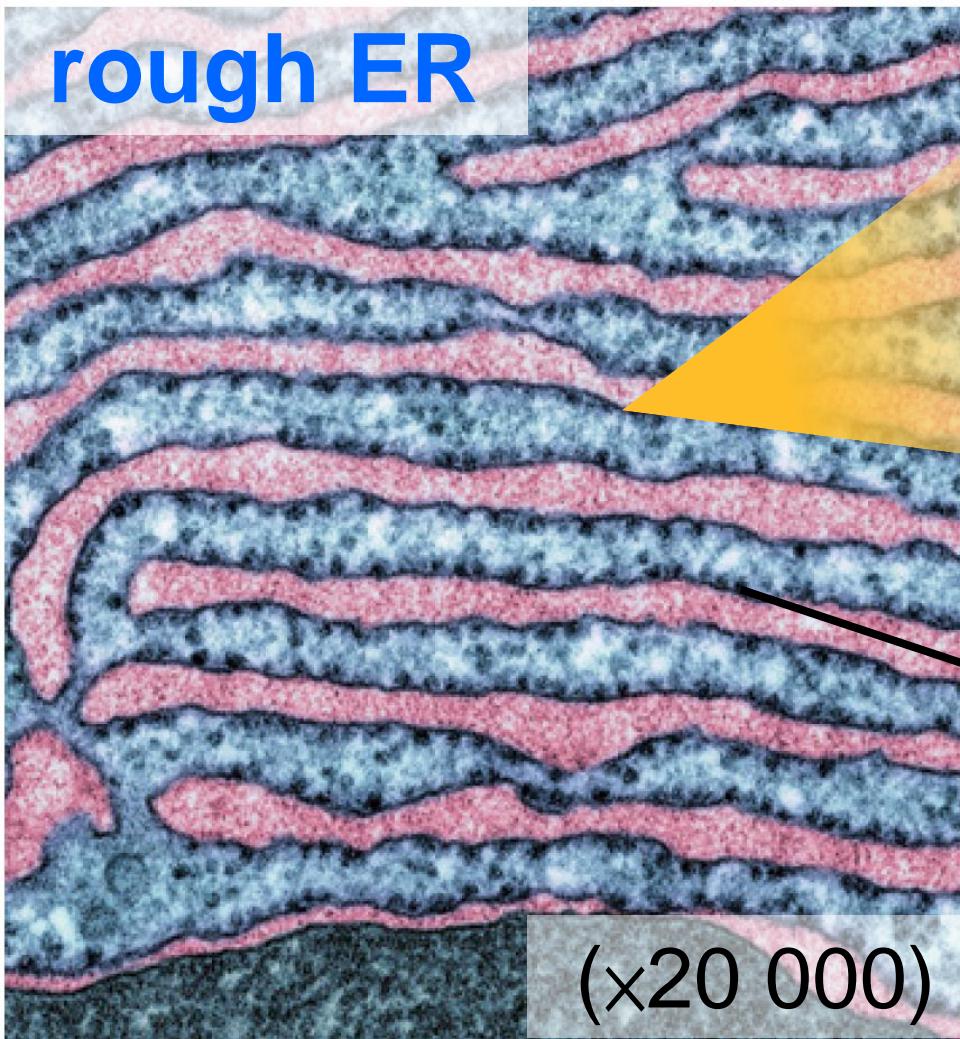
- present in **all plant cells**
- **thick and rigid**
- made up of **cellulose**
- **fully permeable**
- protects, supports and gives shape to the cell

Endoplasmic reticulum (ER)



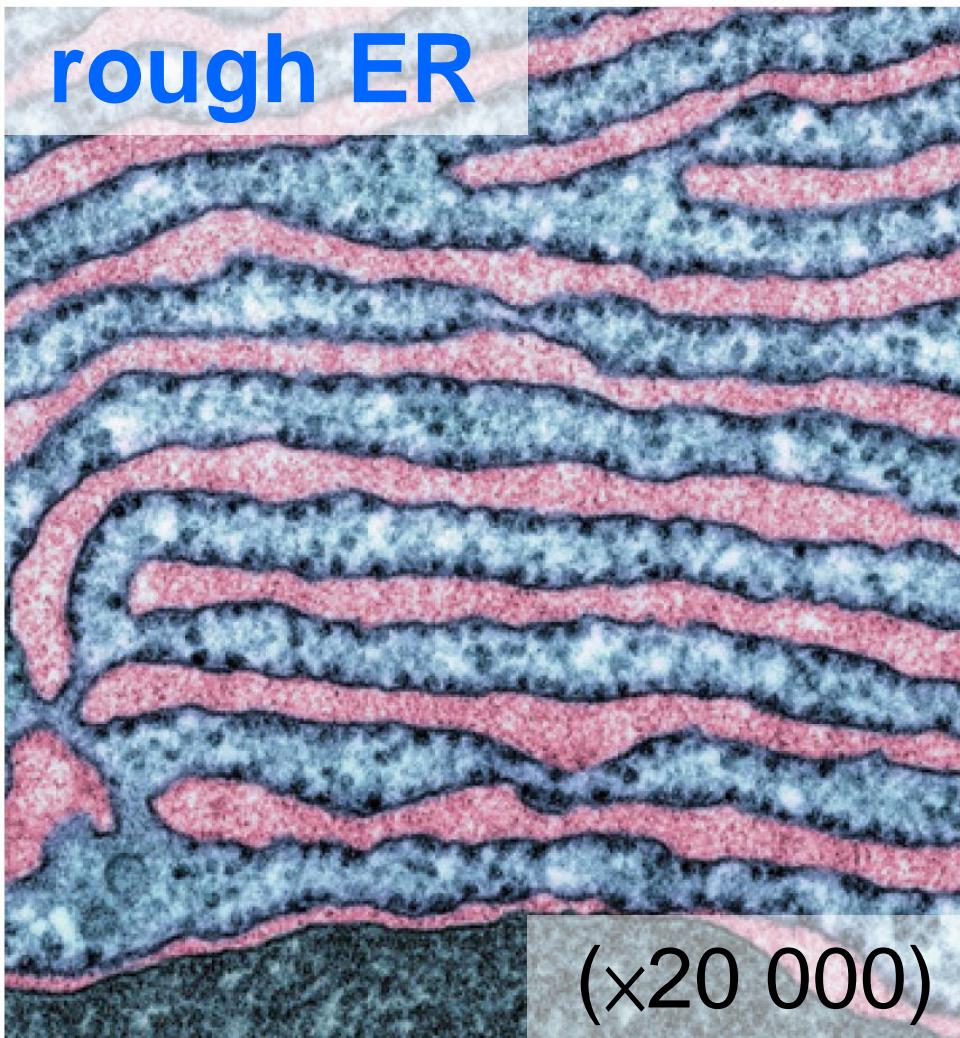
- network of **interconnected membrane-bound sacs**
- continuous with the outer nuclear membrane

Endoplasmic reticulum (ER)



**with ribosomes
attached**

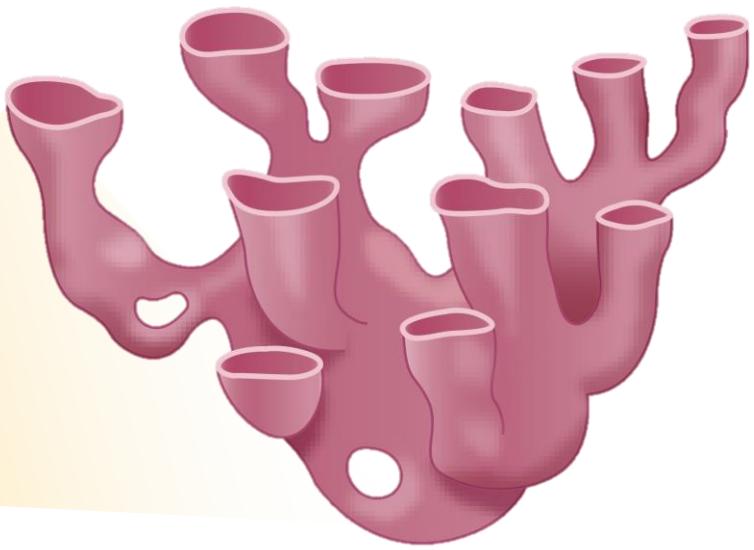
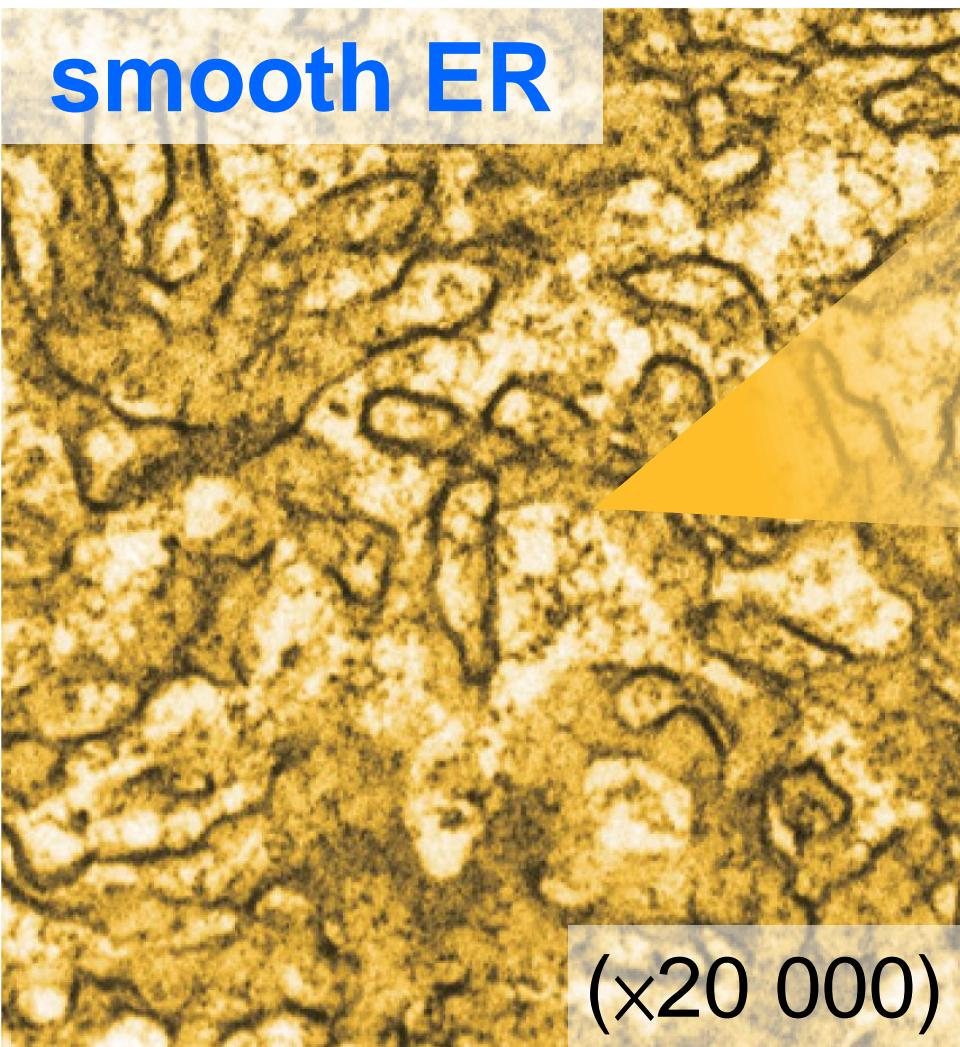
Endoplasmic reticulum (ER)



- site for the **synthesis of proteins**
- abundant in cells that **produce a large amount of proteins**

Endoplasmic reticulum (ER)

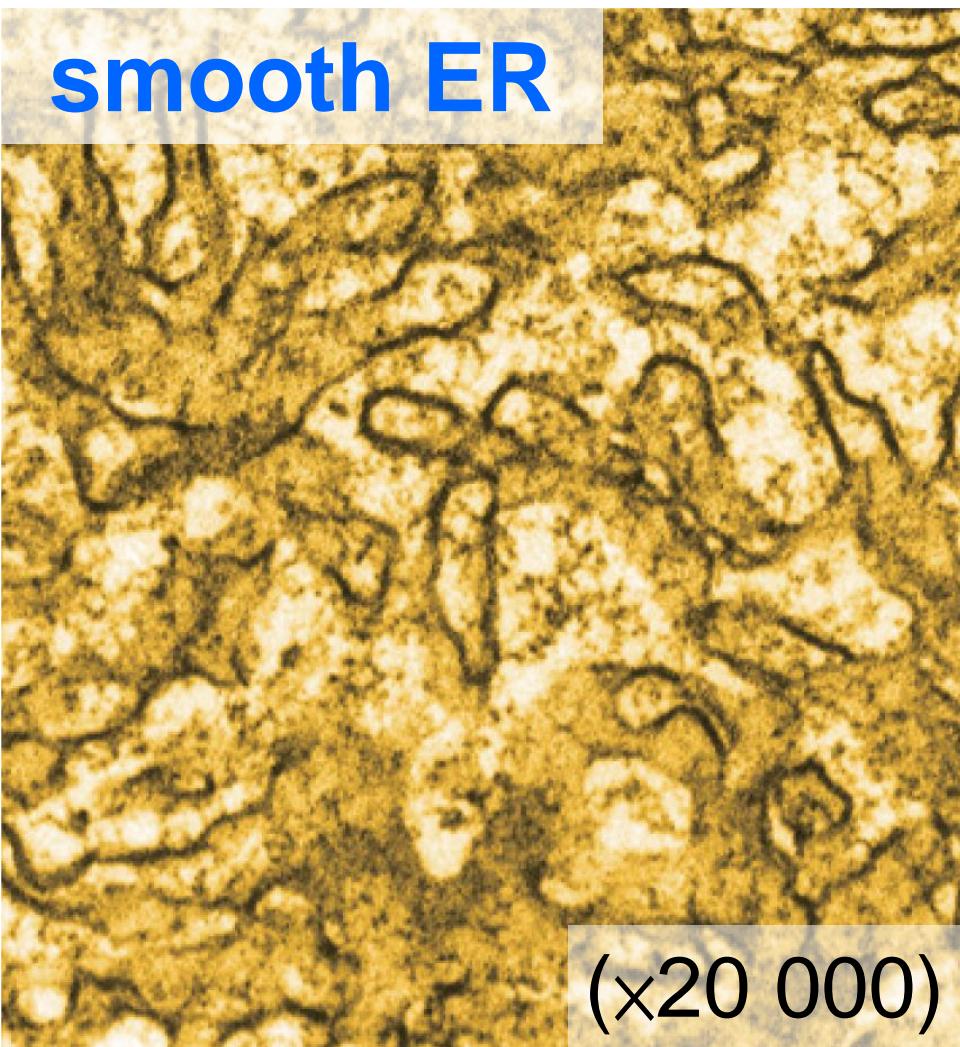
smooth ER



**no ribosomes
attached**

Endoplasmic reticulum (ER)

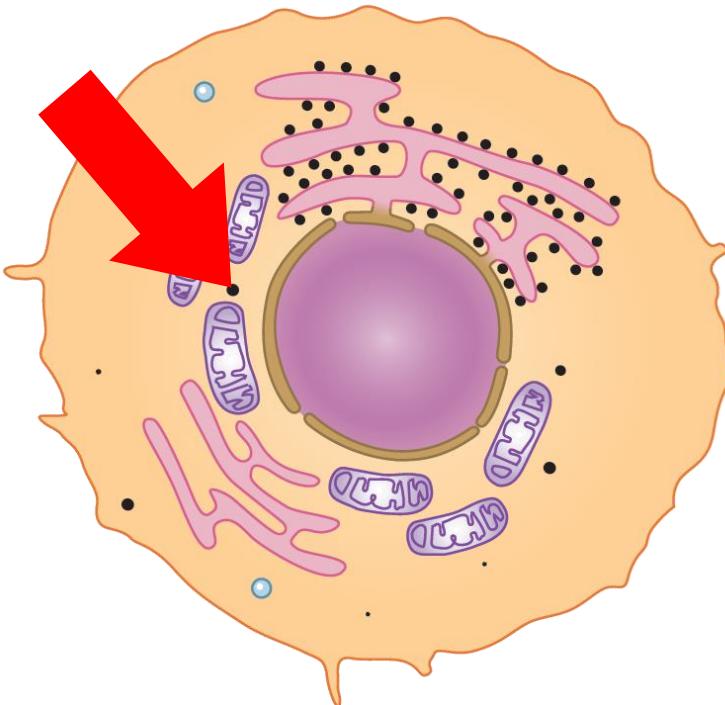
smooth ER



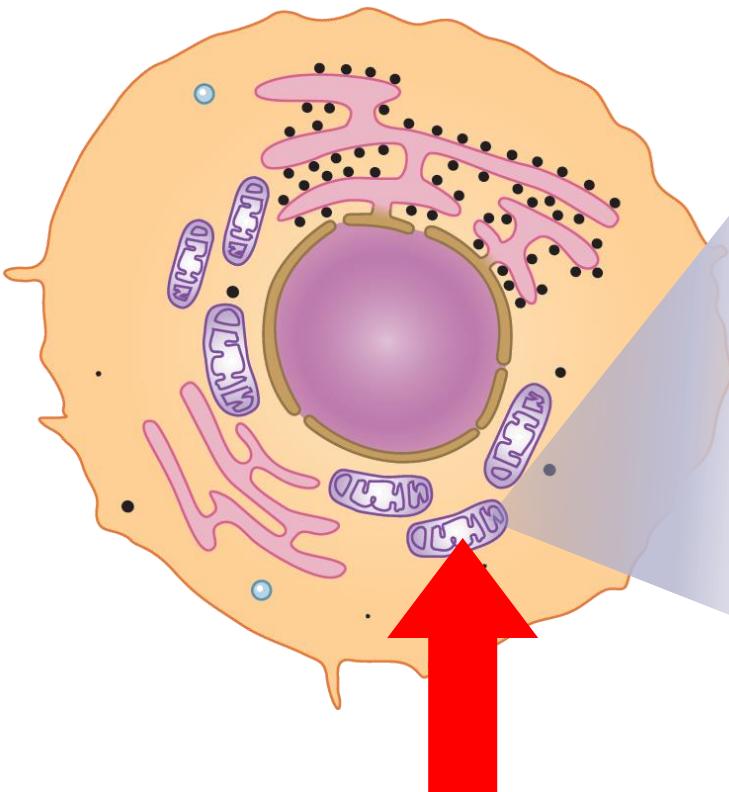
- site for the **synthesis of lipids**
- abundant in cells that **produce a large amount of lipids**

Ribosome

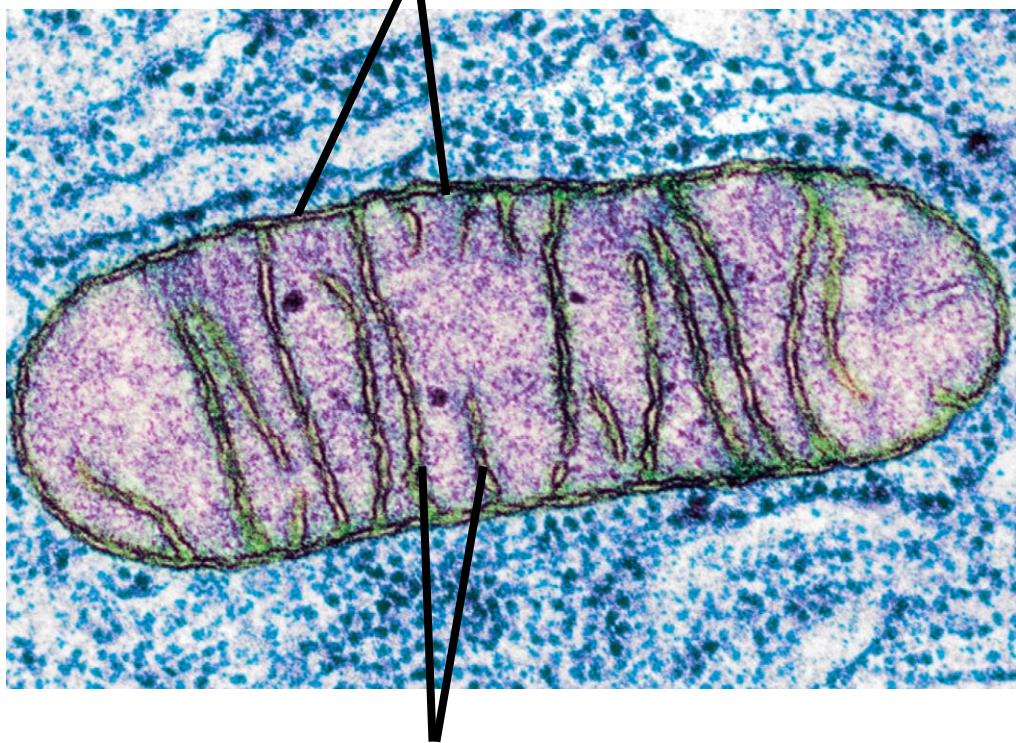
- no membrane
- attached to rough ER or lying free in the cytoplasm
- involved in the **synthesis of proteins**



Mitochondrion

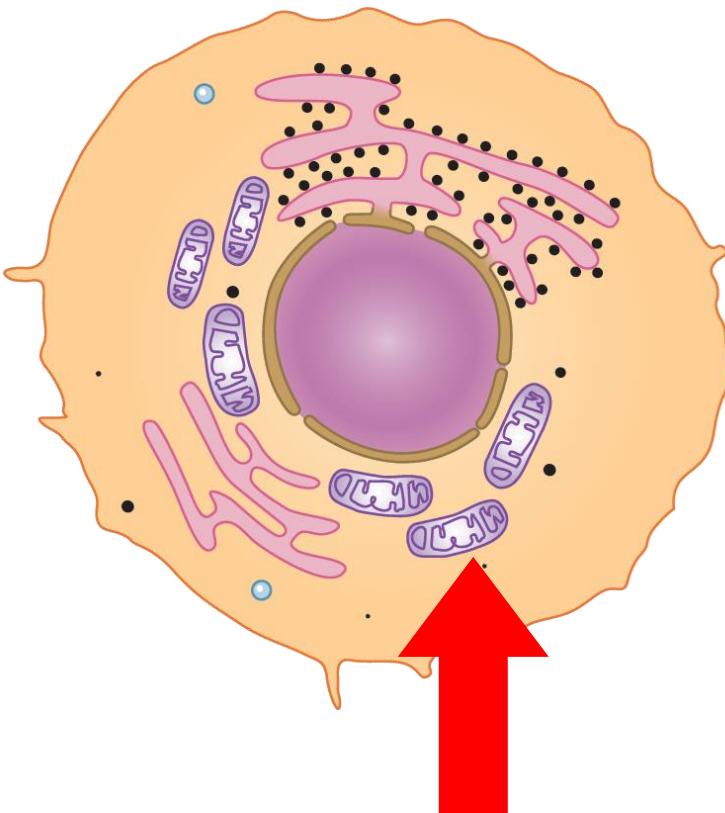


double membrane



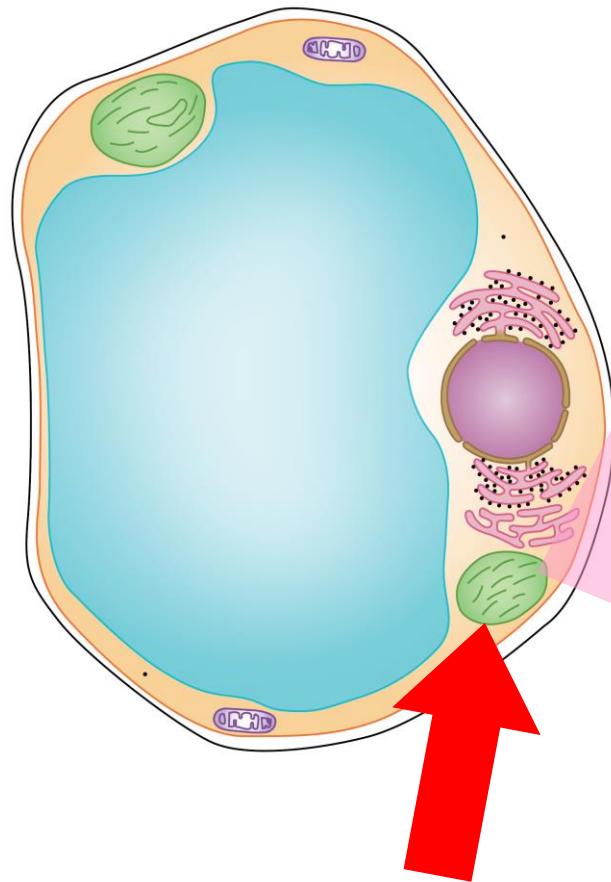
infolding of inner
membrane

Mitochondrion



- main site of **respiration**
- abundant in cells that **use a lot of energy**
(e.g. muscle cells and root hair cells)

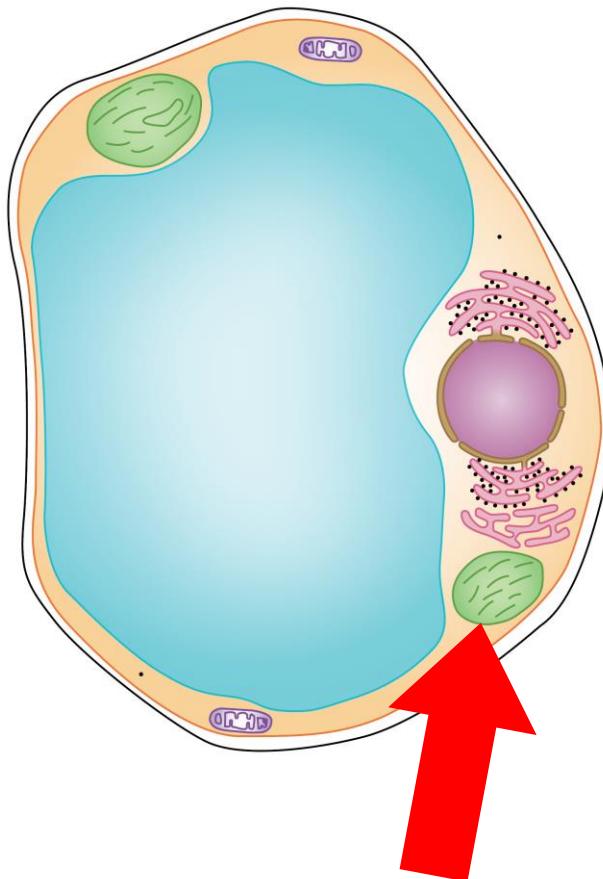
Chloroplast



double membrane

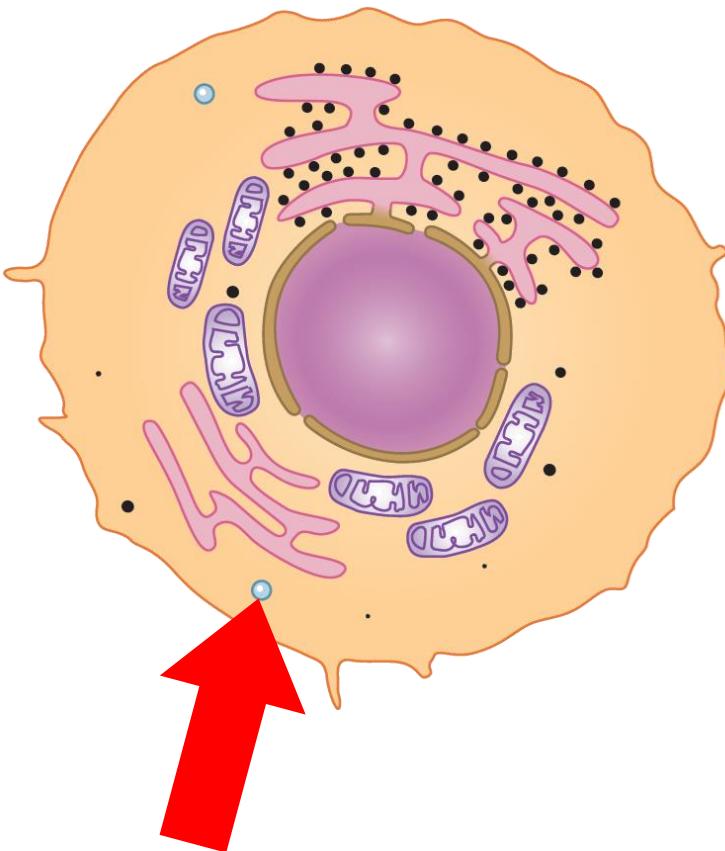


Chloroplast



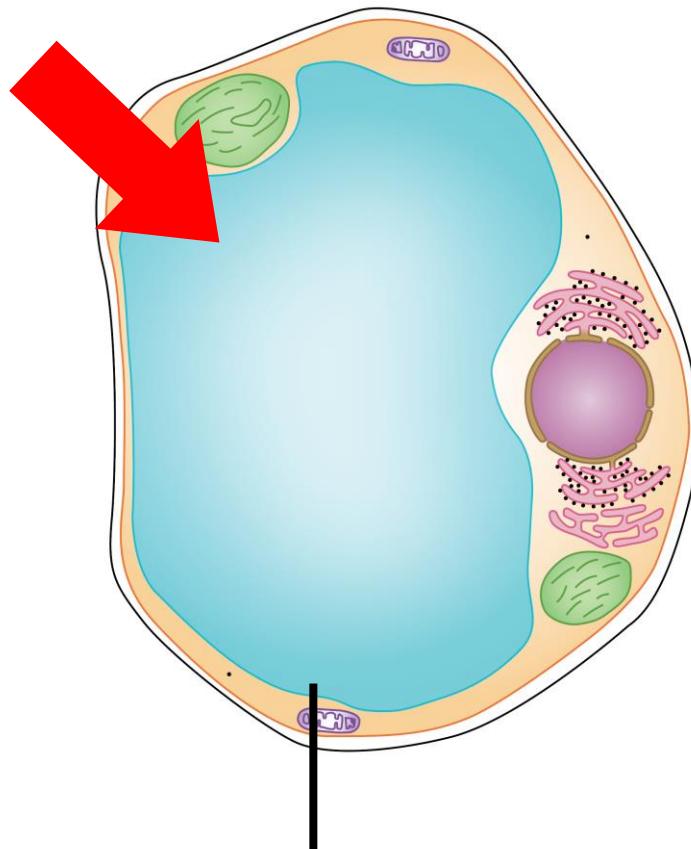
- present in **green plant cells**
- contains **chlorophyll**
- **starch grains** are often present inside

Vacuole



- few and small in animal cells
- fluid-filled sacs bounded by a **single membrane**
- may contain **water, enzymes** and **food**

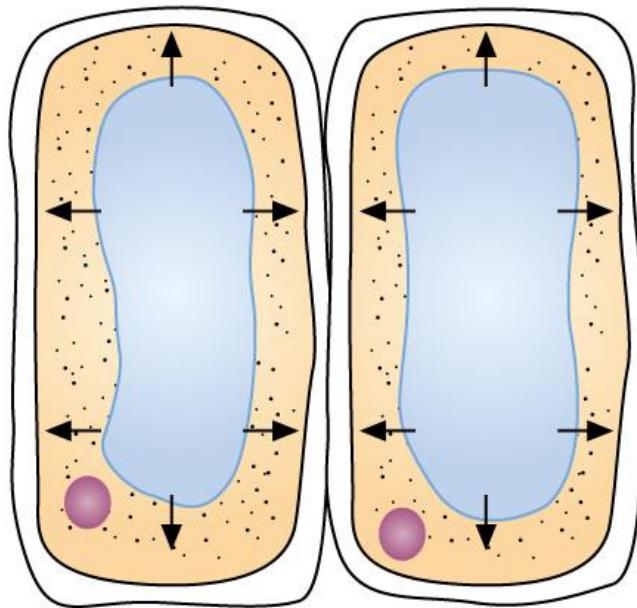
Vacuole



cell sap (細胞液)

- **large central vacuole** in plant cells
- located in the centre
- **cell sap** contains water and dissolved substances

Vacuole



When the large central vacuole is full of water,

- cells become **turgid** and press against one another

→ **provide support** to the plant

Learning through examples

A student is observing a prepared slide of liver tissue using a light microscope. Fig P is a photomicrograph which shows what he is observing. Fig Q is an electron micrograph of part of a liver cell.

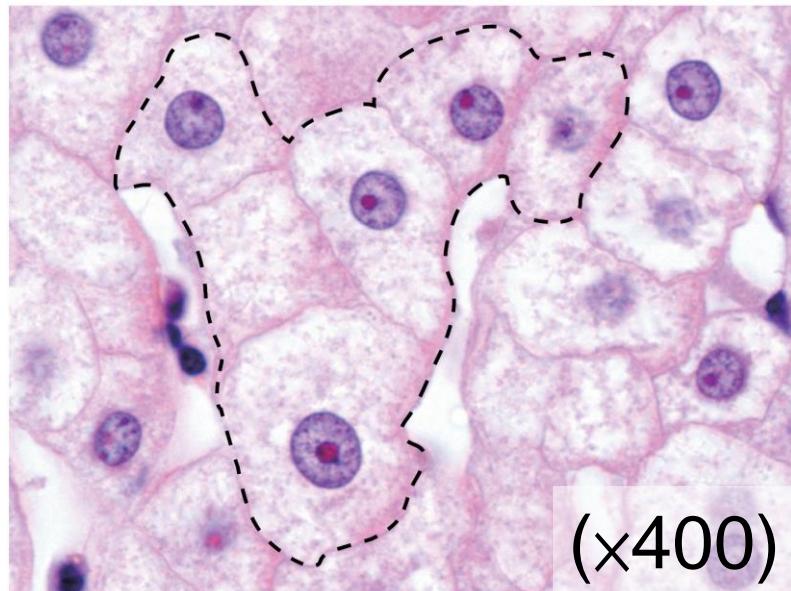


Fig P

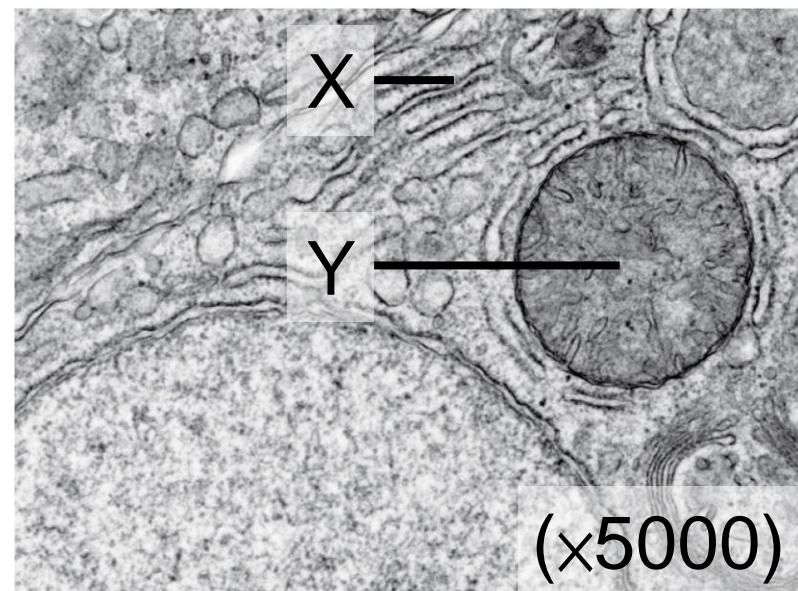


Fig Q

Learning through examples

- a With reference to Fig P below, draw a labelled diagram of the cells enclosed with the dotted line.
(4 marks)

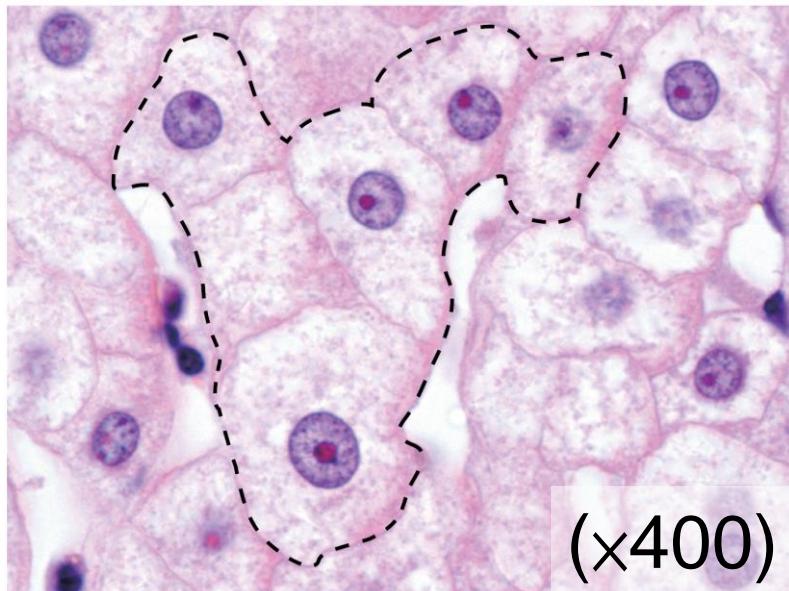


Fig P

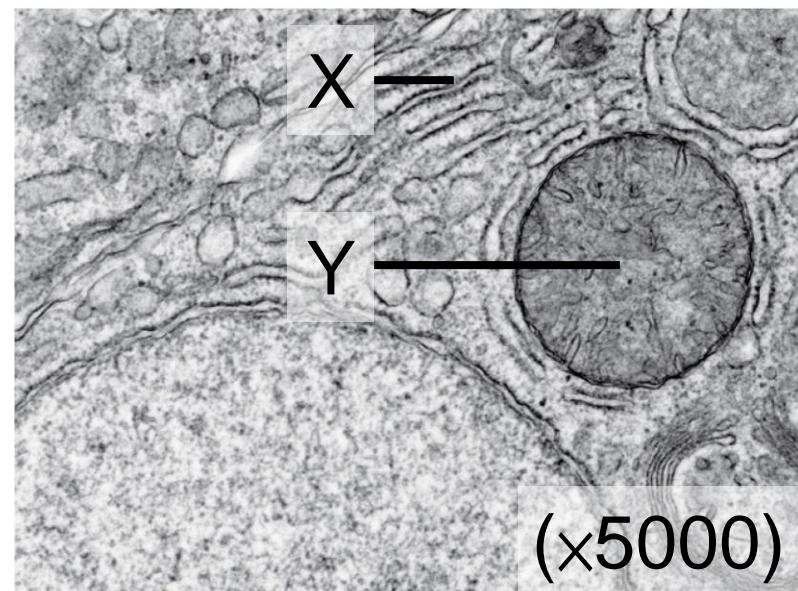
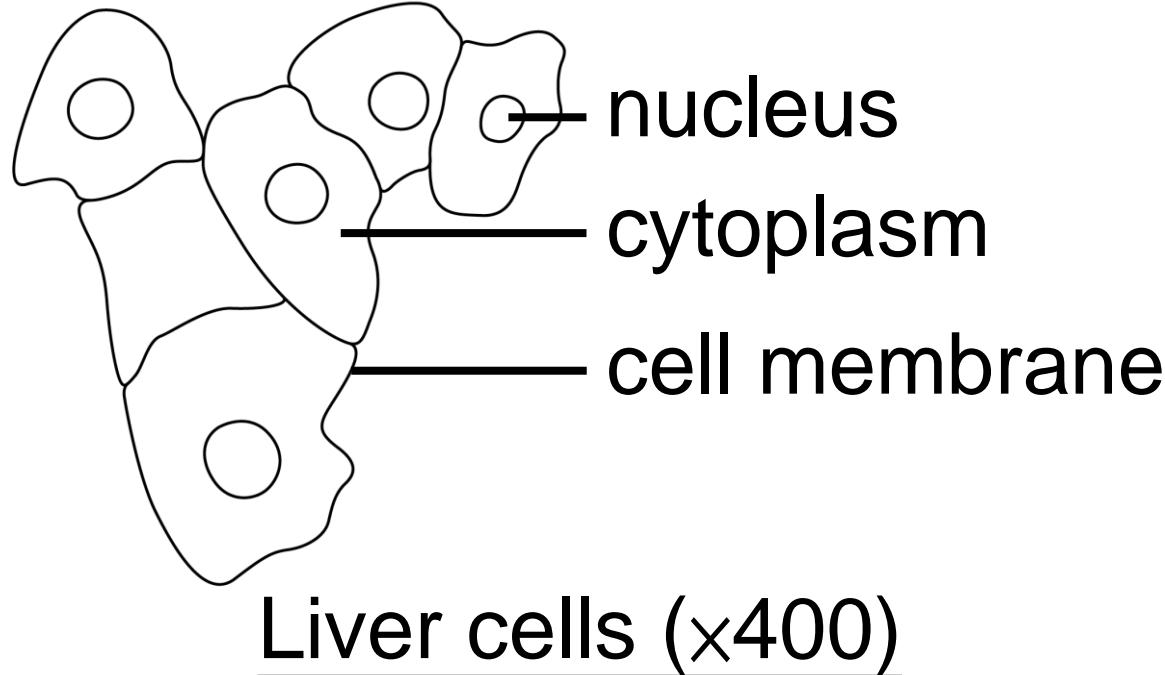


Fig Q

Learning through examples

Suggested answer



a Title (1)

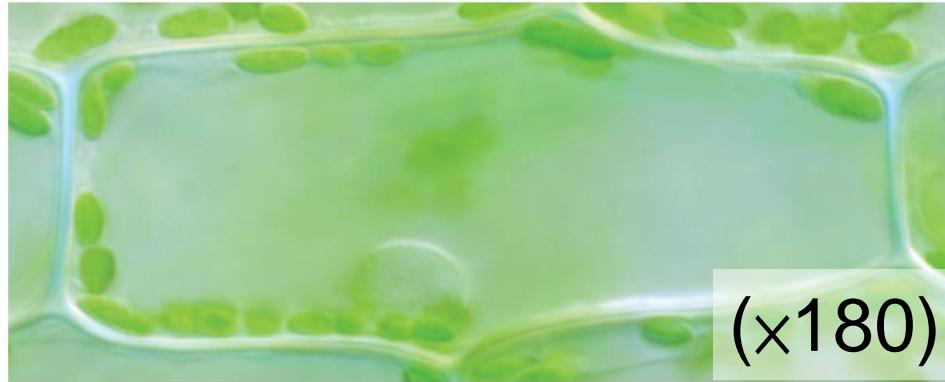
Resemblance of drawing (1)

Labels (any 2) (1) $\times 2$



Drawing high-power biological diagrams

Good biological diagram:

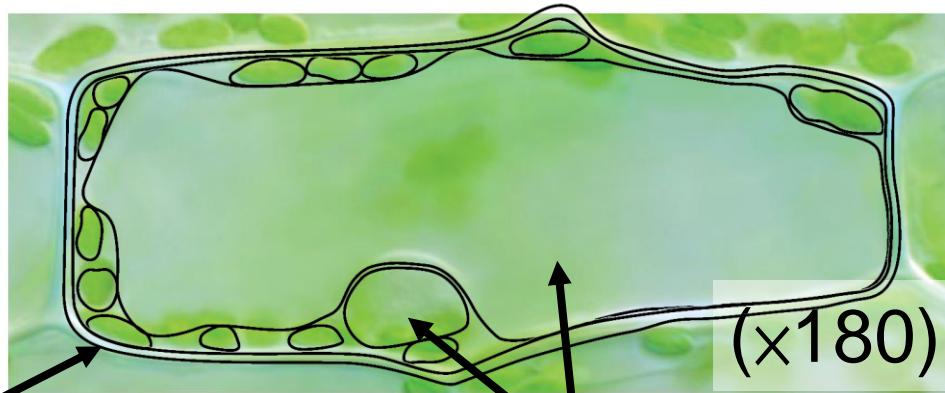


- Use a **sharp HB pencil**.
- Draw **only a few** representative cells.



Drawing high-power biological diagrams

Good biological diagram:



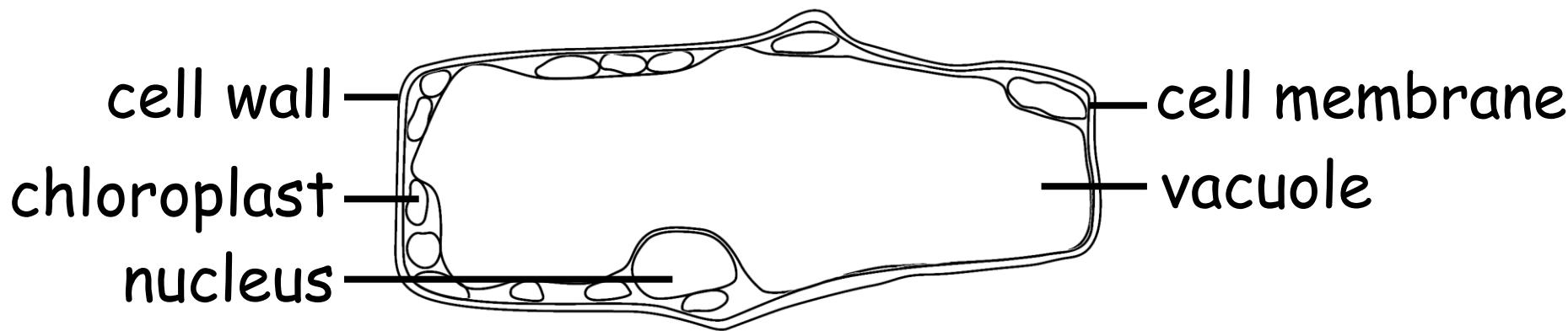
resemble the specimen

structures should be in proportion



Drawing high-power biological diagrams

Good biological diagram:

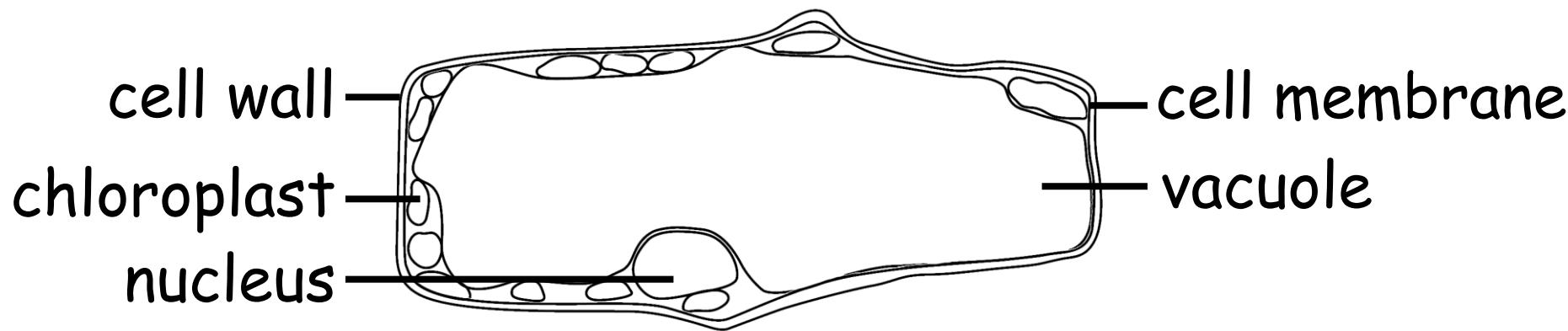


- **Label** relevant structures.



Drawing high-power biological diagrams

Good biological diagram:



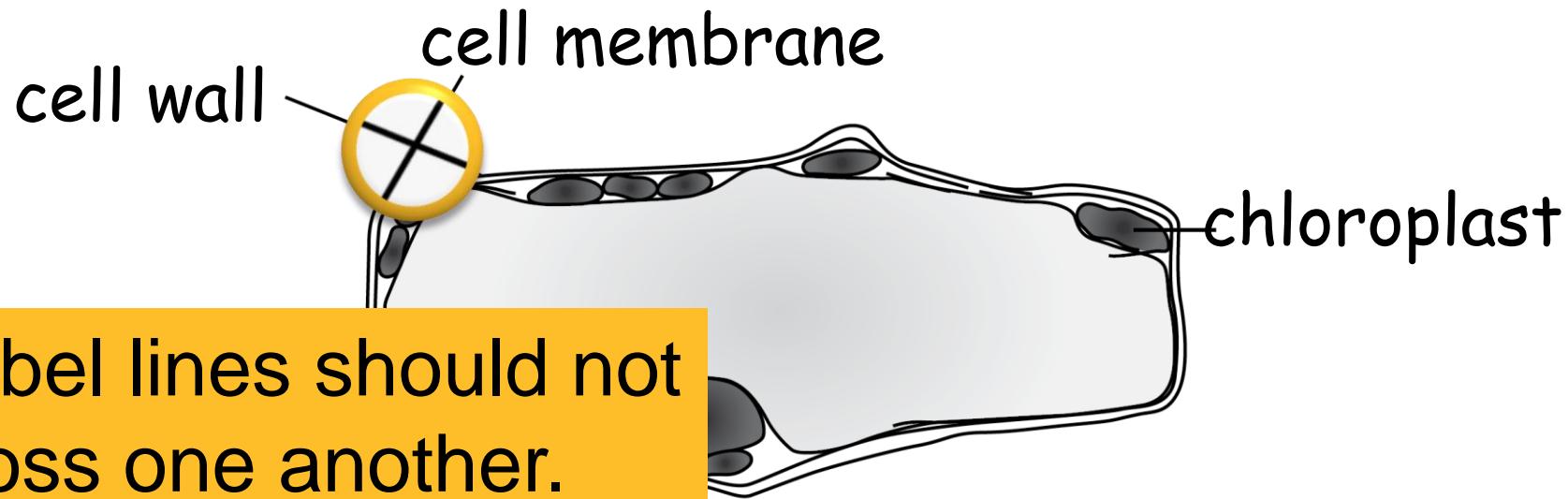
A plant cell (x180)

Give a title and state the magnification



Drawing high-power biological diagrams

Poor biological diagram:

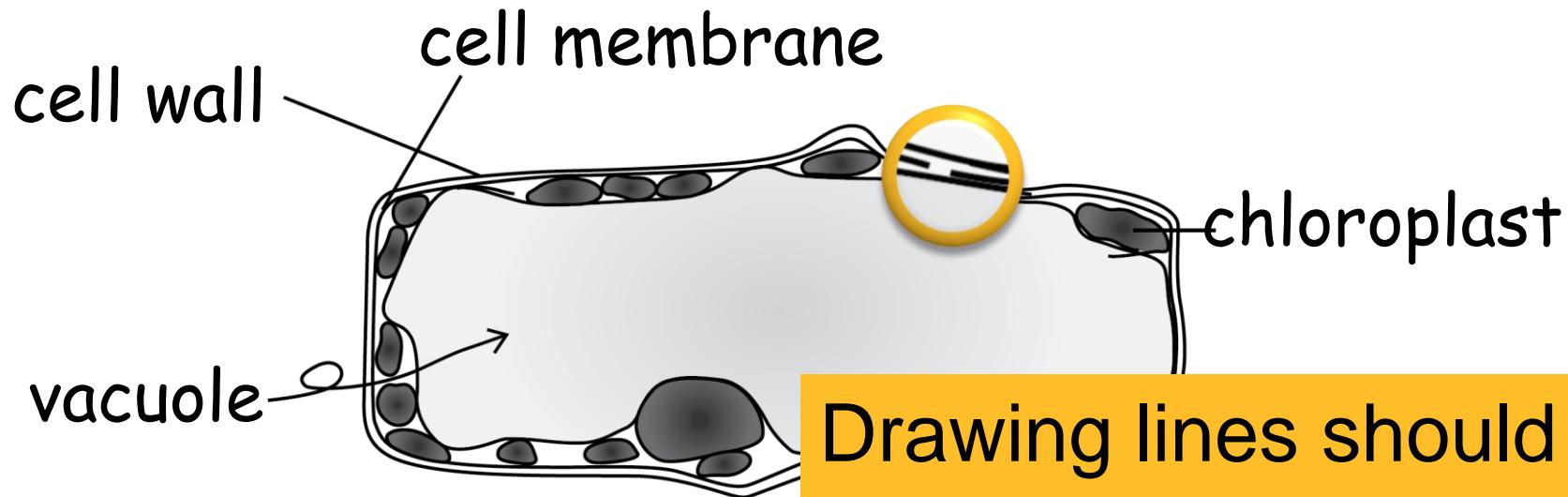


Label lines should not cross one another.



Drawing high-power biological diagrams

Poor biological diagram:

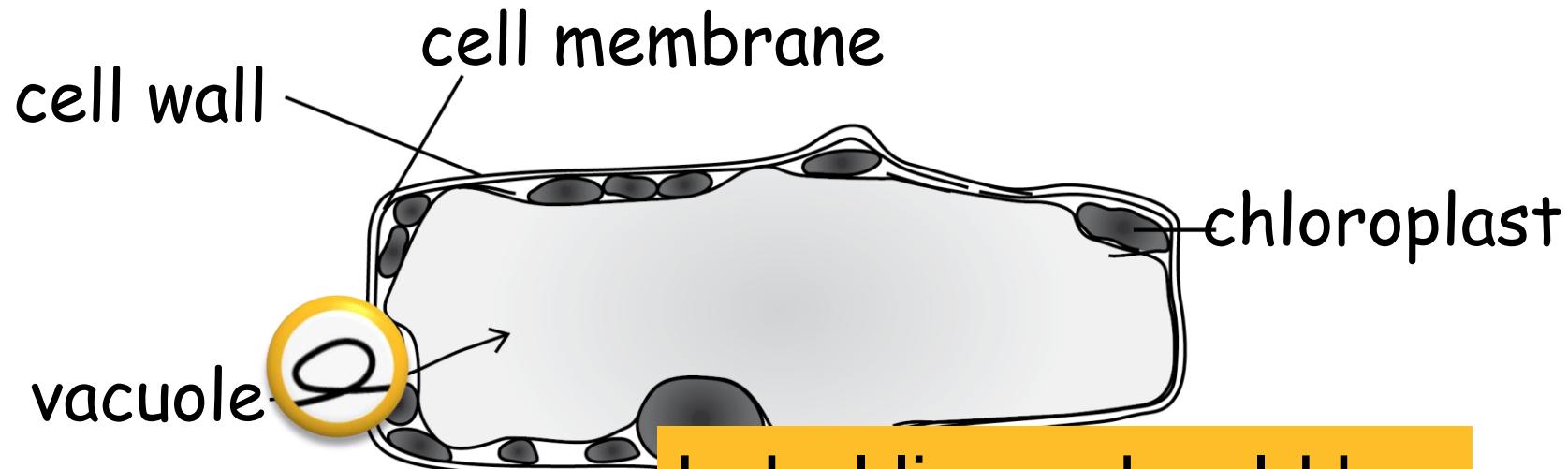


Drawing lines should
be smooth and
continuous.



Drawing high-power biological diagrams

Poor biological diagram:

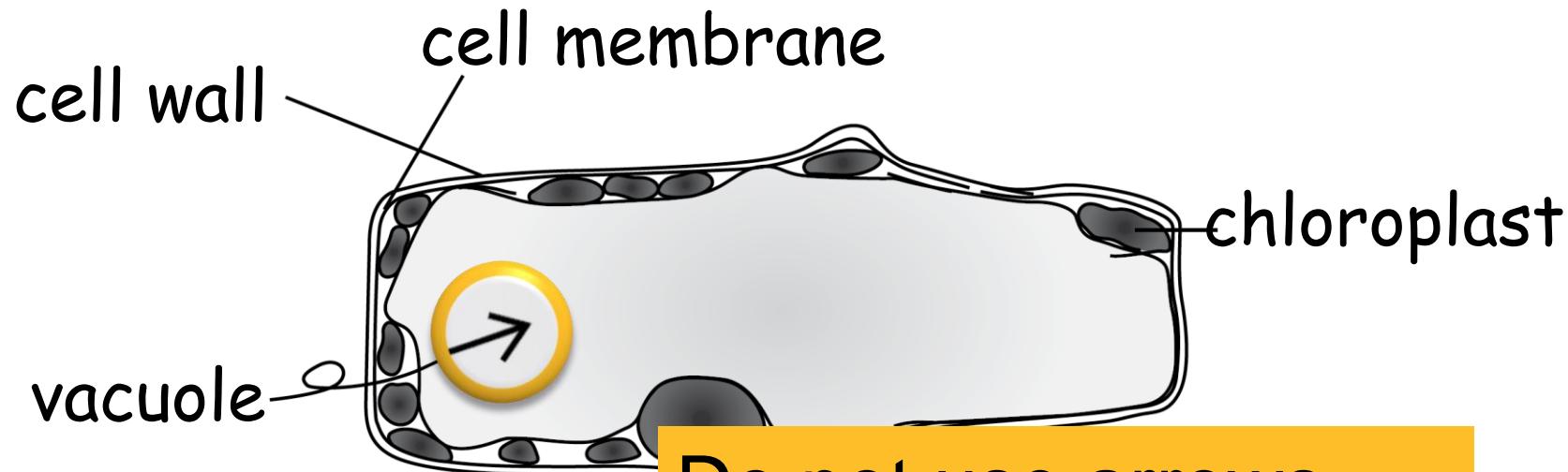


Label lines should be straight.



Drawing high-power biological diagrams

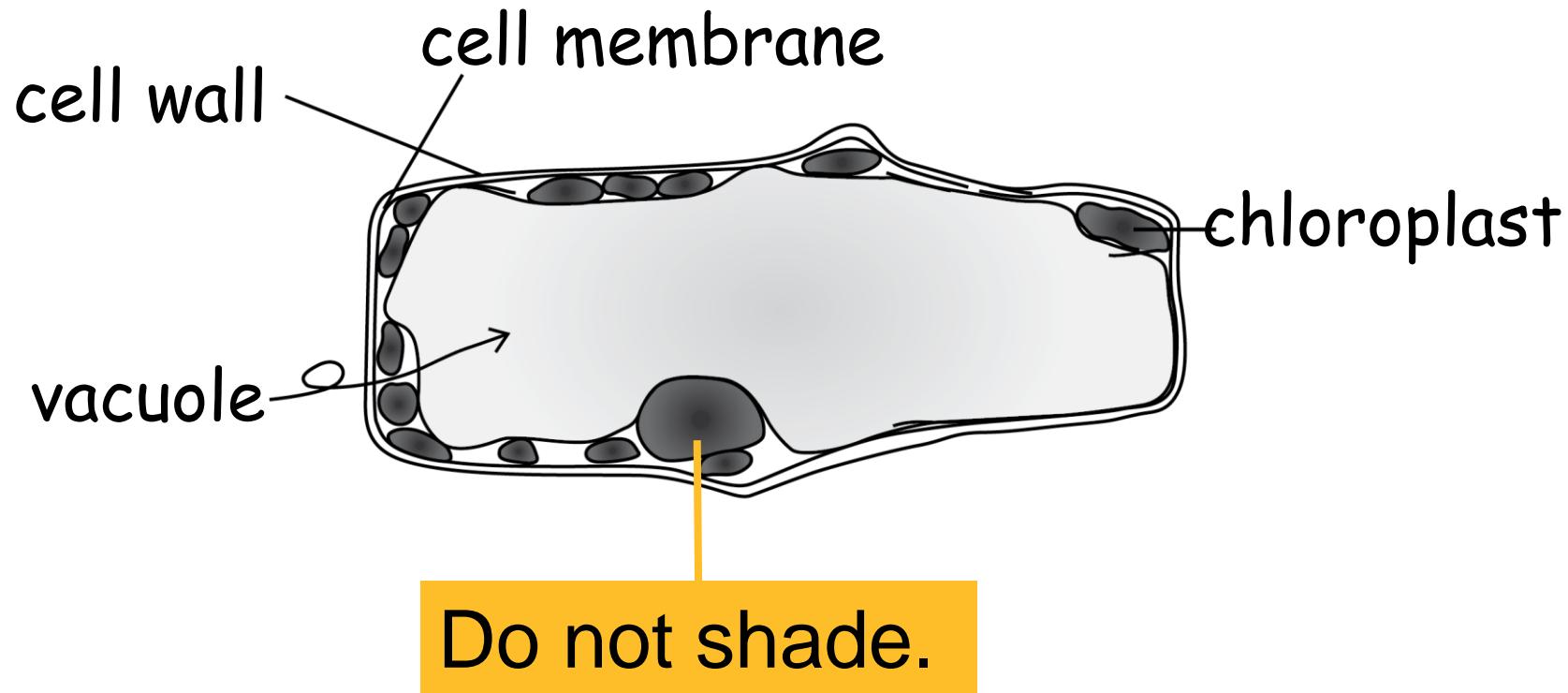
Poor biological diagram:





Drawing high-power biological diagrams

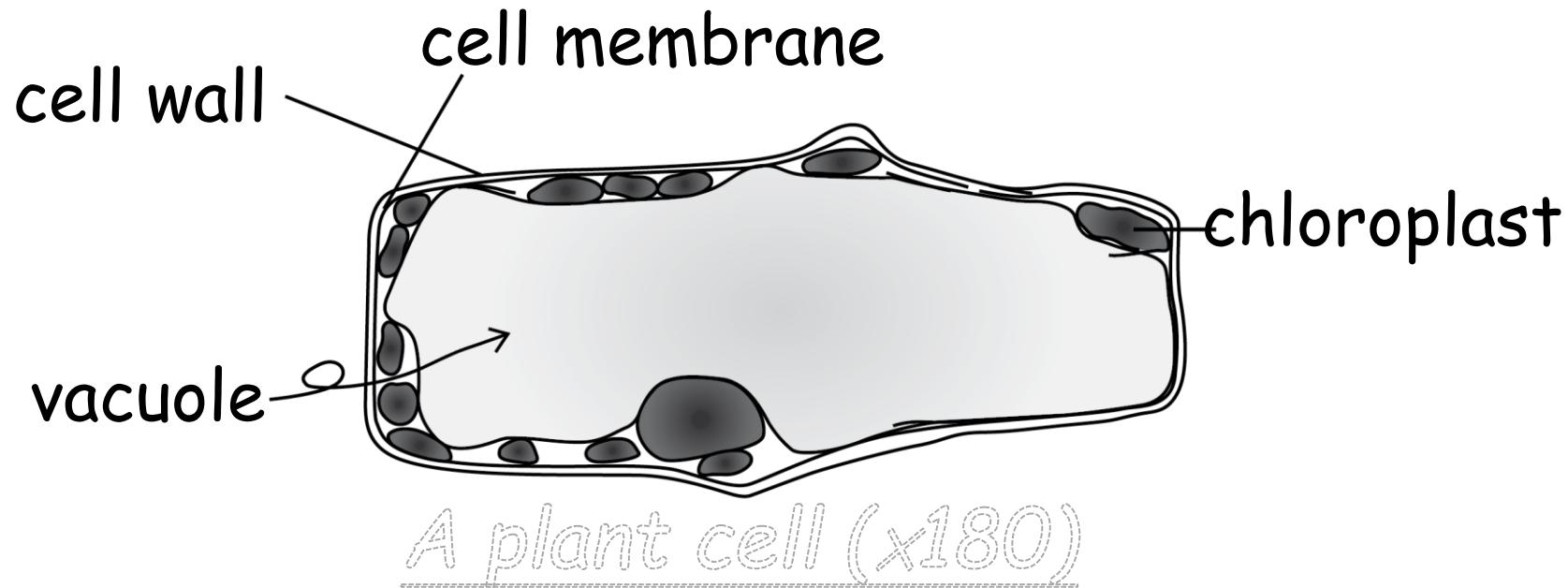
Poor biological diagram:





Drawing high-power biological diagrams

Poor biological diagram:



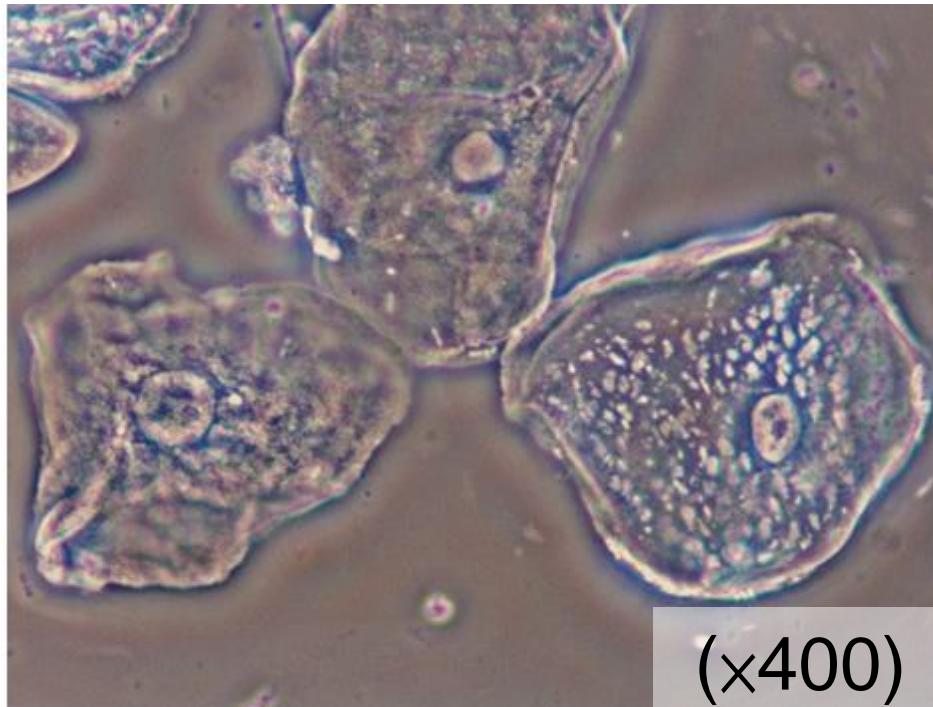
Title and magnification are missing.

Skill practice

Draw a labelled biological diagram of the cells in each of the photomicrographs below.

a Human cheek cells

(4 marks)

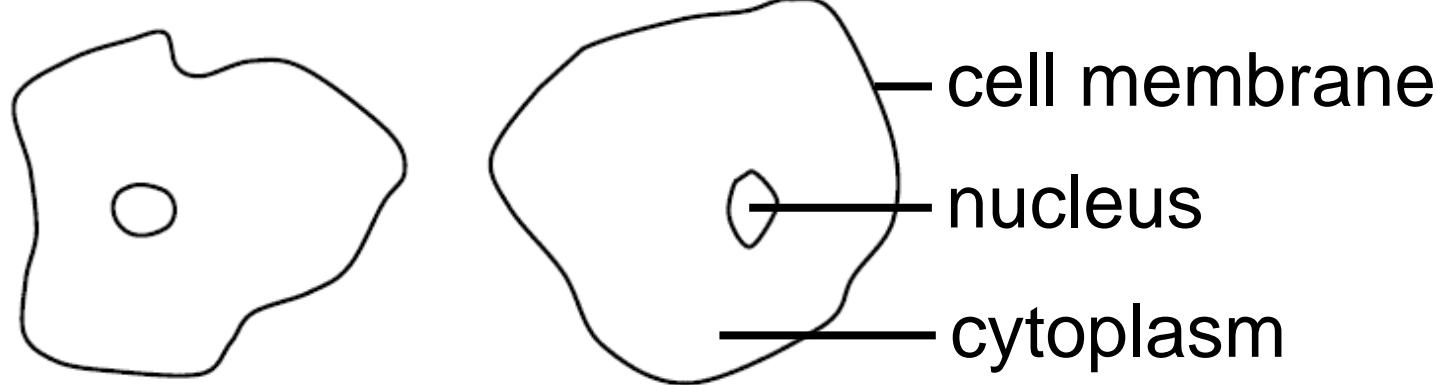


Skill practice

Draw a labelled biological diagram of the cells in each of the photomicrographs below.

a Human cheek cells

(4 marks)



Human cheek cells (x400)

Title (1)

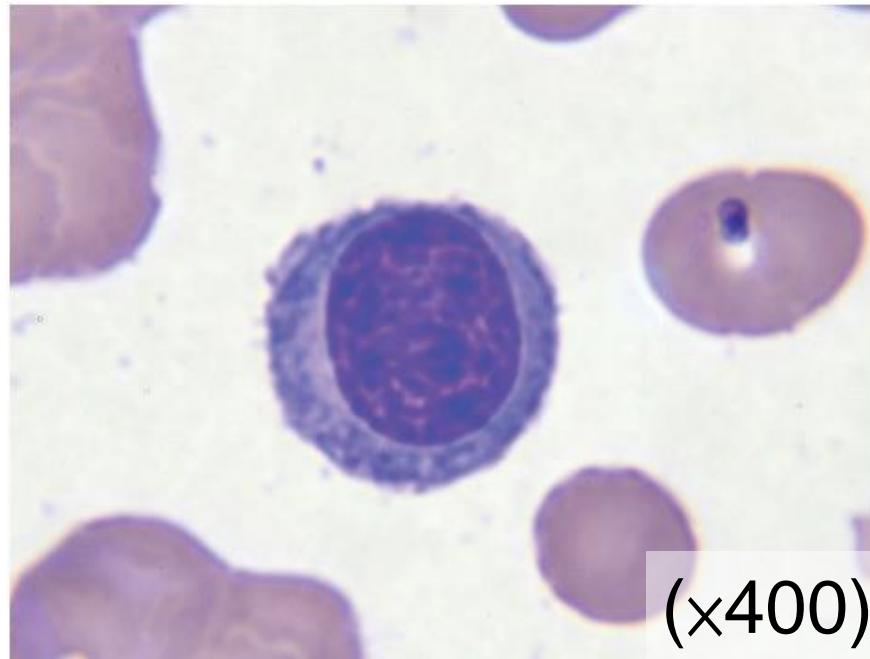
Resemblance of drawing (1)

Labels (any 2) (1)

Skill practice

Draw a labelled biological diagram of the cells in each of the photomicrographs below.

b Human white blood cell (4 marks)

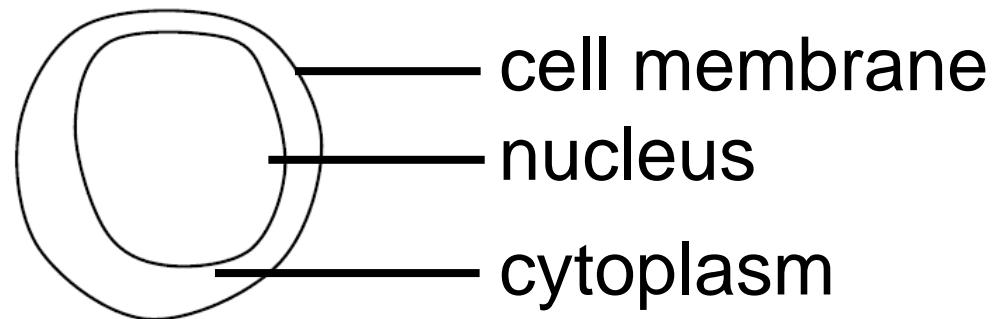


Skill practice

Draw a labelled biological diagram of the cells in each of the photomicrographs below.

b Human white blood cell (4 marks)

Title (1)
Resemblance of
drawing (1)
Labels (any 2) (1)

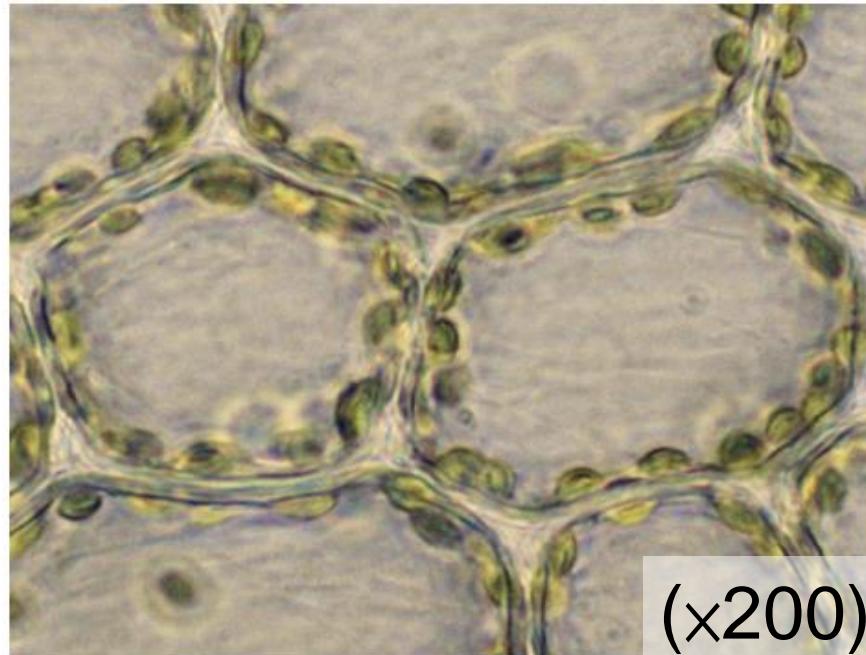


Human white blood cell
($\times 400$)

Skill practice

Draw a labelled biological diagram of the cells in each of the photomicrographs below.

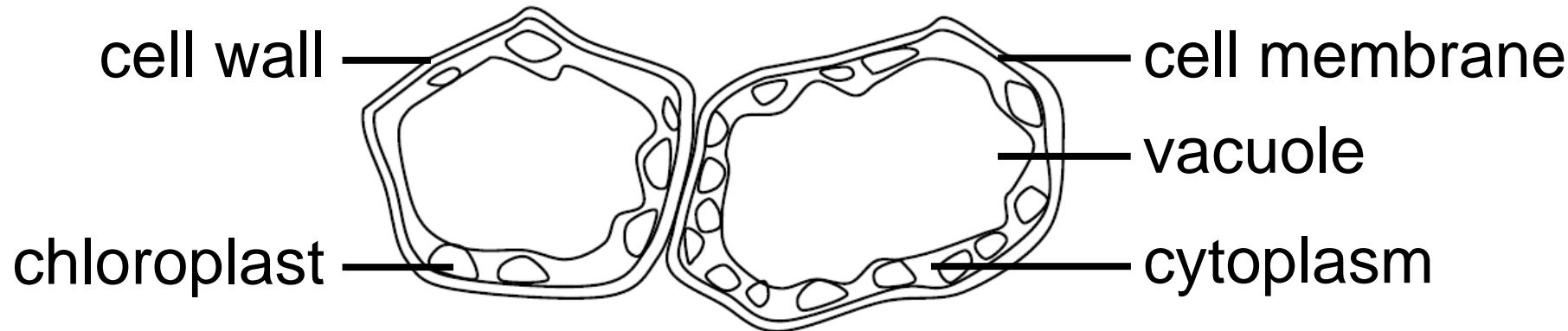
c Leaf cells (4 marks)



Skill practice

Draw a labelled biological diagram of the cells in each of the photomicrographs below.

c Leaf cells (4 marks)



Leaf cells (x200)

Title (1)

Resemblance of drawing (1)

Labels (any 2) (1)

Learning through examples

b Name organelles X and Y shown in Fig Q.
(2 marks)

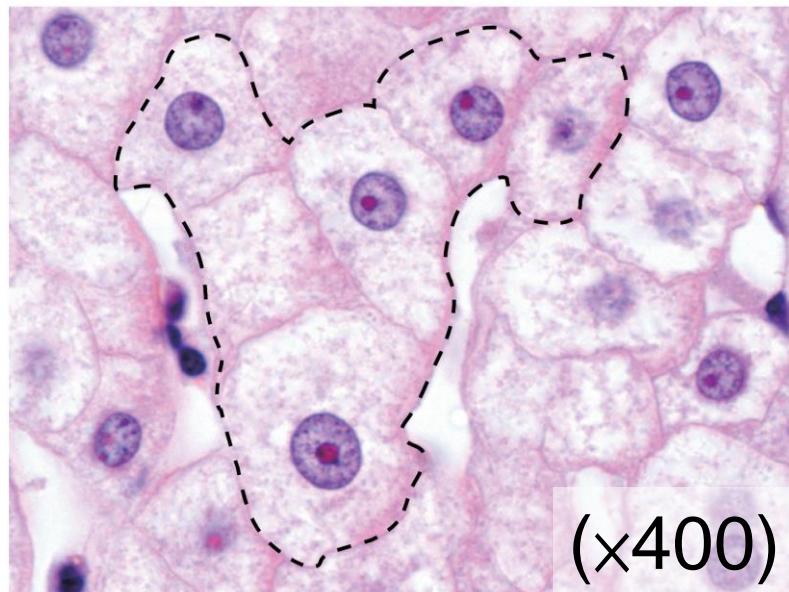


Fig P

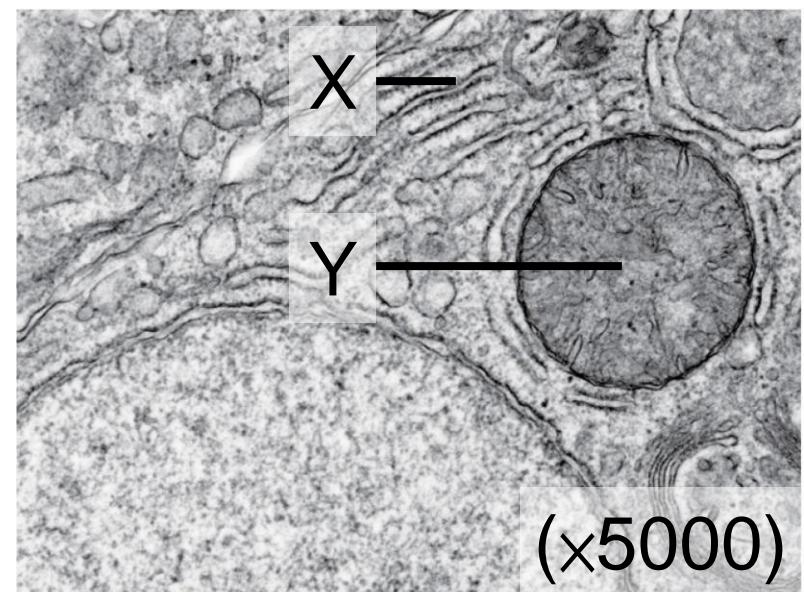


Fig Q

Suggested answer

b X: rough endoplasmic reticulum (1)

Y: mitochondrion (1)

Learning through examples

- c The liver carries out many chemical reactions. To regulate these reactions, liver cells produce many enzymes. Describe how organelles X and Y shown in Fig Q work together so that liver cells can perform their functions. (2 marks)

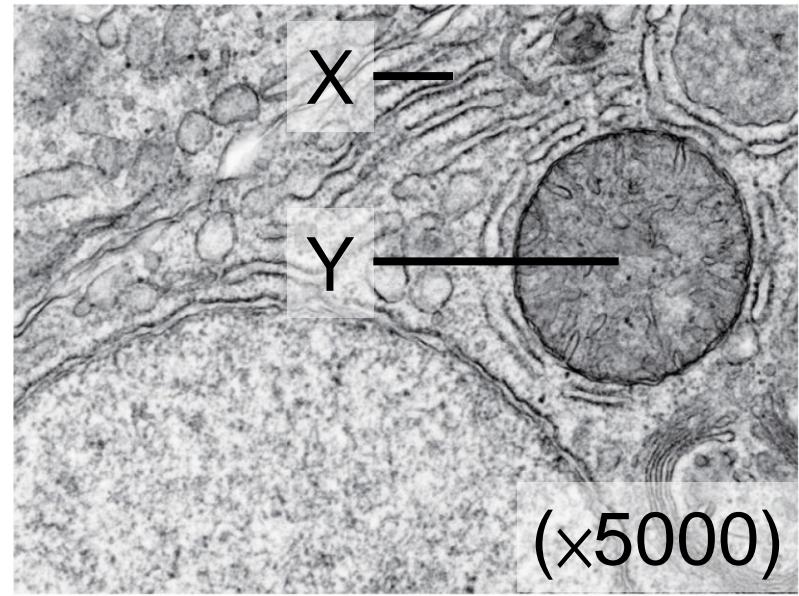


Fig Q

Suggested answer

c X is the site for synthesis of enzymes, which regulate the reactions. (1)

Y provides energy for synthesis of enzymes / for the chemical reactions to occur. (1)



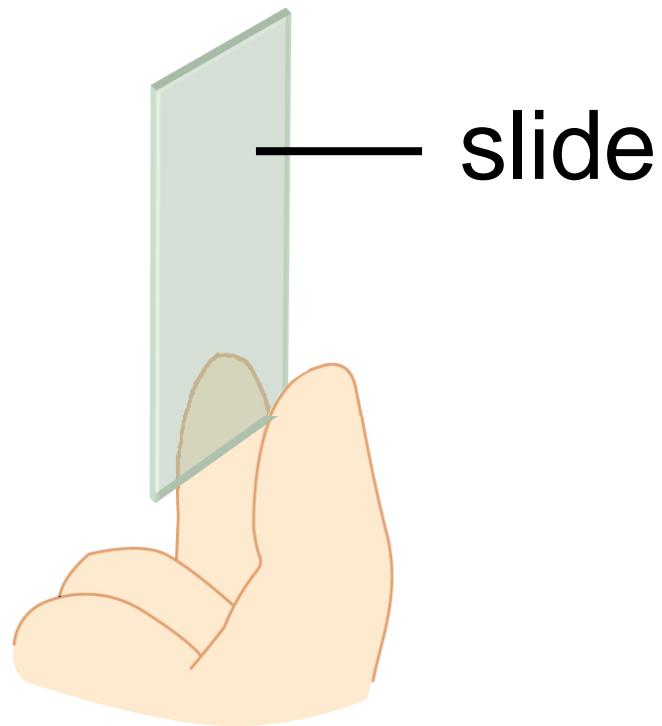
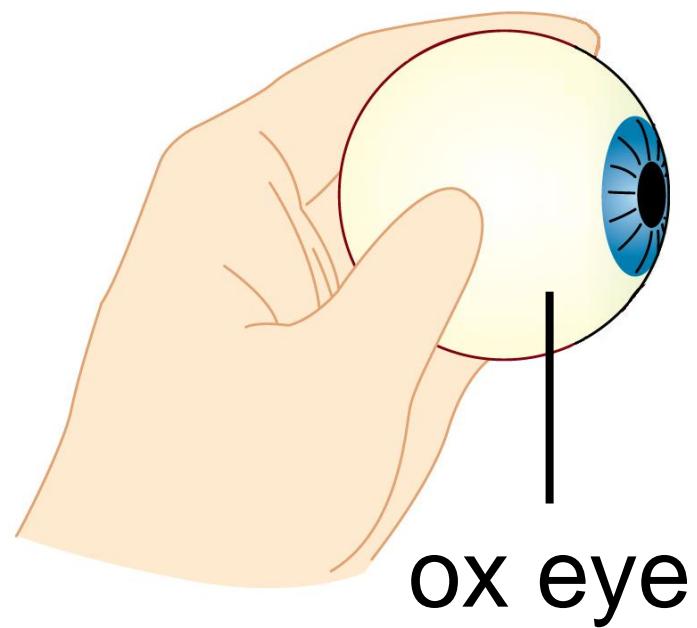
Practical 2.2

Practical 2.2

Preparation of temporary mounts and observation of animal cells

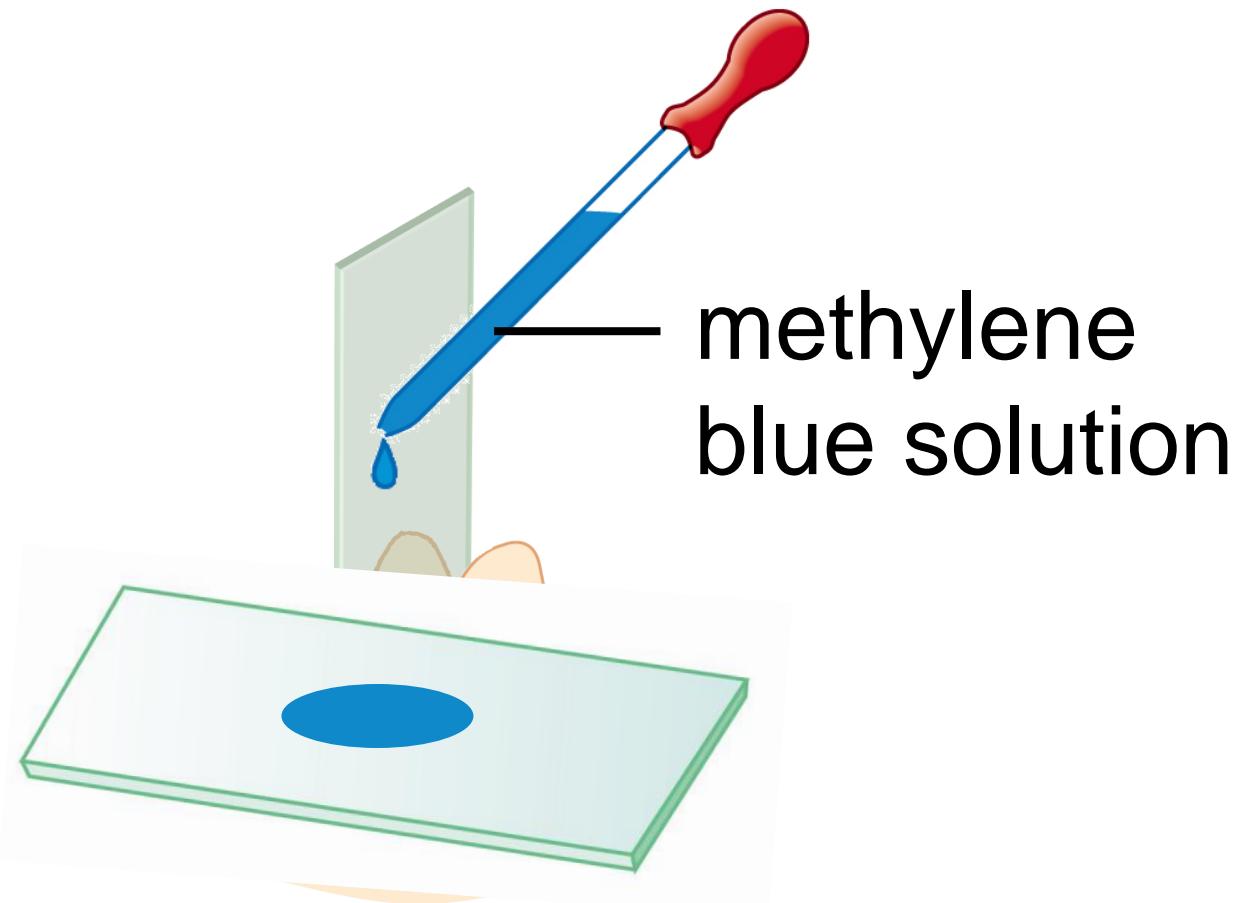
Procedure

1



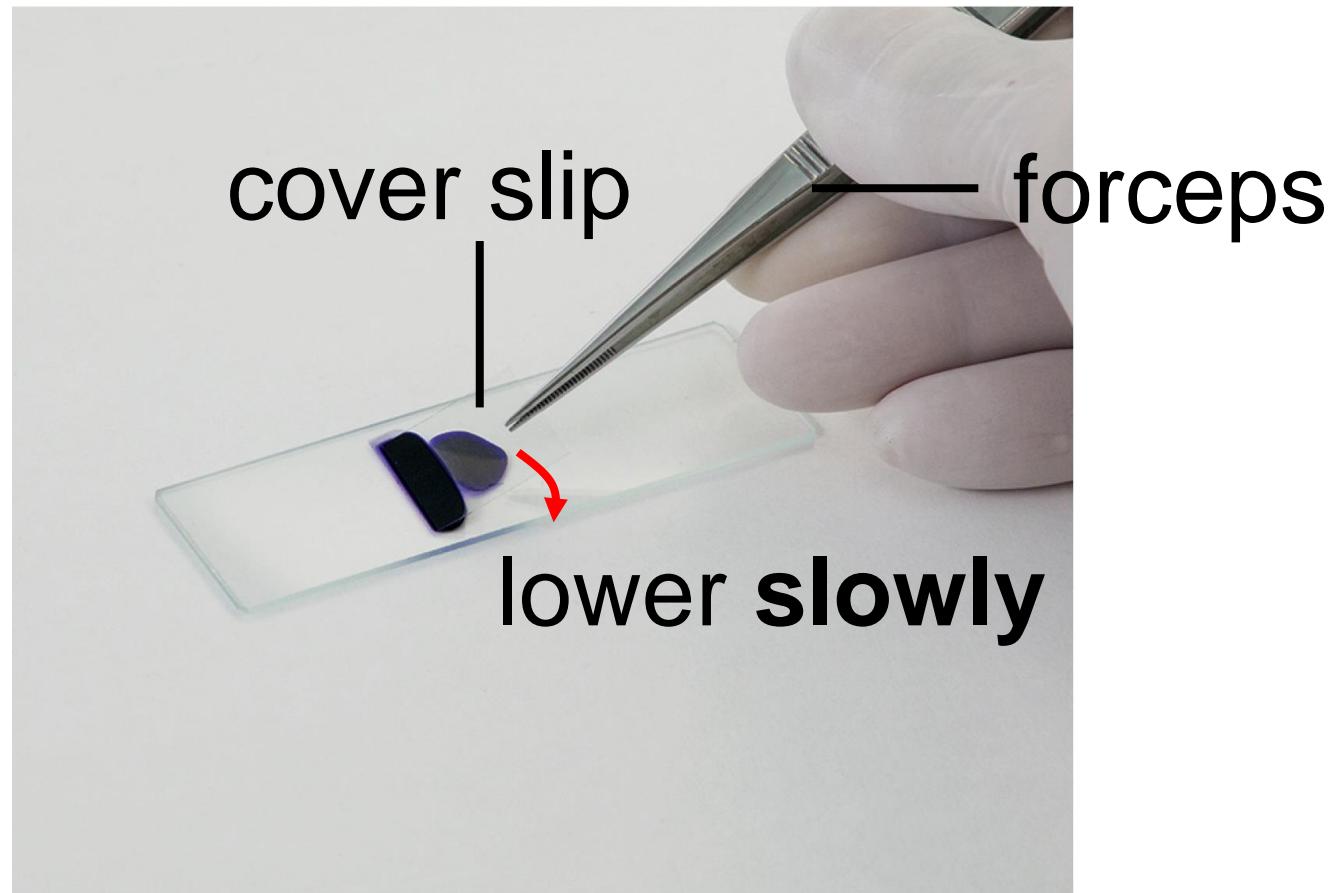
Practical 2.2

2



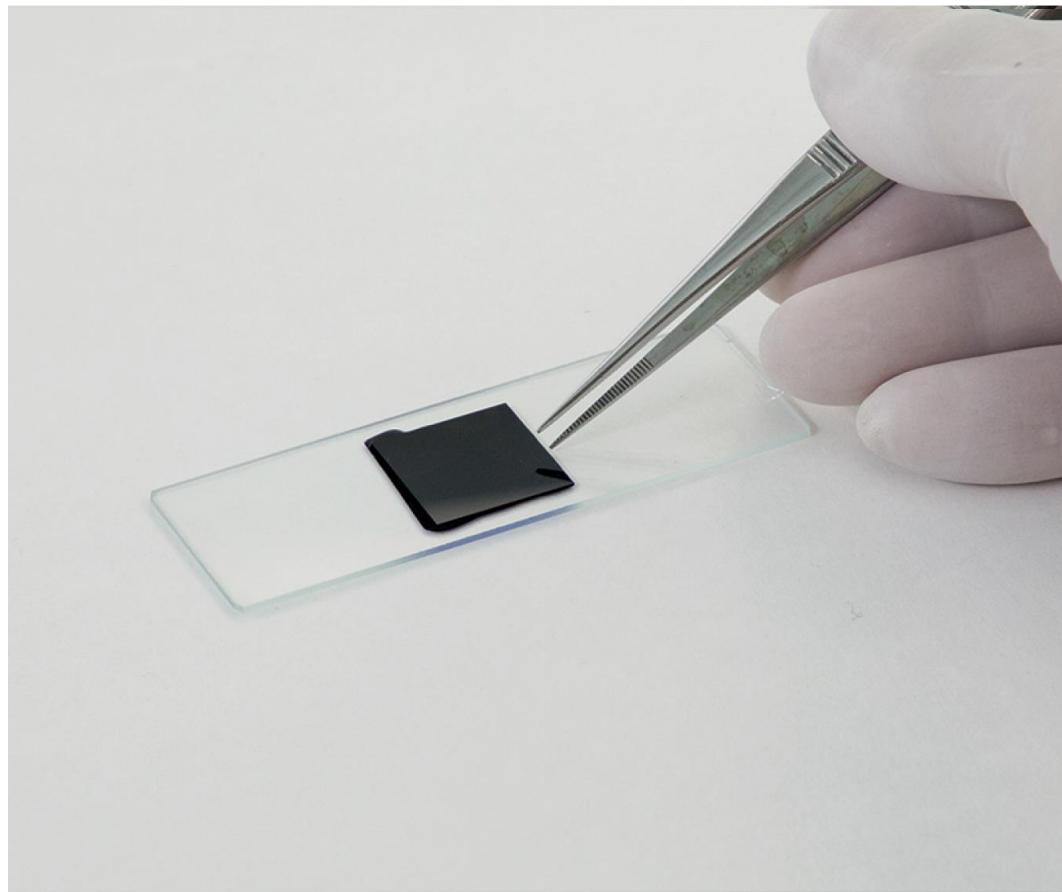
Practical 2.2

3



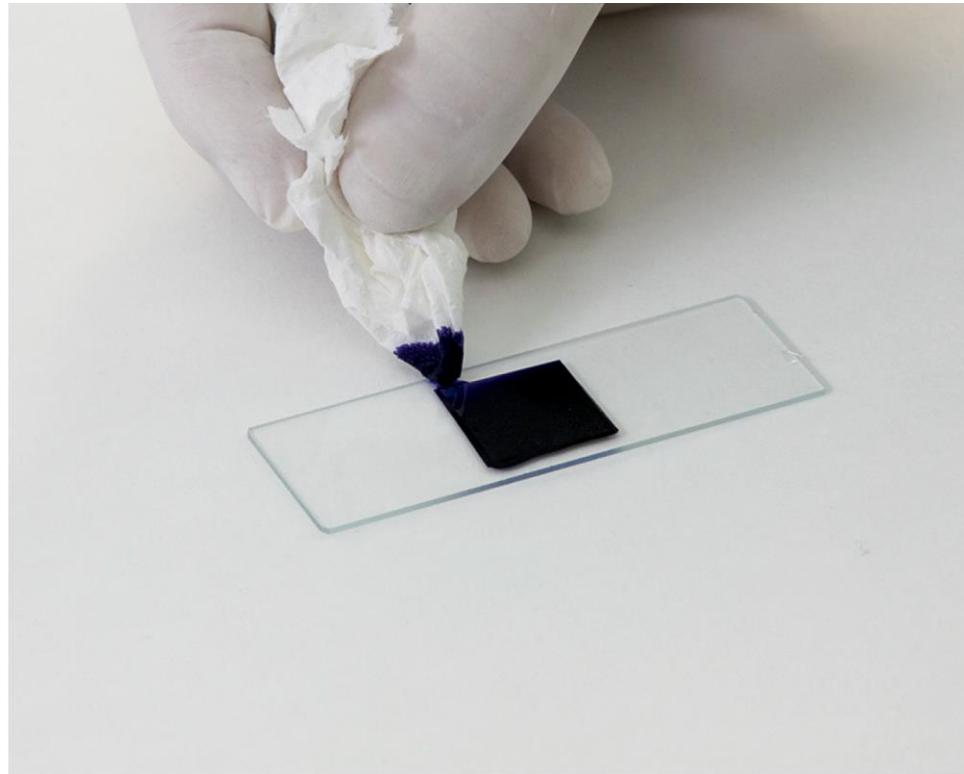
Practical 2.2

3 Make sure no air bubbles are trapped.



Practical 2.2

- 3 Use tissue paper to soak up any excess methylene blue solution.



Practical 2.2

4 Observe cells with a microscope under high-power magnification. Draw a labelled high-power diagram of the ox corneal cells.





Practical 2.3

Practical 2.3

Preparation of temporary mounts and observation of plant cells

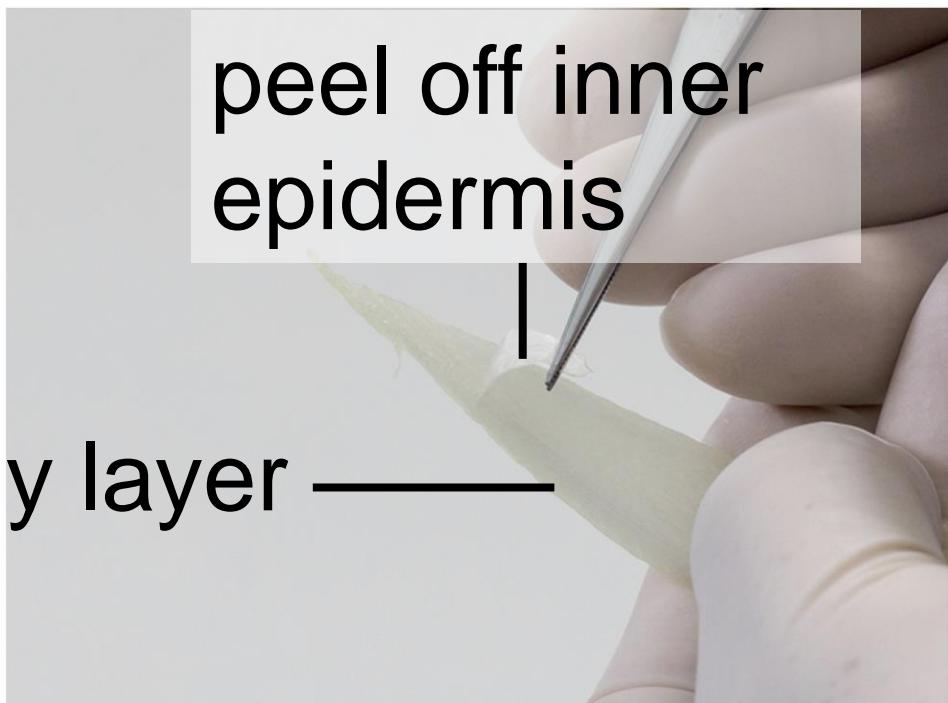
Procedure

A Onion epidermis

1

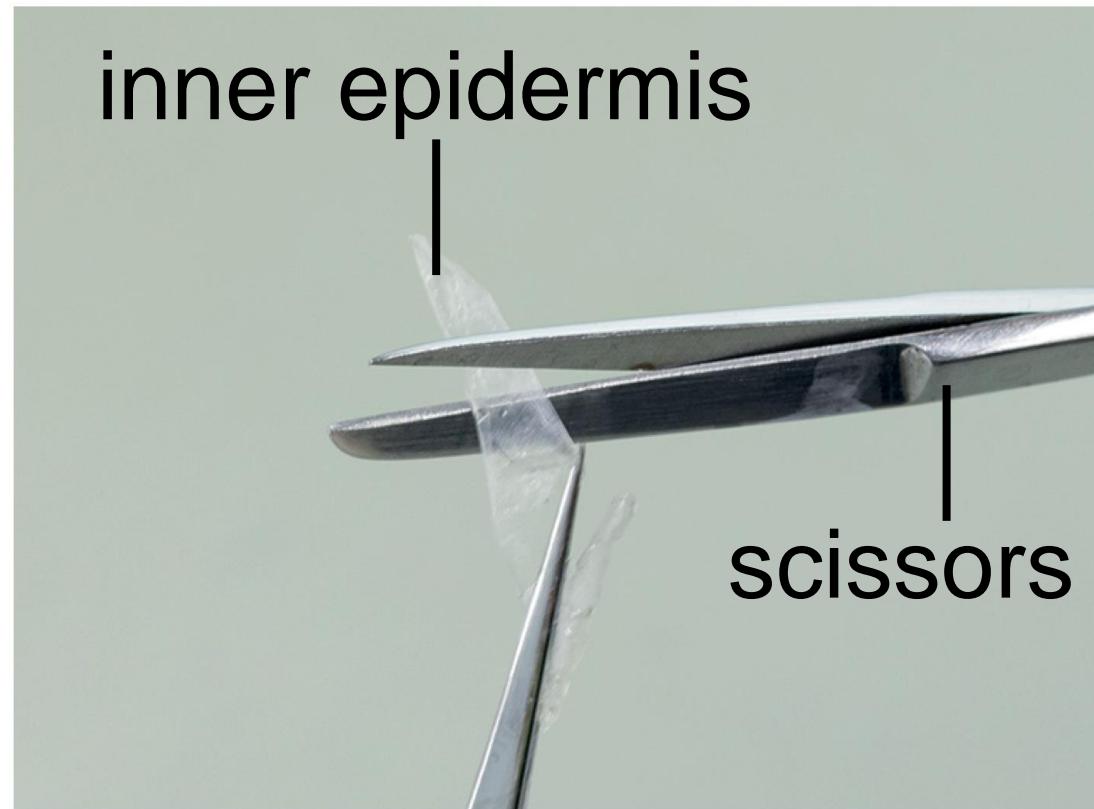
onion fleshy layer —

peel off inner
epidermis



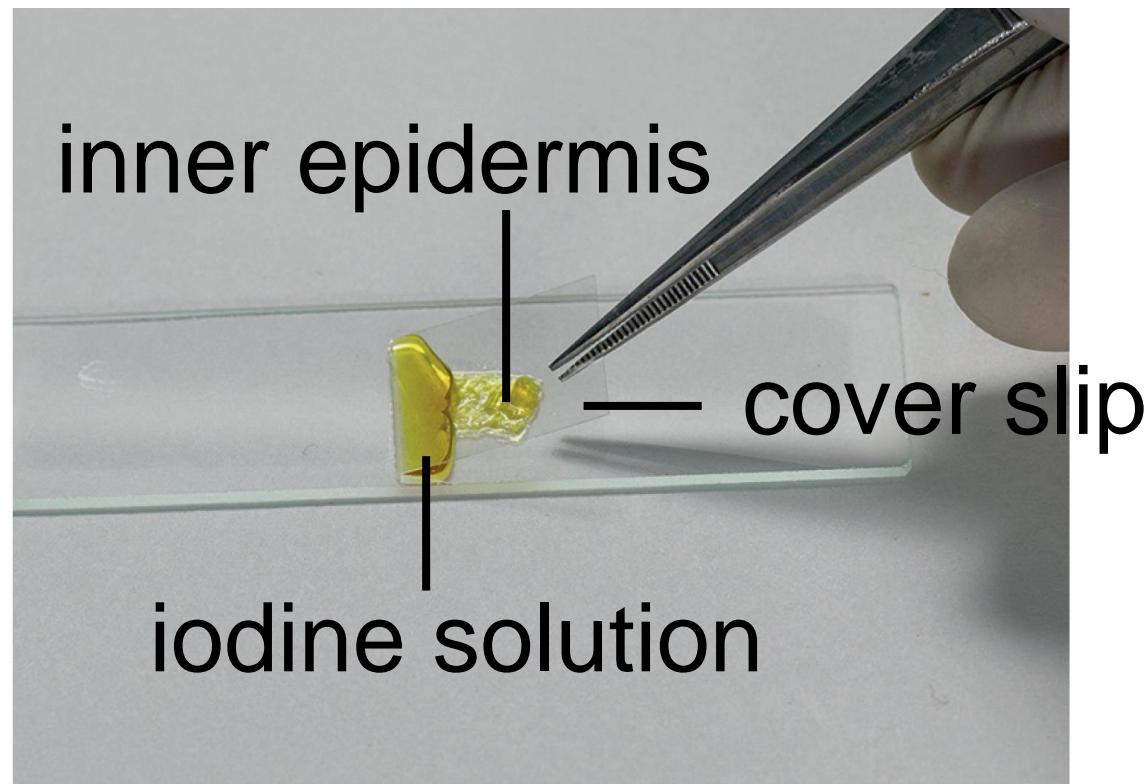
Practical 2.3

2 Cut out a small piece of epidermis.



Practical 2.3

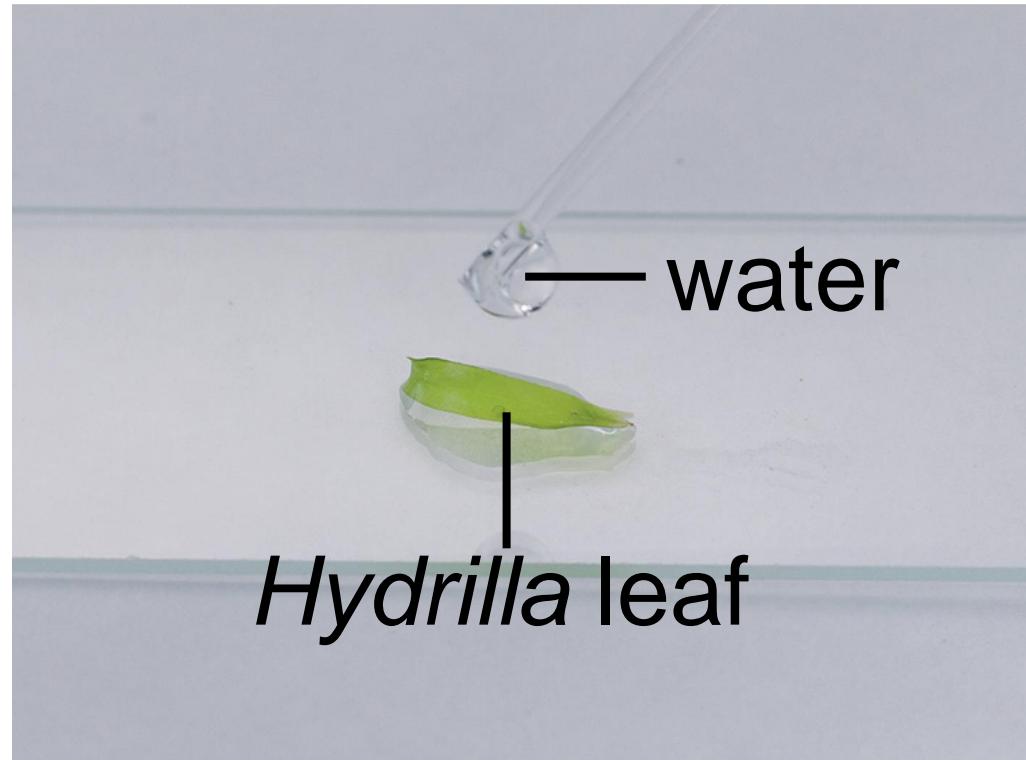
3



Practical 2.3

B *Hydrilla* leaf

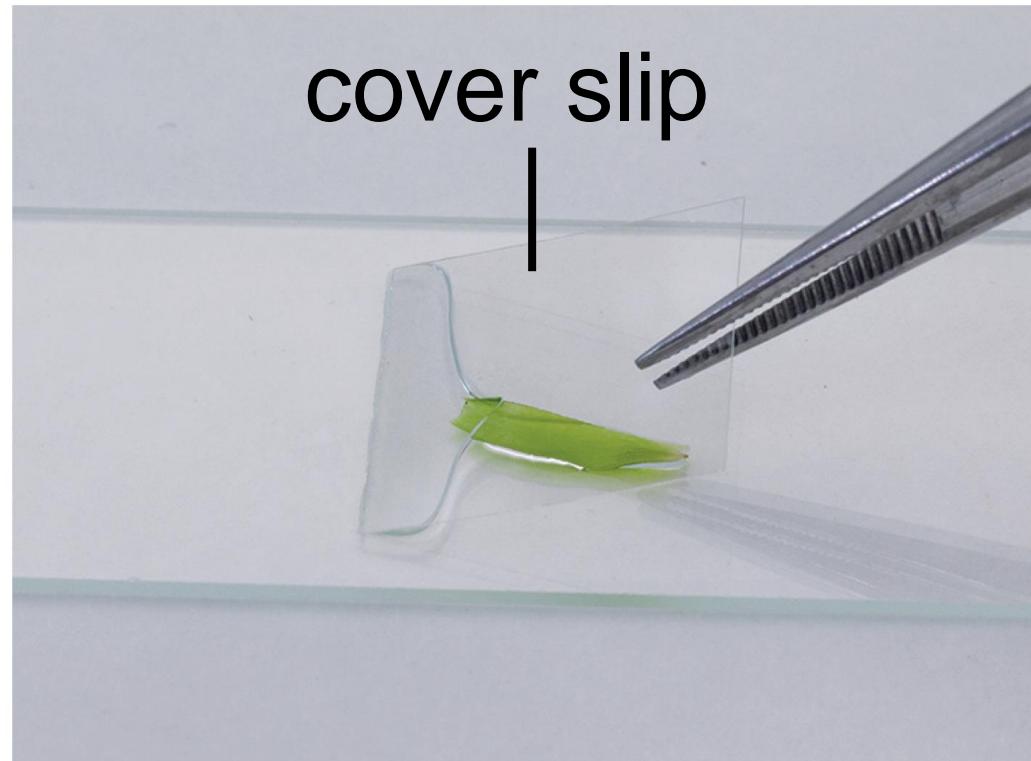
Mount a *Hydrilla* leaf with a drop of water.



Practical 2.3

B *Hydrilla* leaf

Mount a *Hydrilla* leaf with a drop of water.



Practical 2.3

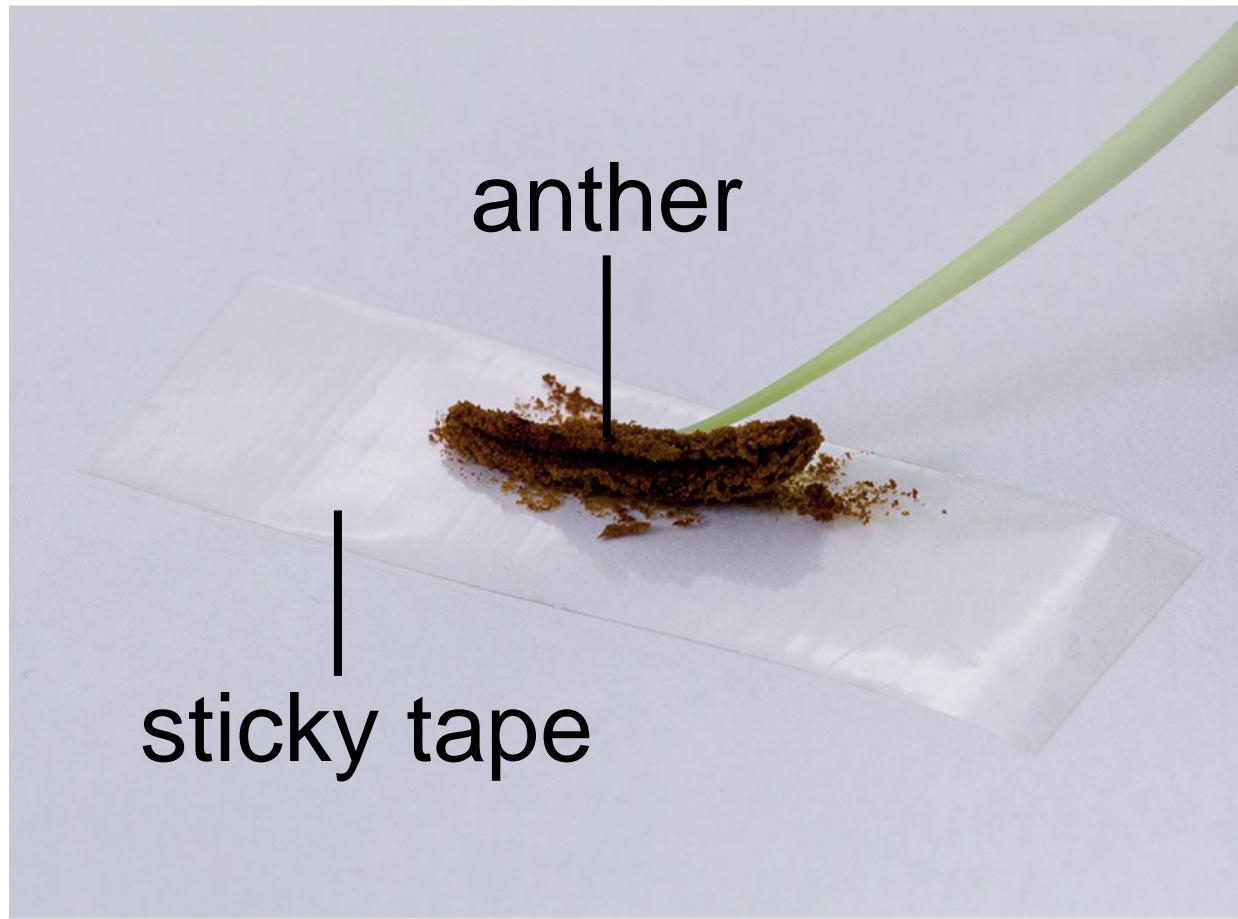
C Pollen grains

Gladiolus —————



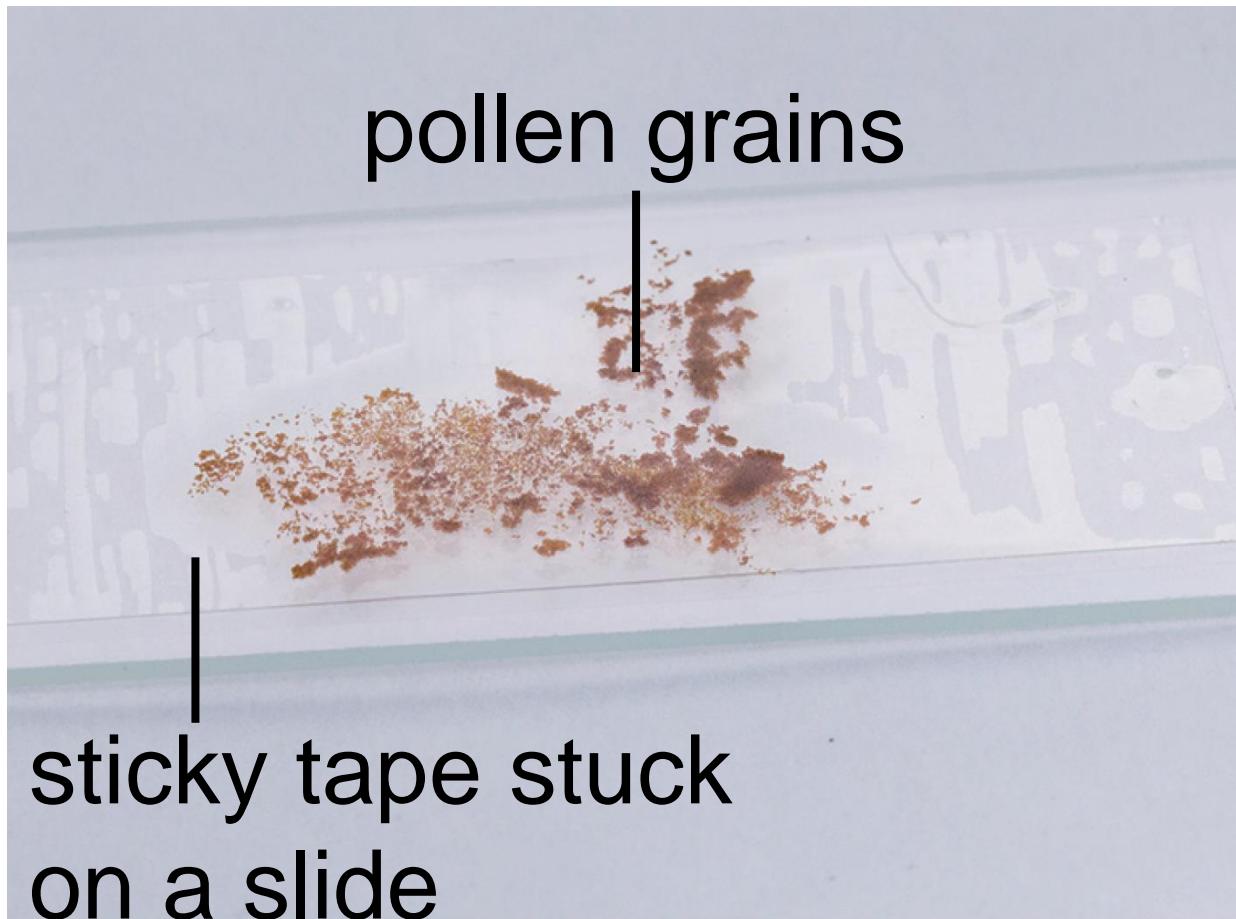
Practical 2.3

1



Practical 2.3

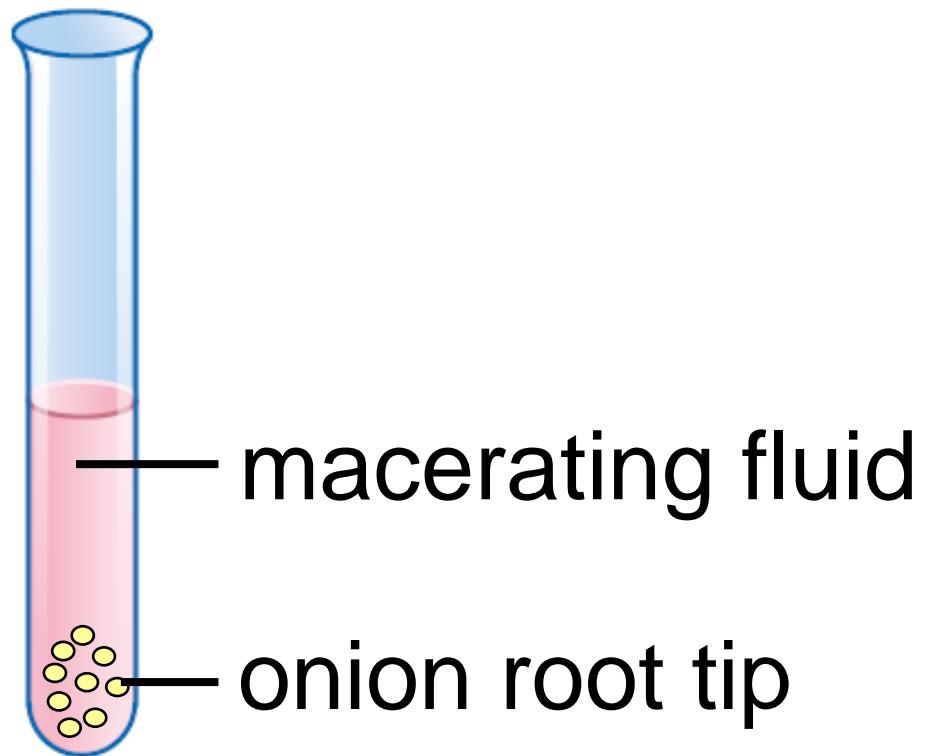
2



Practical 2.3

D Onion root tip cells

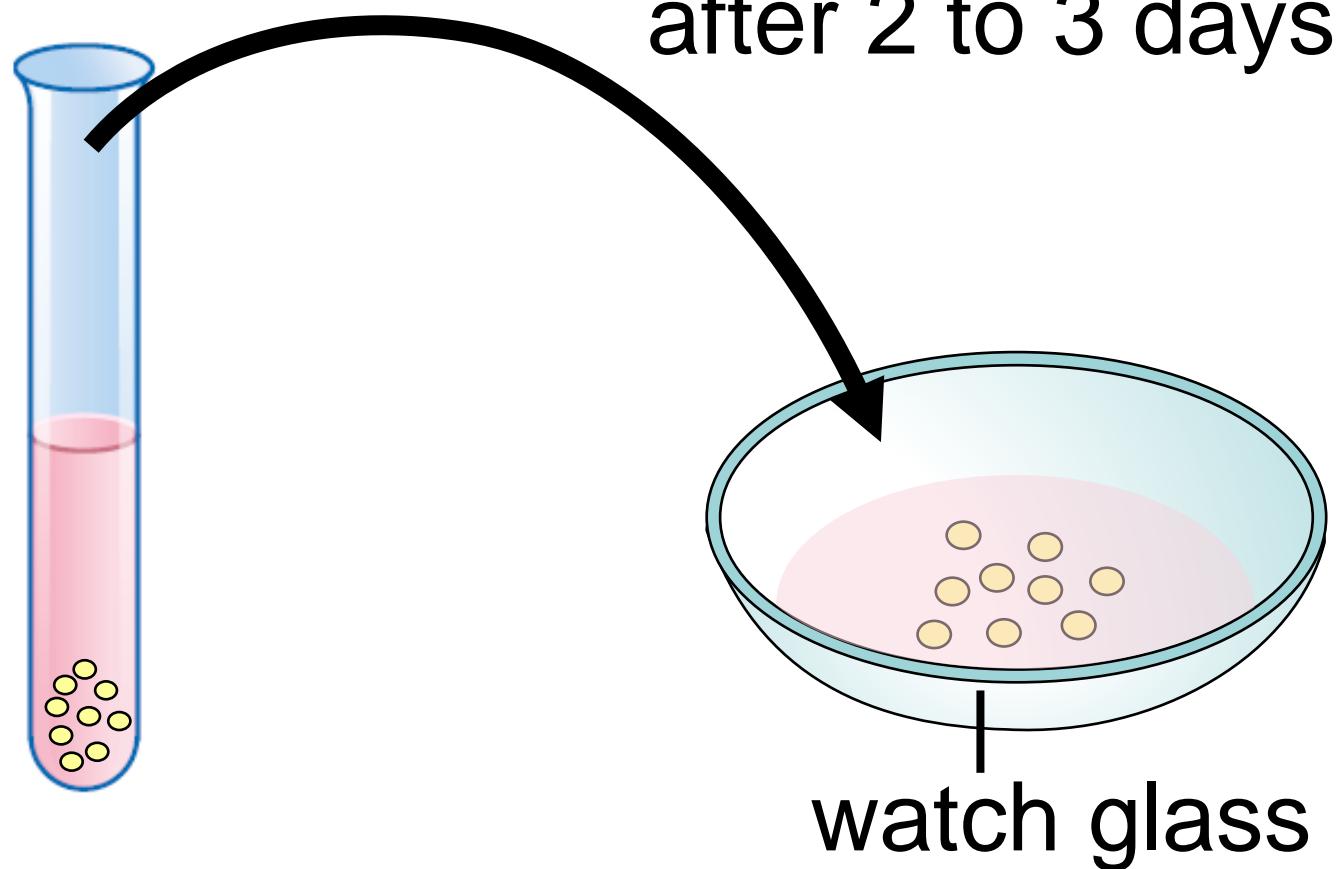
1



Practical 2.3

D Onion root tip cells

1

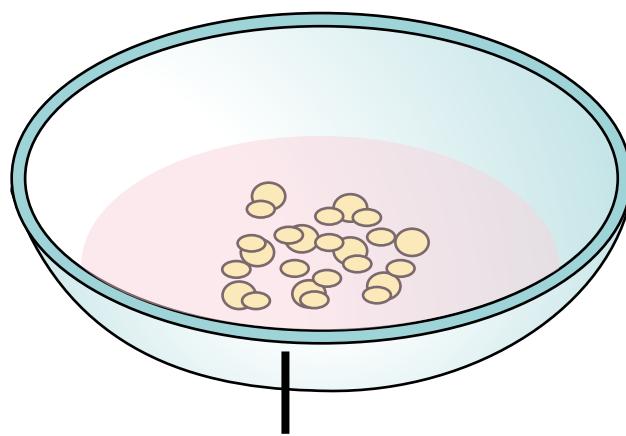


Practical 2.3

D Onion root tip cells

1

tear the tissues apart



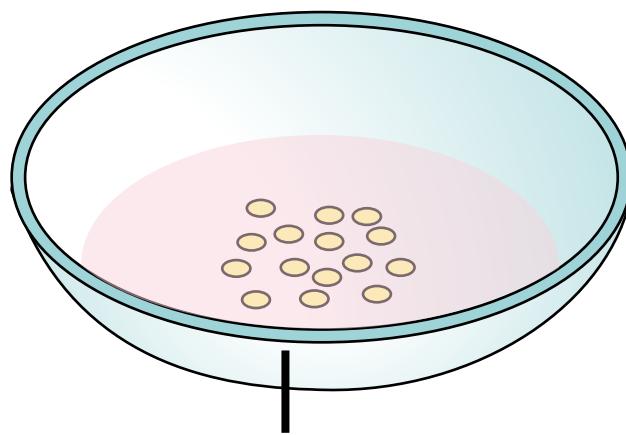
watch glass

Practical 2.3

D Onion root tip cells

1

filter off the
macerating fluid



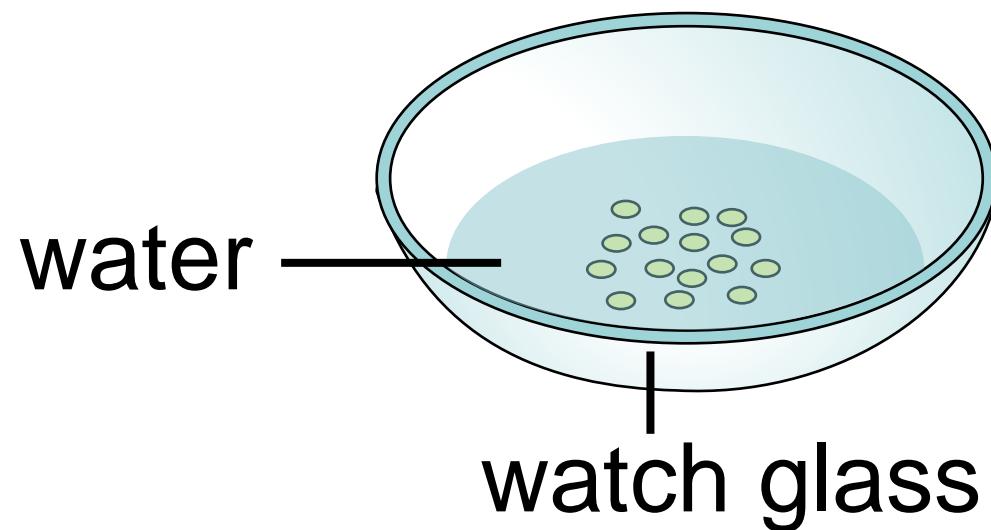
watch glass

Practical 2.3

D Onion root tip cells

1

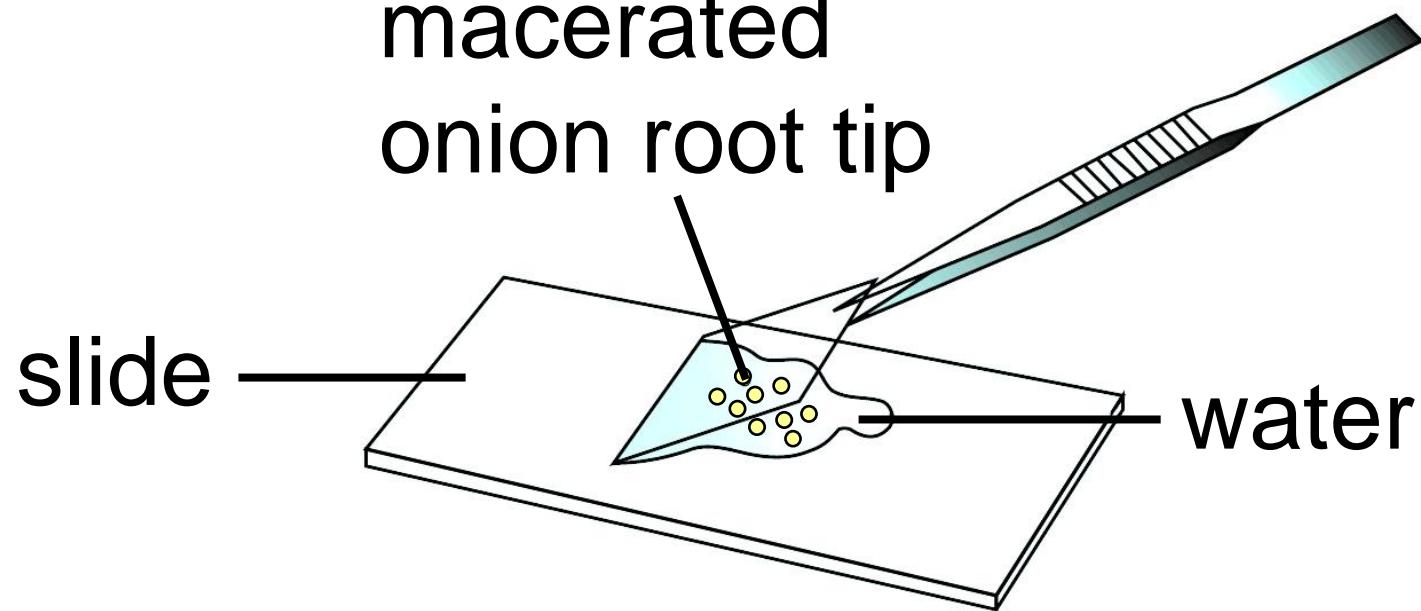
wash gently
with water



Practical 2.3

2

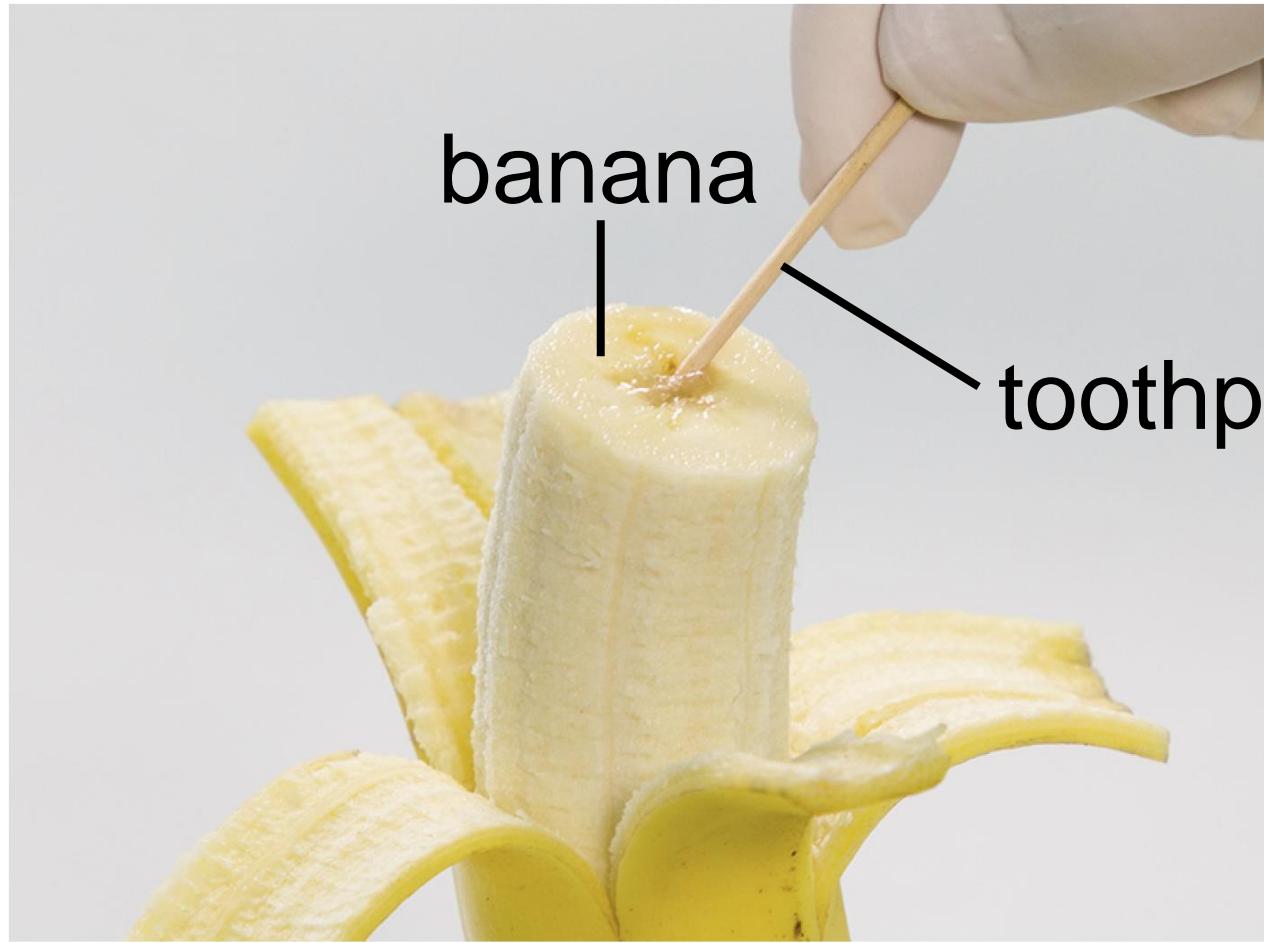
macerated
onion root tip



Practical 2.3

E Banana tissue

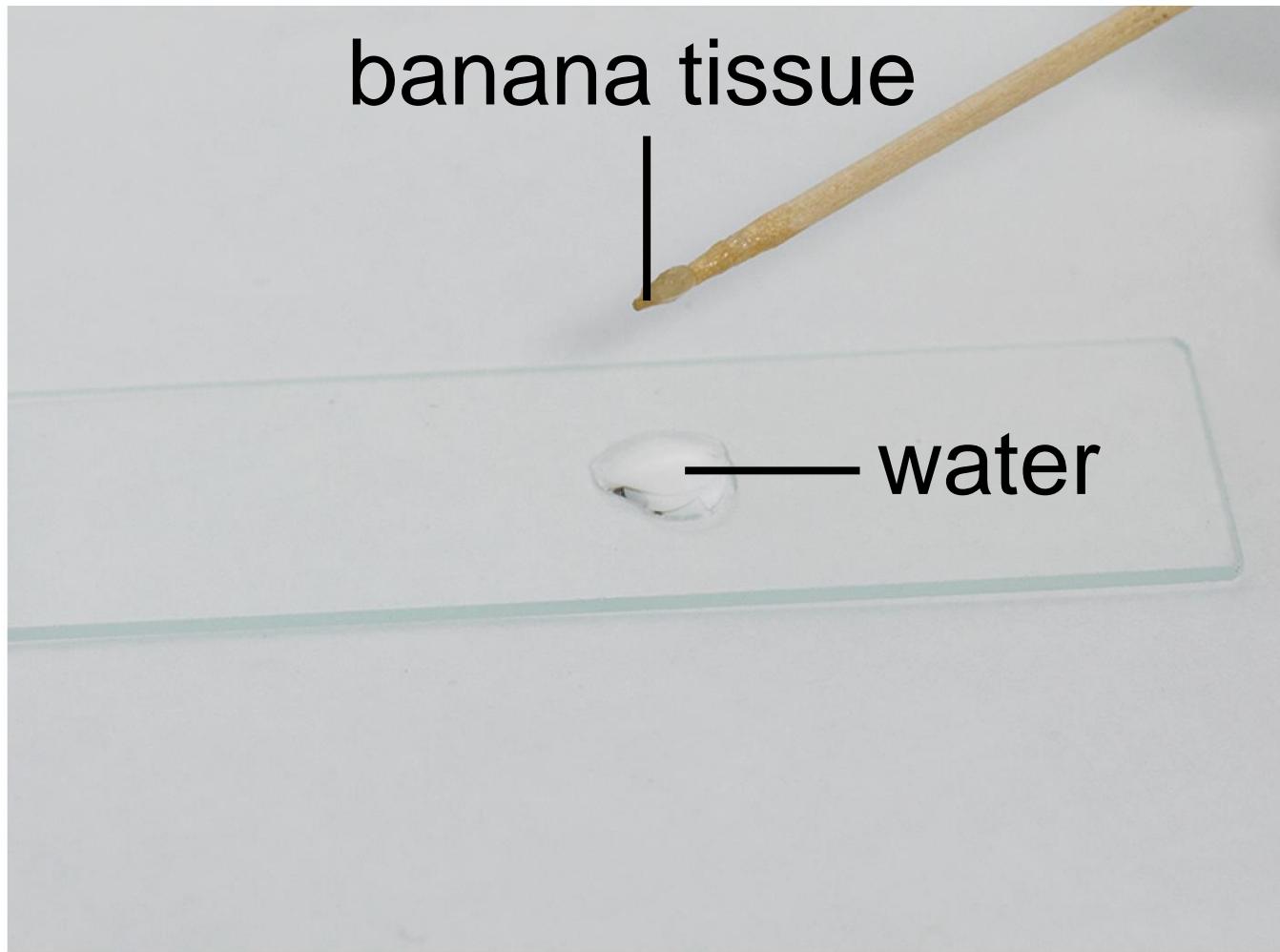
1



toothpick

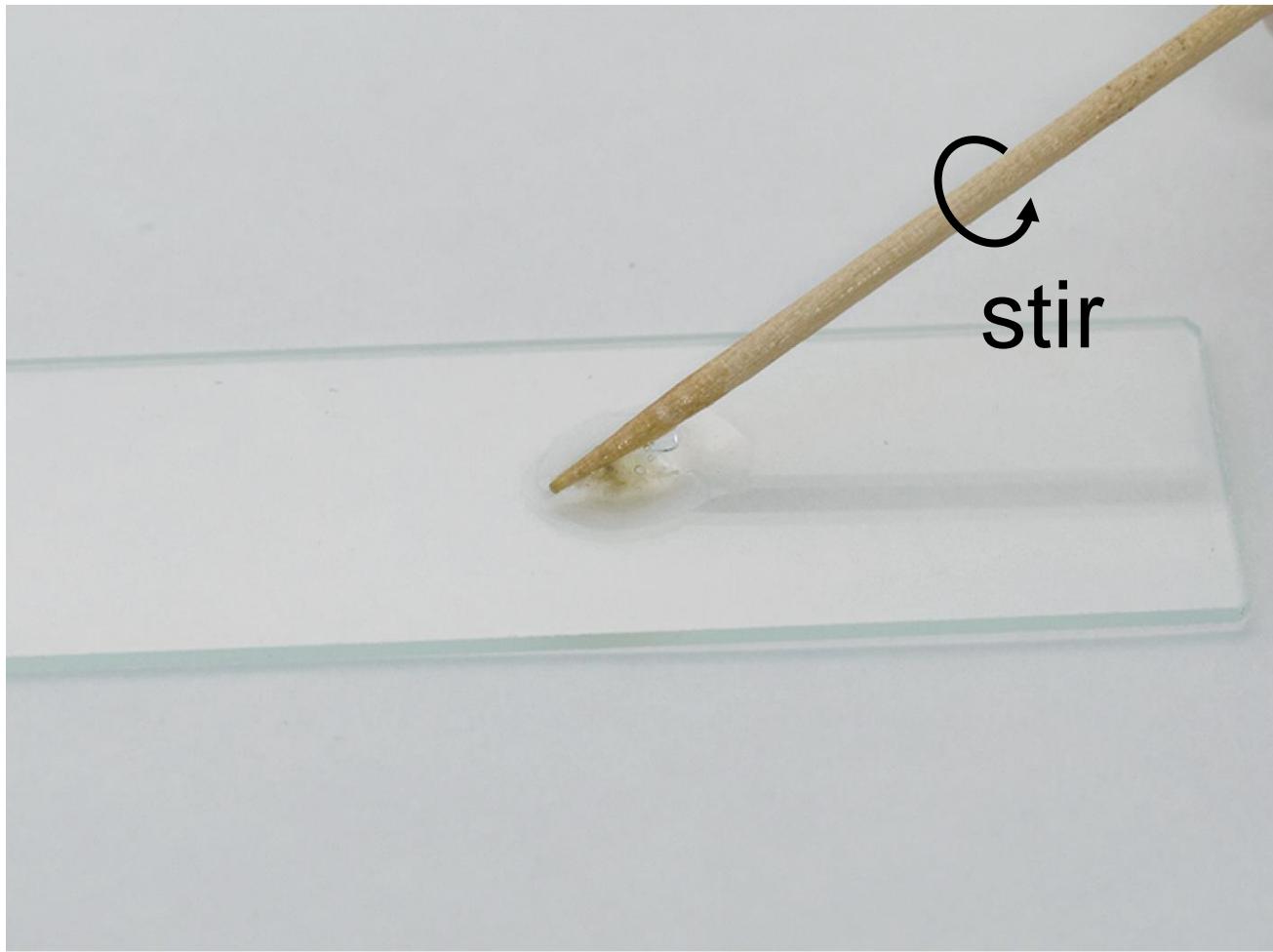
Practical 2.3

2



Practical 2.3

3



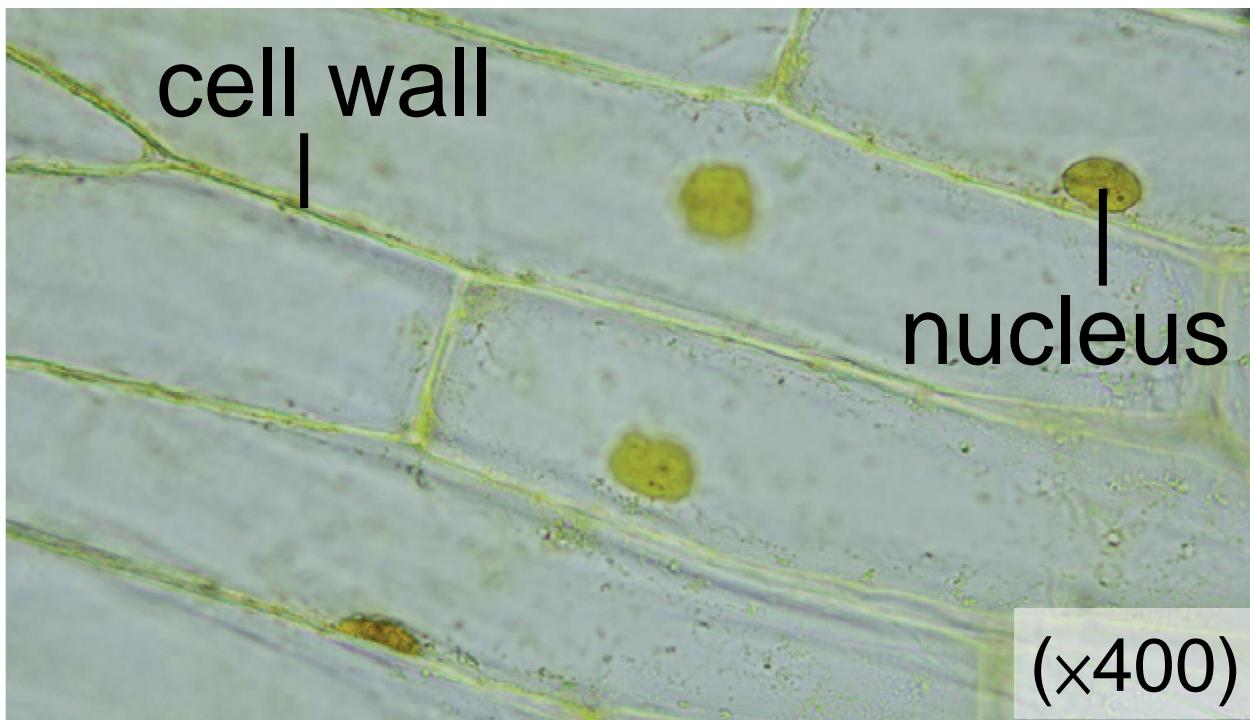
Practical 2.3

4 Mount the cells with a drop of iodine solution.

Practical 2.3

Results and discussion

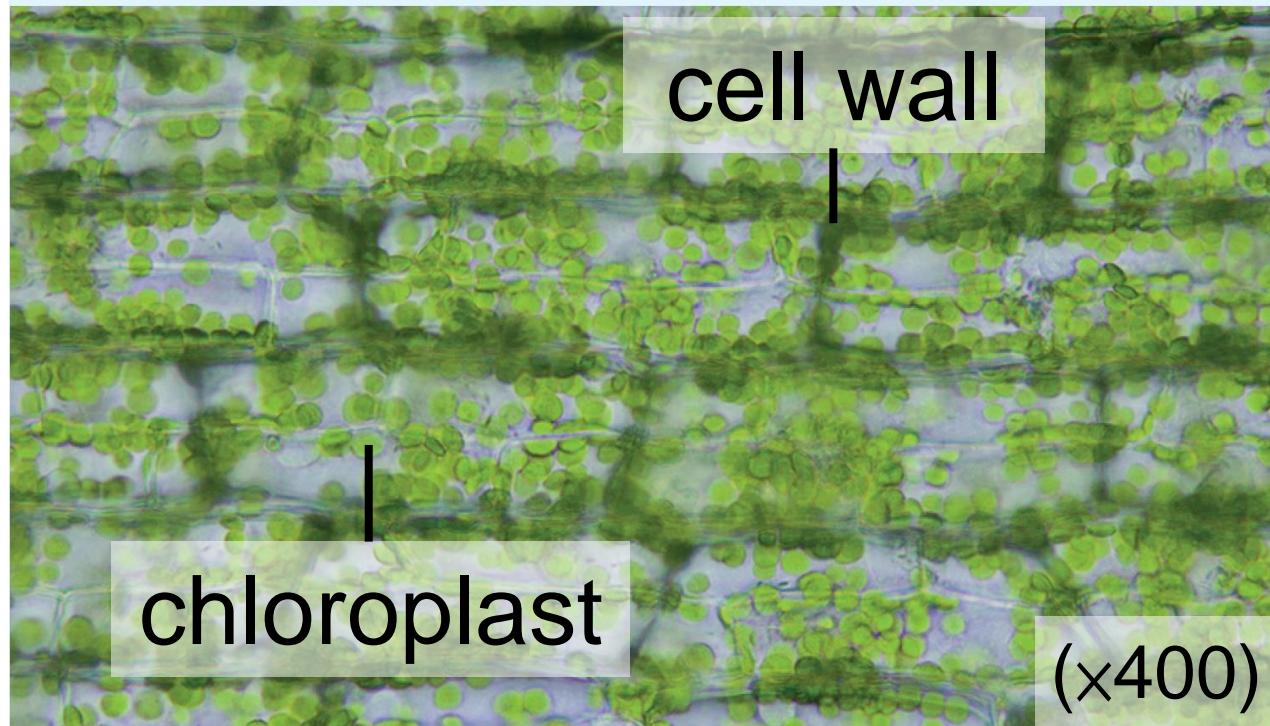
Onion epidermal cells:



Practical 2.3

Results and discussion

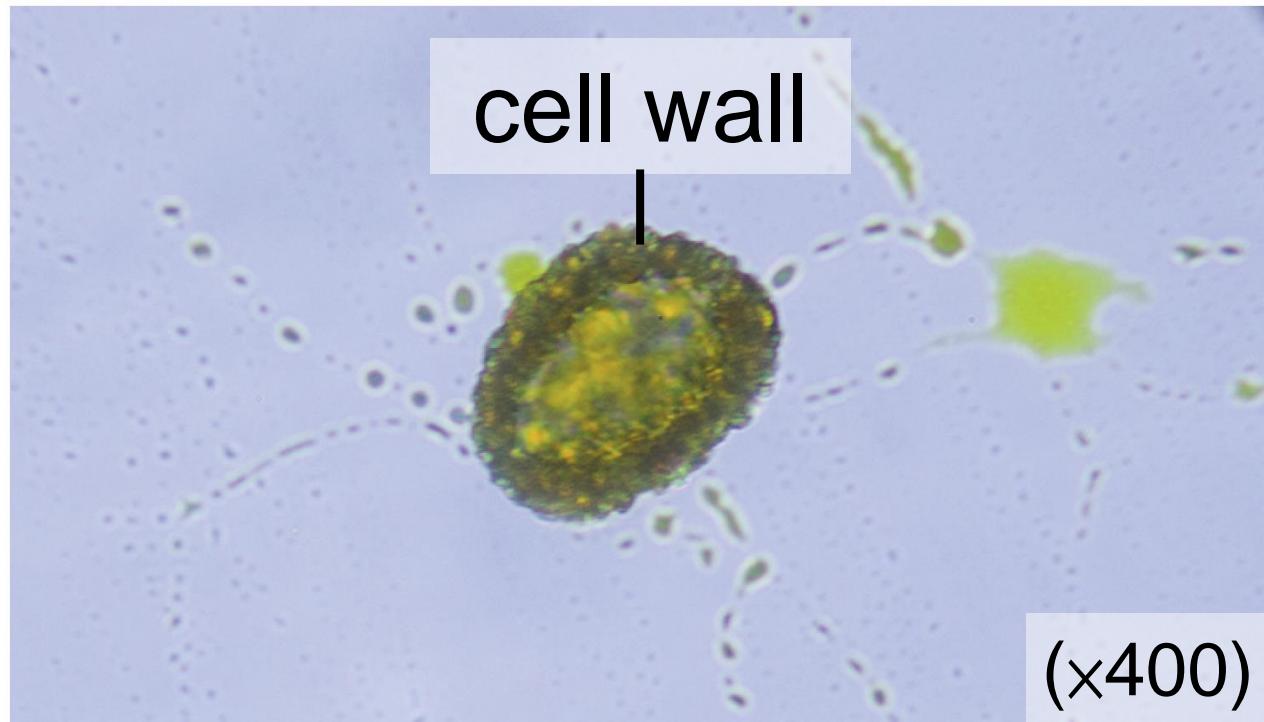
Hydrilla leaf cells:



Practical 2.3

Results and discussion

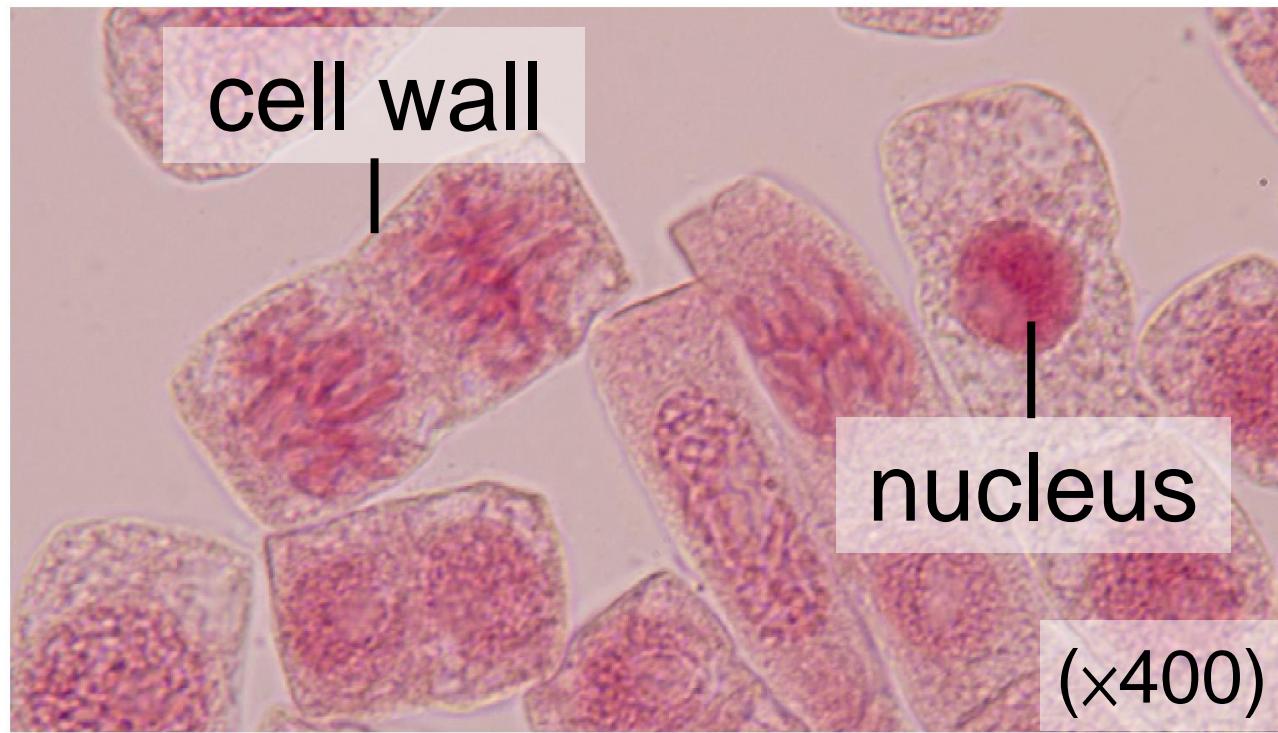
Pollen grain:



Practical 2.3

Results and discussion

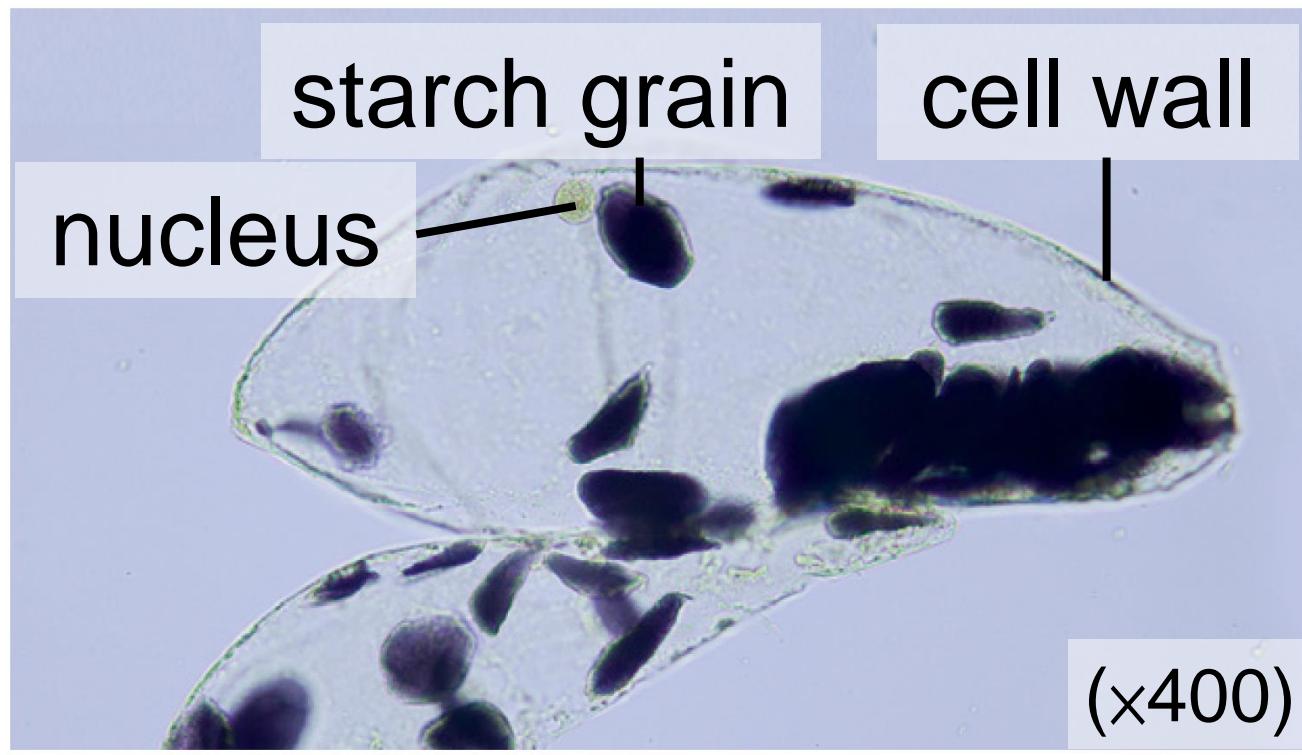
Onion root tip cells:



Practical 2.3

Results and discussion

Cells in banana tissue:



Key learning

1

Sub-cellular structure

Function

Nucleus

- Contains DNA, which controls the activities of the cell

Key learning

1

Sub-cellular structure

Function

Cytoplasm

- Holds many organelles
- A site for many chemical reactions

Key learning

1

Sub-cellular structure

Function

Cytoplasm

- Allows the movement and transport of materials inside the cell

Key learning

1

Sub-cellular structure

Function

Cell membrane

- Encloses the cell and separates the cell contents from the outside environment
- Controls the movement of substances in and out of the cell

Key learning

1

Sub-cellular structure

Function

Cell wall

- Protects, supports and gives shape to the plant cell

Key learning

1

**Sub-cellular
structure**

Function

Rough ER

- A site for the synthesis of proteins

Key learning

1

**Sub-cellular
structure**

Function

Smooth ER

- A site for the synthesis of lipids

Key learning

1

**Sub-cellular
structure**

Function

Ribosome

- Involved in the synthesis of proteins

Key learning

1

Sub-cellular structure

Function

Mitochondrion

- The main site of respiration. It converts chemical energy in food into energy that the cell can use

Key learning

1

Sub-cellular structure

Chloroplast

Function

- Contains chlorophyll which captures light energy and converts it into chemical energy in food in photosynthesis

Key learning

1

Sub-cellular structure

Function

Vacuole

- May contains water, enzymes, food and other dissolved substances

Key learning

1

Sub-cellular structure

Function

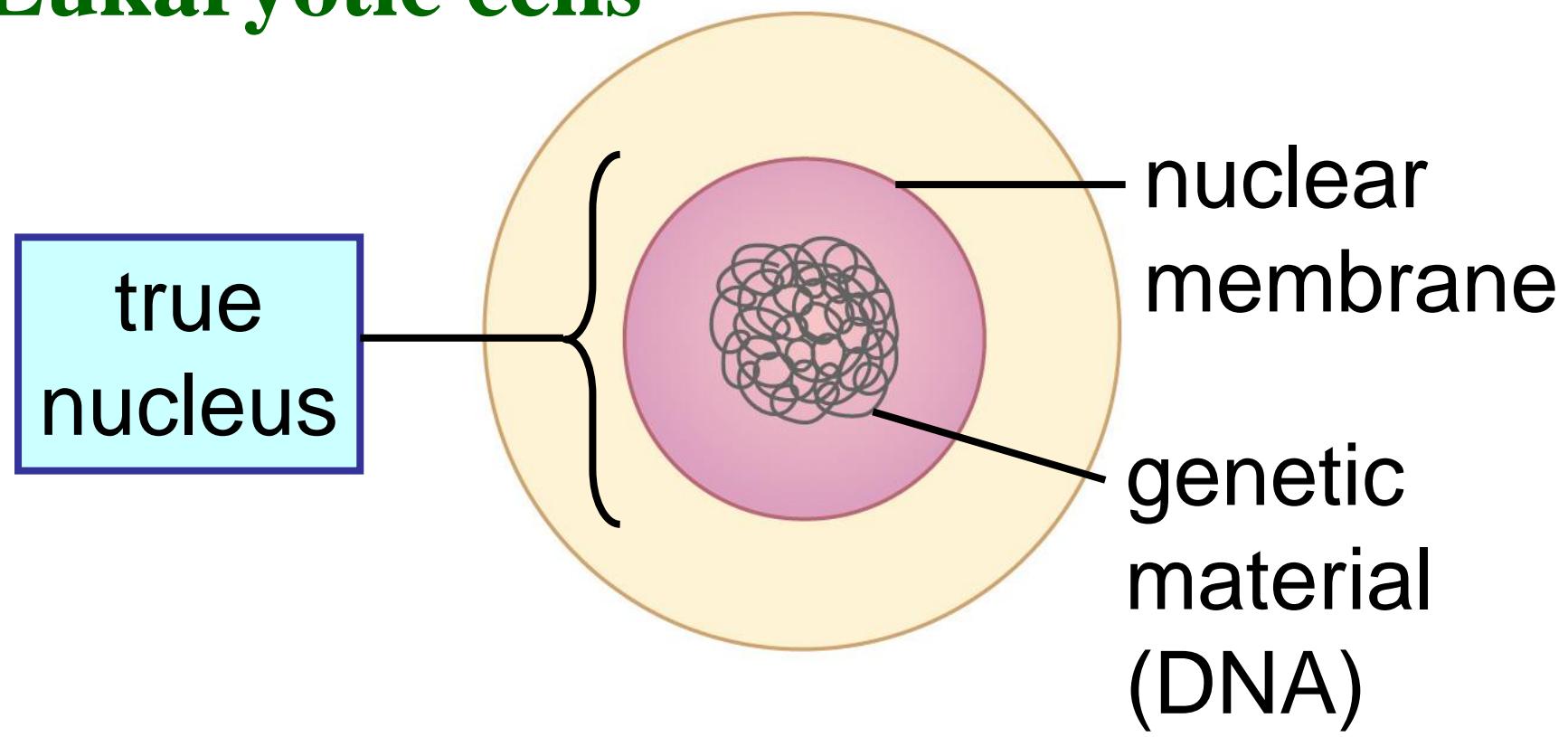
Vacuole

- Provides support to the plant when it is full of water

B

Prokaryotic cells and eukaryotic cells

Eukaryotic cells



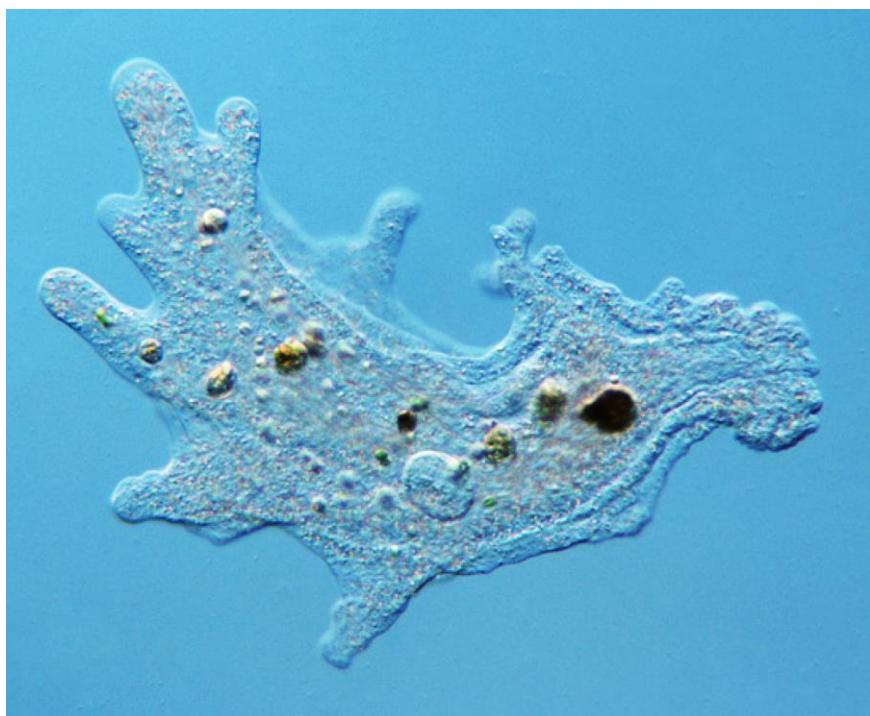
Eukaryotic cells

- make up **eukaryotes** (真核生物)

multicellular (多細胞的)
(e.g. animals and plants)

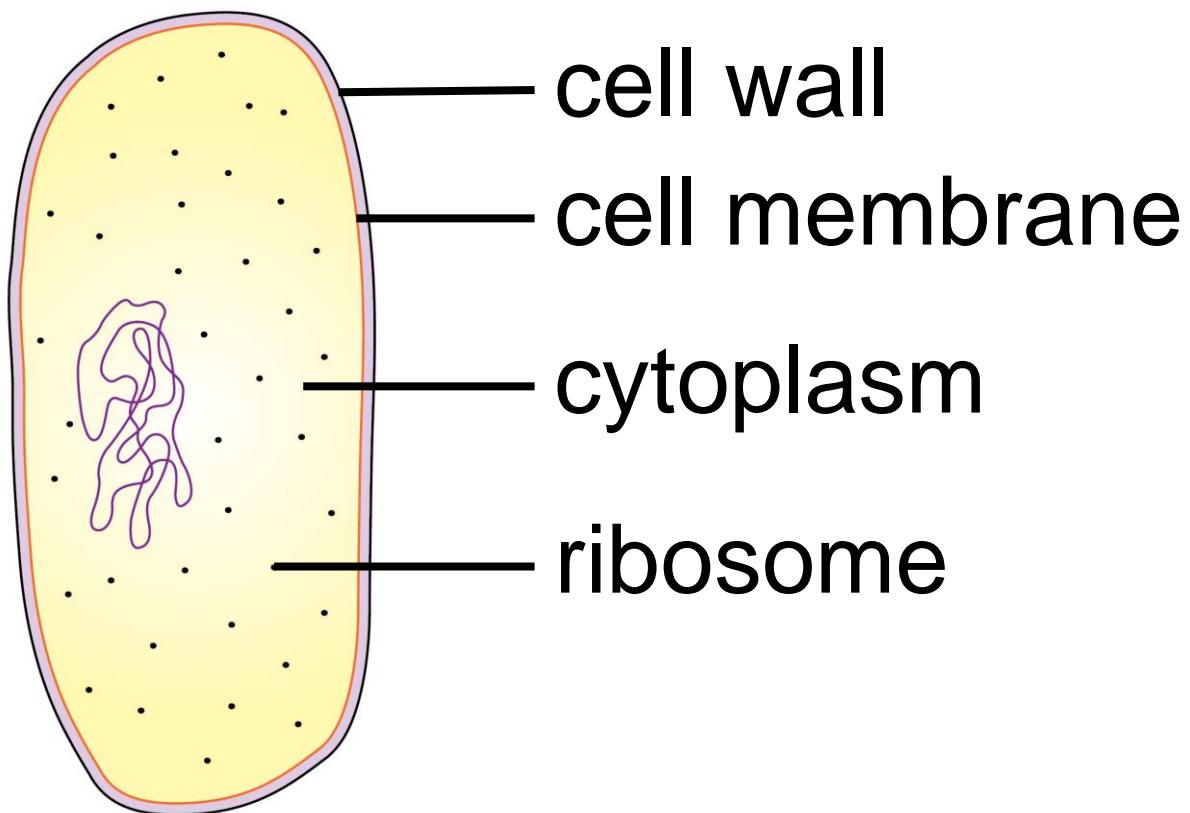


unicellular (單細胞的)
(e.g. Amoeba)



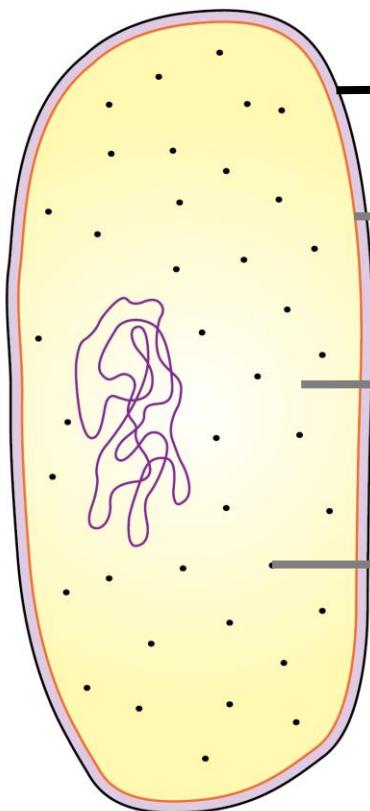
Prokaryotic cells

- **smaller** and have **no true nucleus**



Prokaryotic cells

- **smaller** and have **no true nucleus**

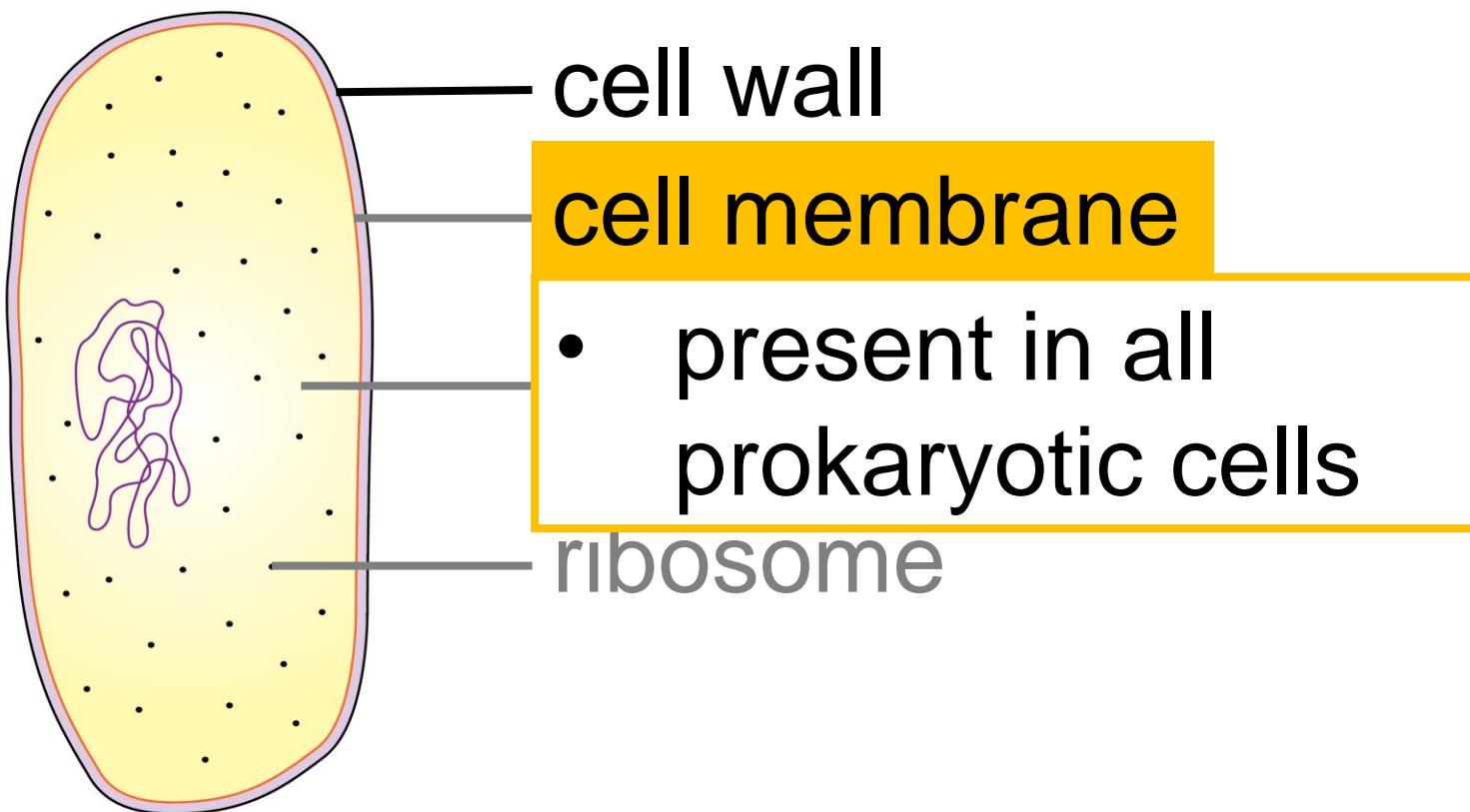


cell wall

- present in most prokaryotic cells
- **does not contain cellulose**

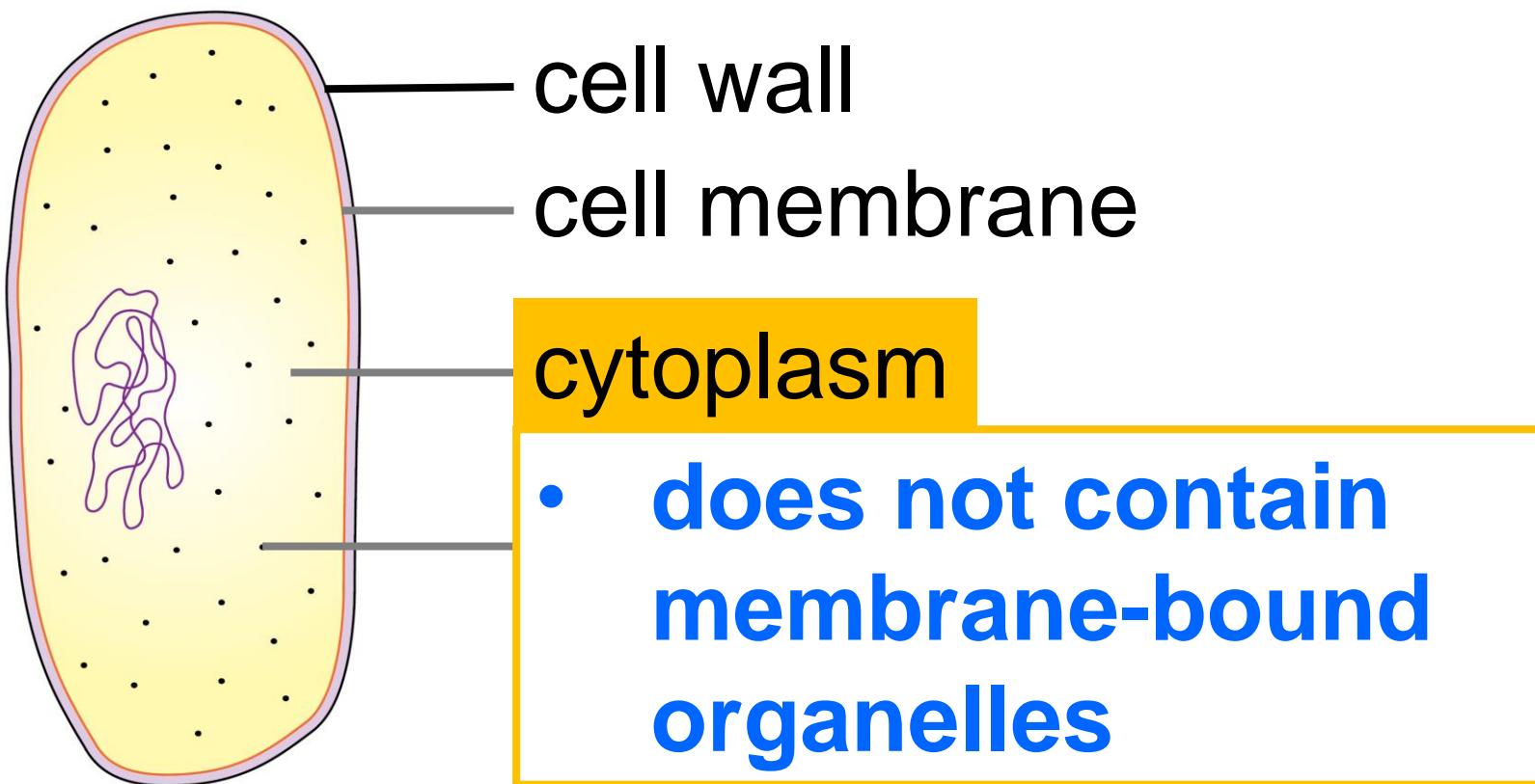
Prokaryotic cells

- **smaller** and have **no true nucleus**



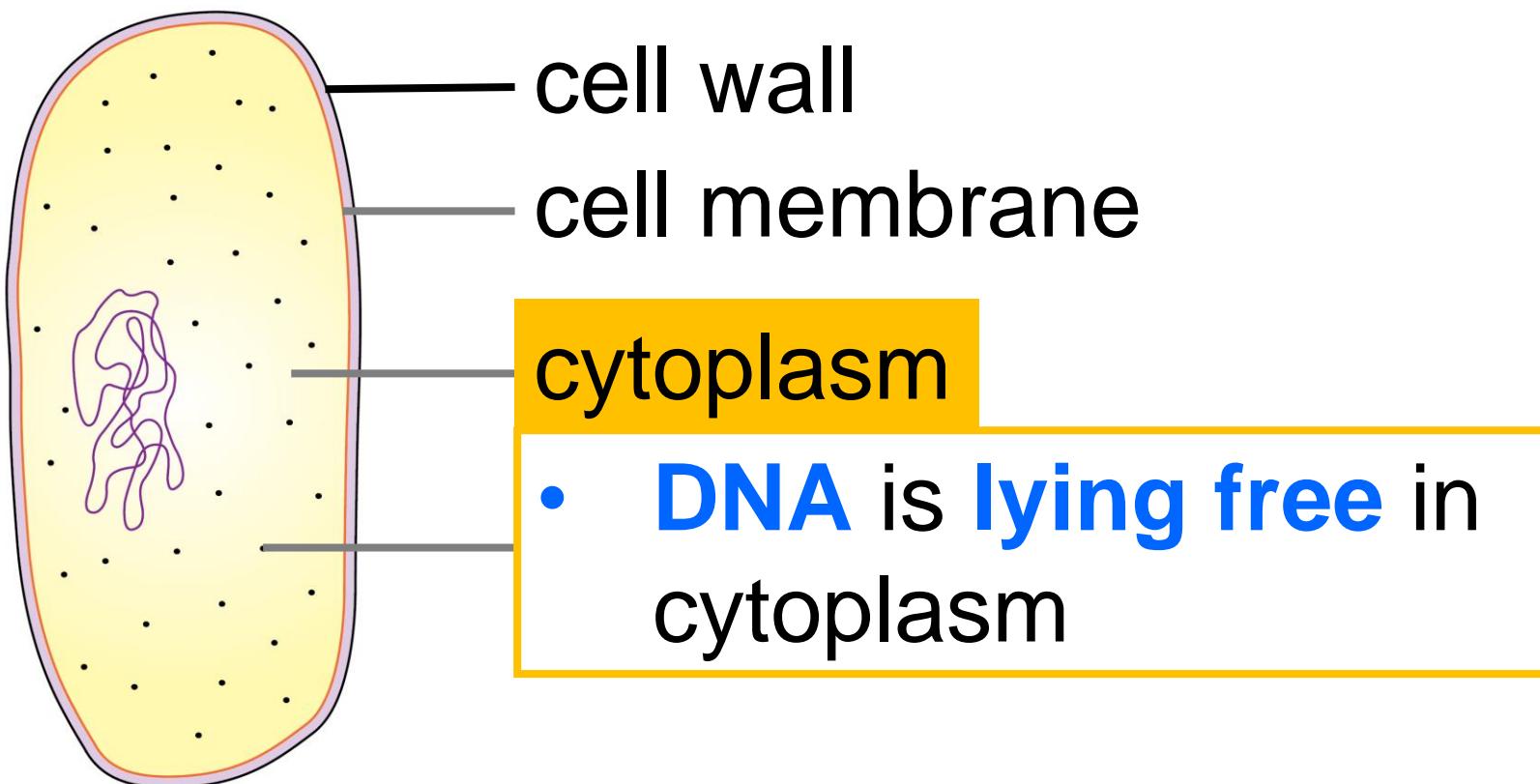
Prokaryotic cells

- **smaller** and have **no true nucleus**



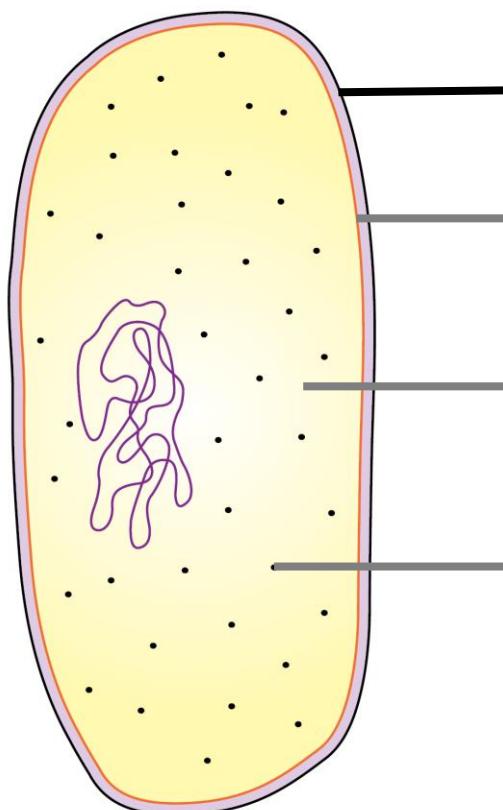
Prokaryotic cells

- **smaller** and have **no true nucleus**



Prokaryotic cells

- **smaller** and have **no true nucleus**



cell wall
cell membrane

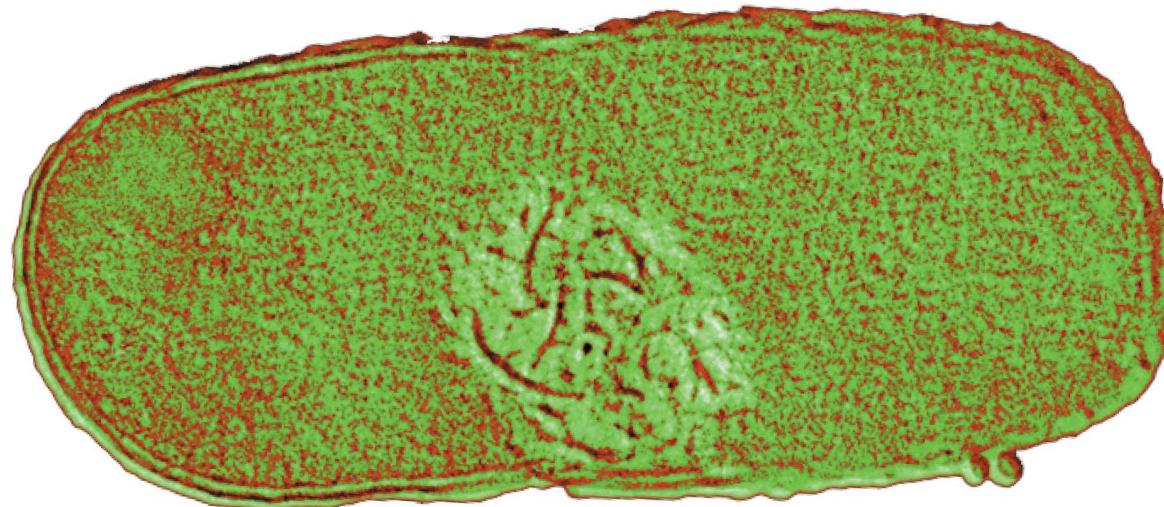
cytoplasm

ribosome

- **lying free** in the cytoplasm

Prokaryotic cells

- make up **prokaryotes** (原核生物)
- all prokaryotes are **unicellular**
- e.g.



bacteria ($\times 12\,000$)

Key learning

Compare prokaryotic cells and eukaryotic cells

Similarities

- Both bounded by a **cell membrane**.
- Their genetic material is **DNA**.

Key learning

Differences

	Prokaryotic cell	Eukaryotic cell
Size	Usually smaller	Usually larger
Nucleus	No true nucleus	Have a true nucleus

Key learning

Differences

	Prokaryotic cell	Eukaryotic cell
Genetic material	DNA lying free in cytoplasm	DNA enclosed in nucleus

Key learning

Differences

	Prokaryotic cell	Eukaryotic cell
Membrane-bound organelles	Absent	Present

Key learning

Differences

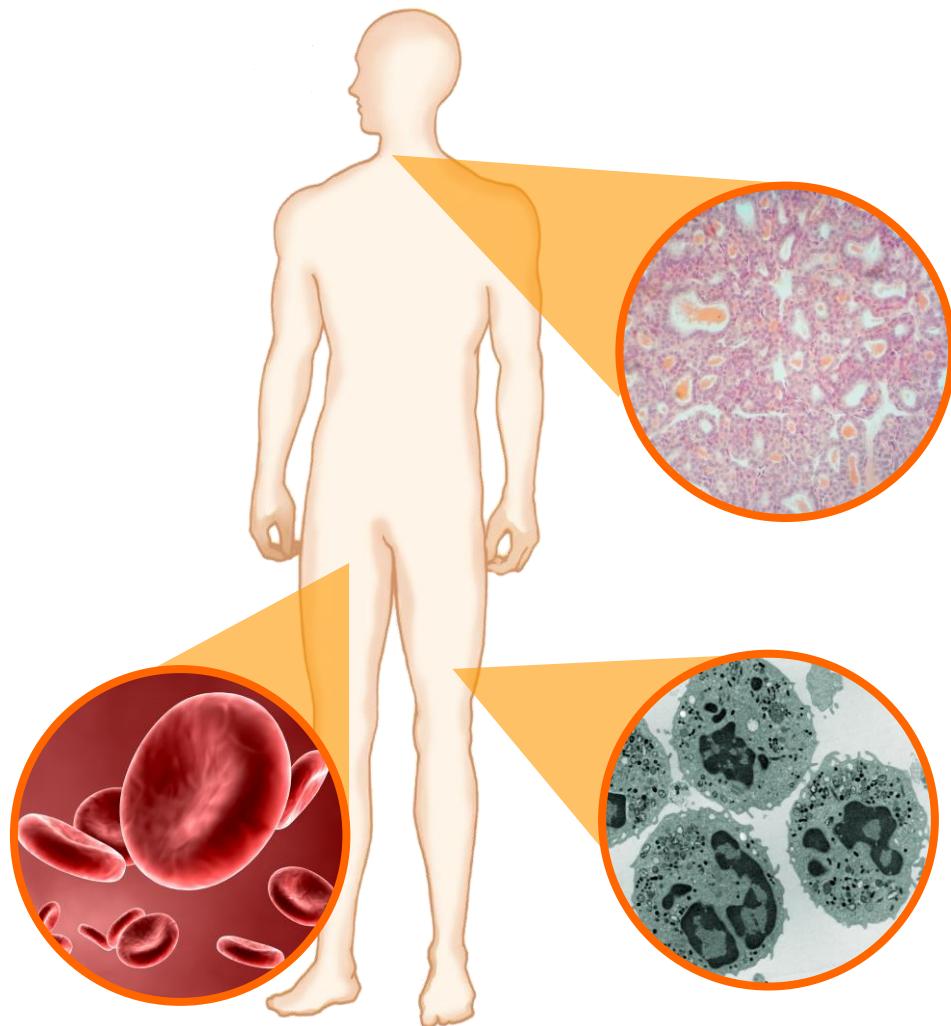
	Prokaryotic cell	Eukaryotic cell
Ribosomes	Lying free in the cytoplasm	Some are attached to ER and some lying free in the cytoplasm

Key learning

Differences

	Prokaryotic cell	Eukaryotic cell
Cell wall	<ul style="list-style-type: none">• May be present or absent• No cellulose	<ul style="list-style-type: none">• Present in plant cells• Contains cellulose

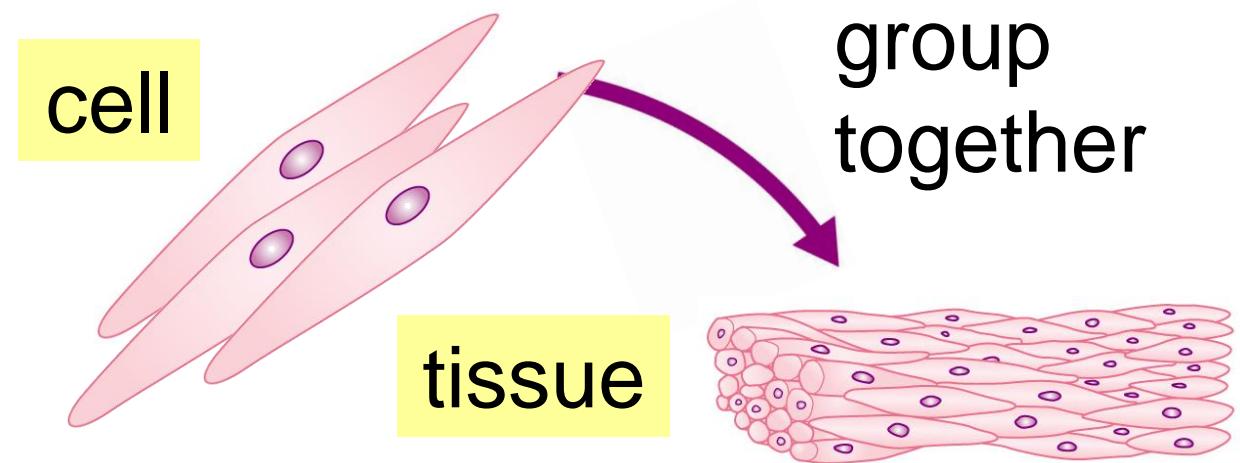
2.5 Levels of body organization



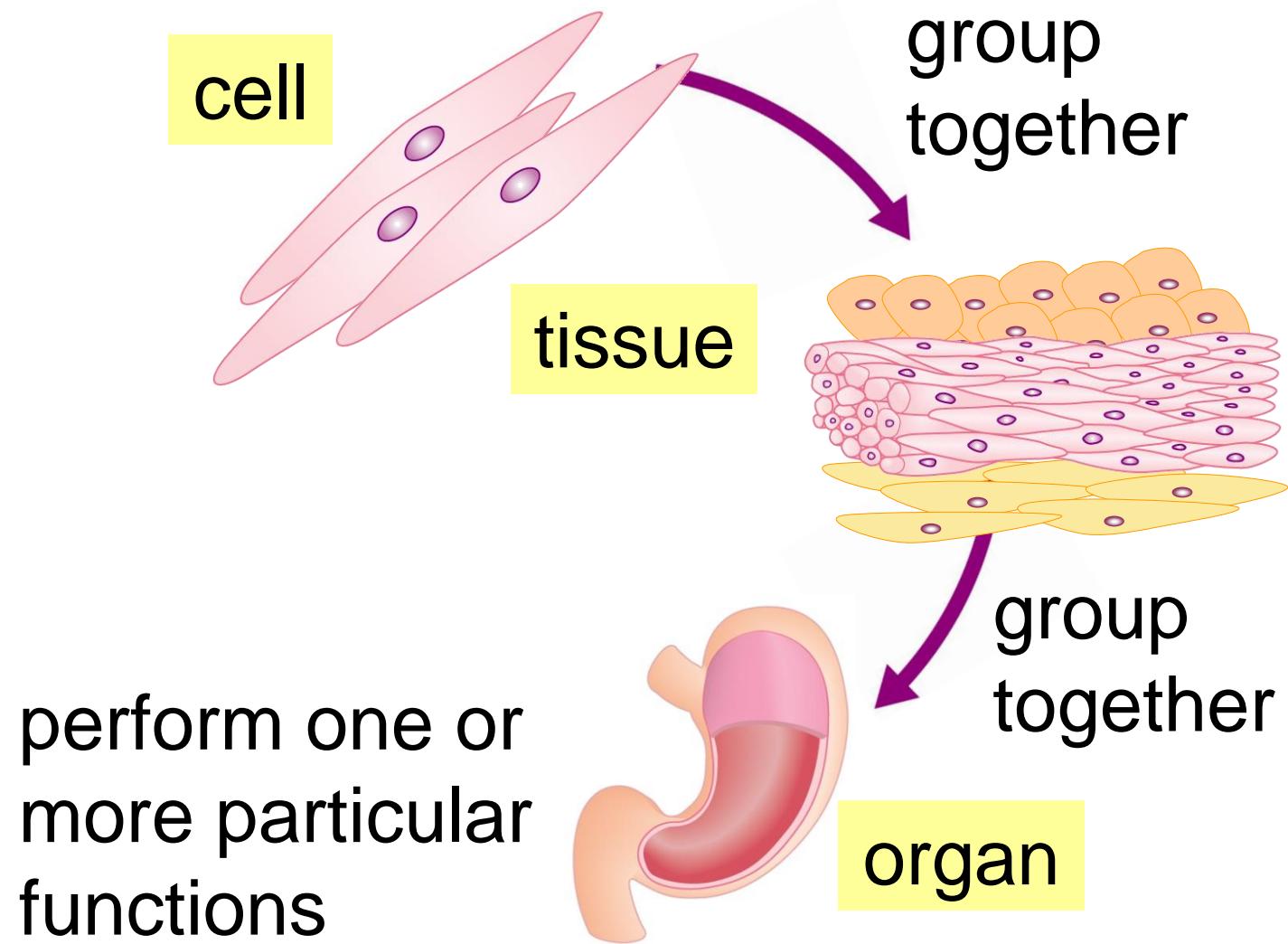
In **multicellular organisms**

(多細胞生物),

cells work in a coordinated way for different functions

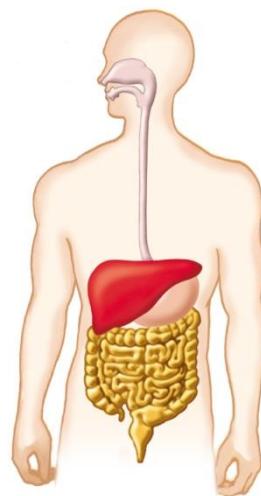


perform one or
more particular
functions



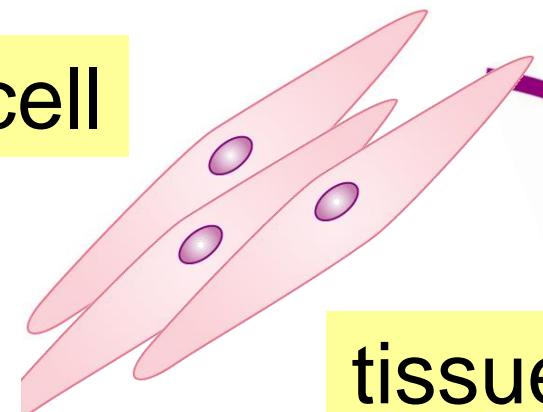
perform a particular task

system



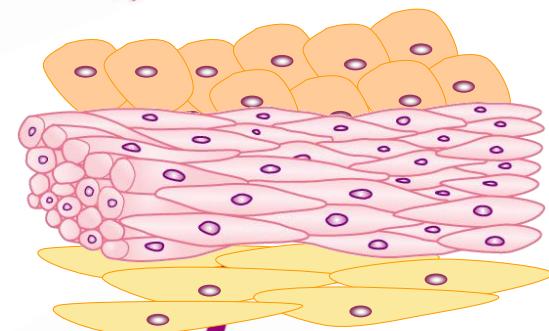
work together

cell

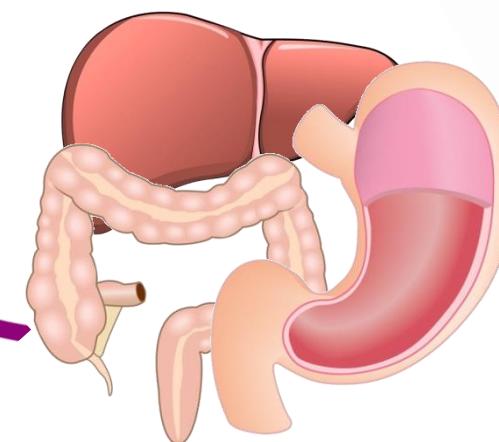


tissue

group together



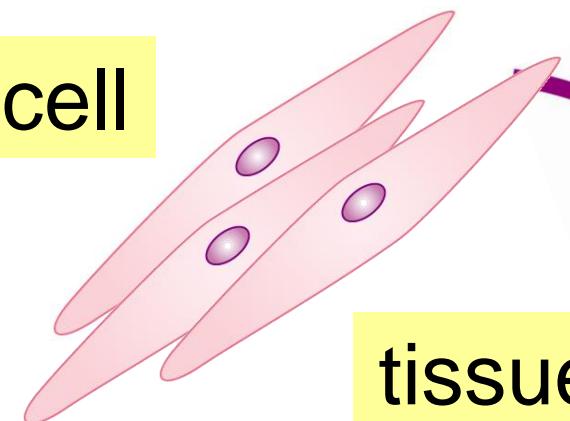
organ



organism

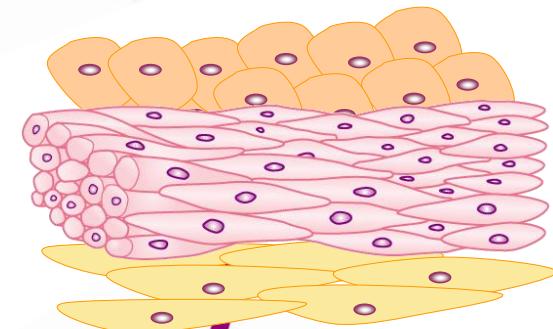


cell

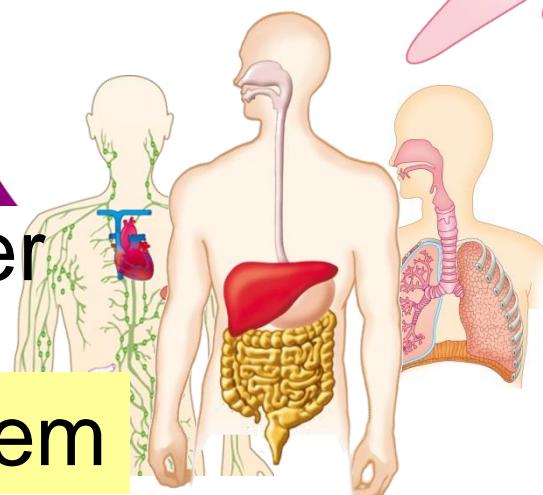


group
together

tissue

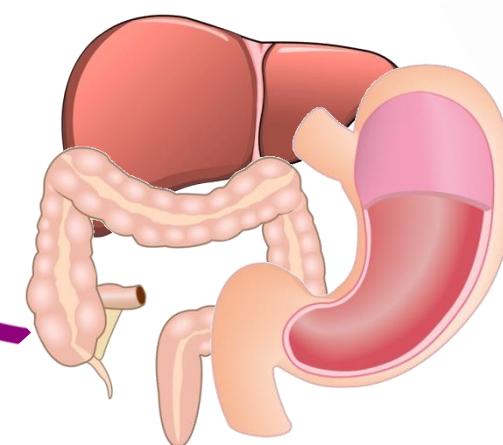


work
together

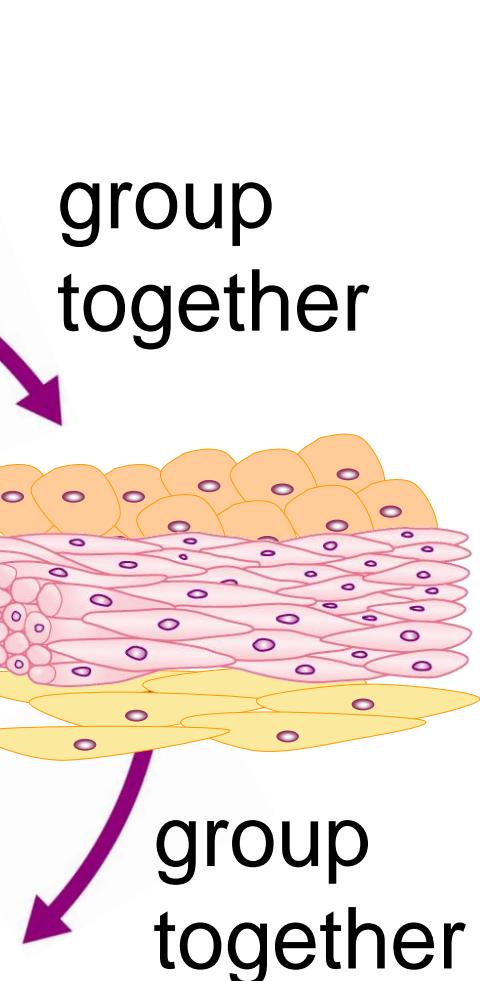


system

work
together



organ



Recall '*Think about...*'

- 1 Cells are too small to be seen with the naked eye. What tool can we use to view them when selecting them?

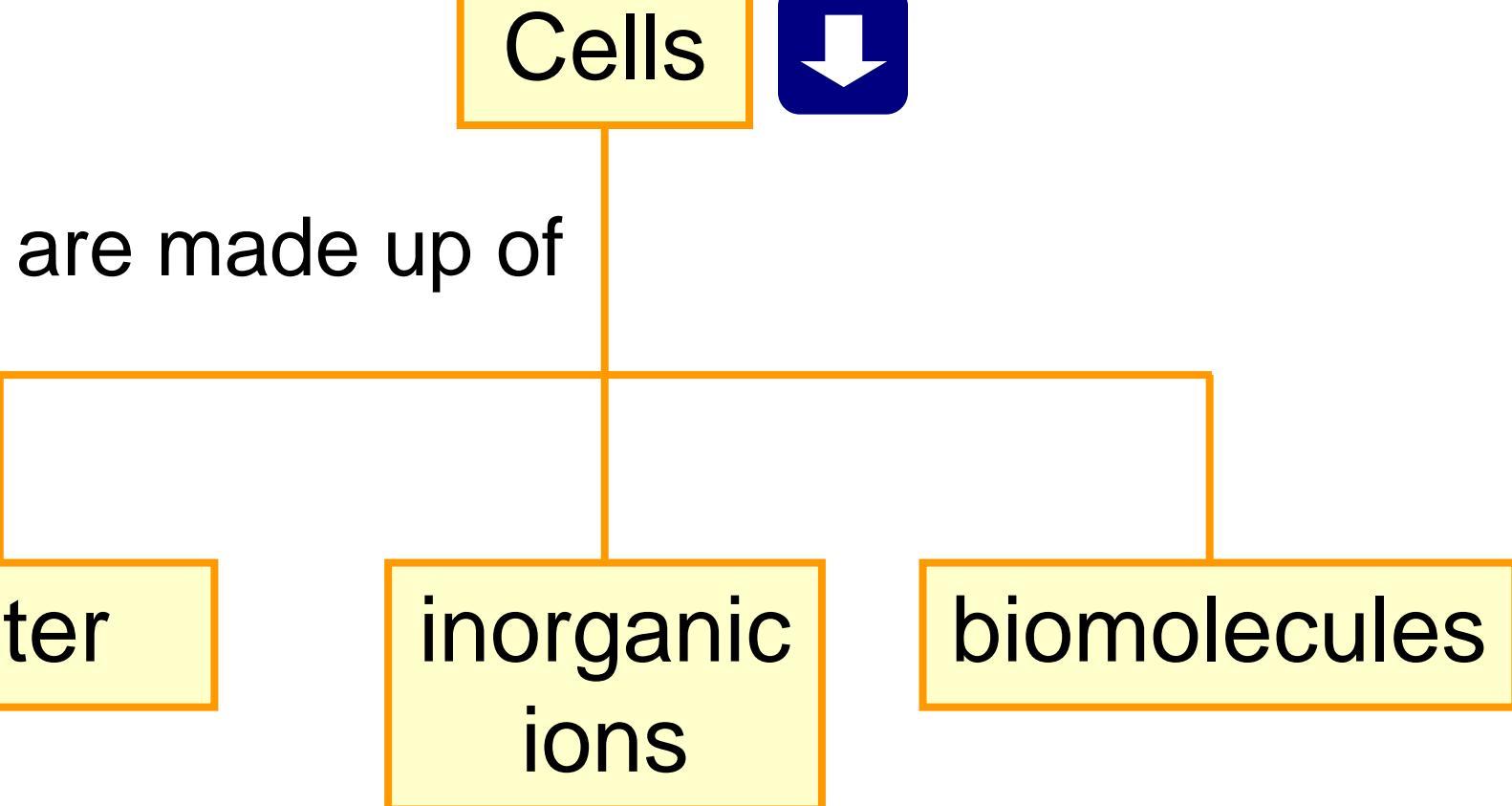
Microscopes

Recall '*Think about...*'

2 To produce new cells, what materials have to be supplied?

Materials like carbohydrates, lipids, proteins and nucleic acids have to be supplied to produce new cells.

Concept map



Concept map

can be observed
under the



microscope



with a true
nucleus

eukaryotic
cells

without
a true
nucleus

prokaryotic
cells

Concept map

microscope



reveals the sub-cellular structures of cells, such as

cell wall

cytoplasm

cell membrane

organelles



Concept map

