NAME _____ CLASS _____ DATE _____

IB BIOLOGY · A2.2

Cell structure

Notes to fill in alongside the guide. Each numbered block matches a chapter of the guide, and of the lesson slides. Write in the gaps, answer the cues, annotate the figures, and sum up each section in your own words.

BY THE END YOU CAN

- [ ] State cell theory and use it to make a prediction about a newly discovered organism A2.2.1
- [ ] Make and stain a temporary mount, focus it, measure a cell with a graticule, and calculate actual size, magnification and a scale bar A2.2.2
- [ ] Outline the advantages of electron microscopy, freeze fracture, cryogenic electron microscopy and fluorescent stains A2.2.3
- [ ] Explain why every cell has DNA, a watery cytoplasm and a plasma membrane A2.2.4
- [ ] Draw and label a prokaryote cell: wall, membrane, cytoplasm, naked DNA in a loop and 70S ribosomes A2.2.5
- [ ] Describe the structures every eukaryote cell has, with the function of each A2.2.6
- [ ] Explain how a single-celled organism carries out all eight functions of life A2.2.7
- [ ] Compare the cells of animals, fungi and plants: walls, vacuoles, plastids, centrioles, cilia and flagella A2.2.8
- [ ] Use numbers of nuclei to describe four atypical eukaryote cells A2.2.9
- [ ] Identify cell types and structures in micrographs, and draw and annotate them from electron micrographs A2.2.10, A2.2.11
- [ ] Explain the endosymbiotic origin of mitochondria and chloroplasts and the evidence for it A2.2.12
- [ ] Explain differentiation as different patterns of gene expression, and why multicellularity evolved again and again A2.2.13, A2.2.14

01 Every living thing is made of cells

A2.2.1

CUES

Predict: Biologists find a new kind of organism in a hot spring. Before they look at it under a microscope, what does cell theory let them predict?

What is meant by cell theory?

What is meant by deduce?

NOTES

1 _____ has three parts.

2 A strong theory also lets you _____ what you have not seen yet.

3 A theory lets you predict: _____.

4 **1665:** Robert Hooke sees the walls of dead cells in cork, and names them _____.

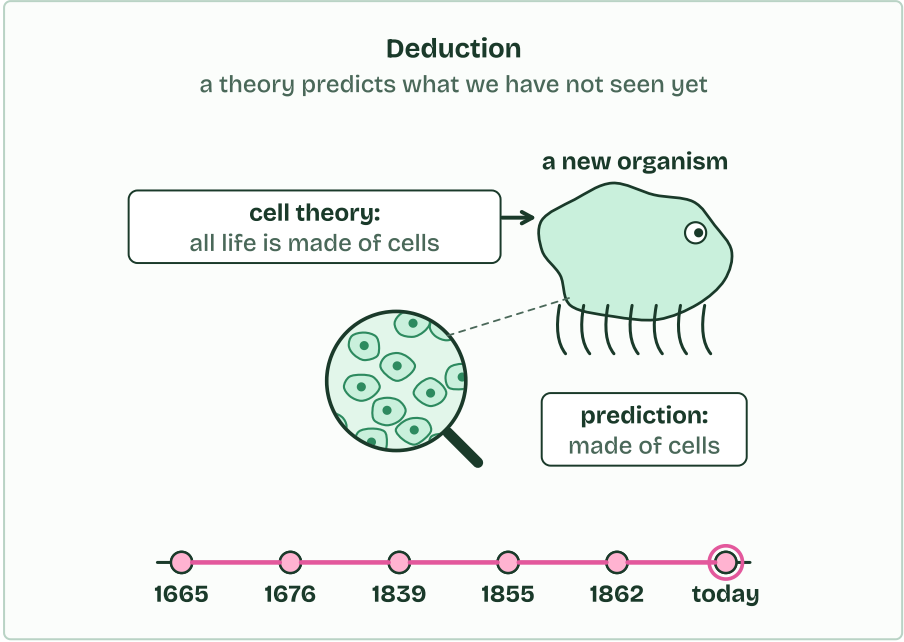
5 **1670s:** Antonie van Leeuwenhoek, with lenses he ground himself, sees _____ in pond water.

6 **1838 and 1839:** Schleiden finds that plants, and Schwann that animals, are _____.

Your own notes

ANNOTATE THE FIGURE

Number the 6 steps on the figure and note what happens at each: 1 1665:, cells; 2 1670s:, living single cells; 3 1838 and 1839:, made of cells; 4 1855:, every cell comes from a cell; 5 1860s:, cells from outside; 6 Today:, predict.



SPOT THE MISTAKE

A student writes: "Cells are the smallest living things." Spot the mistake, then put it right.

The mistake

Put it right

SUMMARY

Sum up section 01 in two or three sentences of your own.

02 Mount it, focus it, measure it

A2.2.2

CUES

Predict: A chloroplast is 5 µm long. In a photograph it is 25 mm long. What is the magnification?

What is meant by temporary mount?

What is meant by stain?

What is meant by eyepiece graticule?

What is meant by stage micrometer?

What is meant by quantitative observation?

What is meant by magnification?

What is meant by scale bar?

NOTES

1 A _____ is a thin layer of cells, such as onion skin or cells scraped from inside your cheek, in a drop of liquid on a slide, with a coverslip lowered at an angle so no air bubbles are trapped.

2 A _____ makes parts show up: iodine for plant cells, methylene blue for cheek cells.

3 An _____ is a scale in the eyepiece, but its units mean nothing until you line it up with a _____, a slide with a real scale on it.

4 Measuring is a form of _____.

5 To find the _____ of a photograph or drawing, divide the image size by the actual size, in the same units.

6 A _____ does the same job and still works when the picture is enlarged.

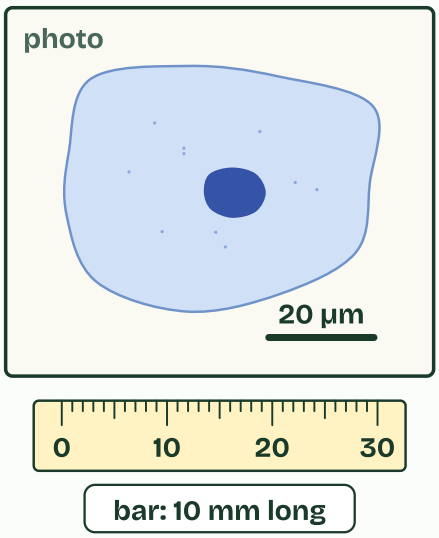
7 Calibrate the graticule against a _____, separately for each objective.

8 _____ = image size ÷ actual size; convert to the same units first.

Your own notes

ANNOTATE THE FIGURE

Number the 5 steps on the figure and note what happens at each: 1 eyepiece graticule; 2 stage micrometer, 1 unit = 2.5 µm; 3 24 units, 60 µm; 4 Magnification = image ÷ actual, ×500; 5 scale bar, 10 mm long.



a scale bar

20 µm × 500
= 10 000 µm
= 10 mm long

REMEMBER IT

Size and magnification

I I	A Am	M Magnified
I	A	M

SPOT THE MISTAKE

What do students often get wrong about microscopy skills? Write the mistake, then put it right.

The mistake

Put it right

SUMMARY

Sum up section 02 in two or three sentences of your own.

03 Seeing smaller: beyond the light microscope

A2.2.3

CUES

Predict: A researcher wants to watch where one particular protein goes inside living cells over an hour. Which technique fits best?

What is meant by resolution?

What is meant by electron microscope?

What is meant by freeze fracture?

What is meant by cryogenic electron microscopy?

What is meant by fluorescent stains?

What is meant by immunofluorescence?

NOTES

1 Making it sharper is the hard part. _____ is how close two points can be and still be seen as separate.

2 An _____ uses a beam of electrons, whose wavelength is far shorter.

3 In _____, frozen cells are cracked open and the break runs through the middle of membranes, showing the proteins inside them.

4 In _____, thousands of copies of a protein are frozen in solution and imaged from every angle, and a computer combines them into a 3D model, without crystals.

5 And back in light microscopy, _____ make one part of a living cell glow; in _____, the dye rides on an antibody that binds a single protein.

6 Light: living cells, colour, about 0.2 µm _____.

7 _____ shows proteins inside membranes; cryo-EM gives protein structures; fluorescence picks out one part or one protein.

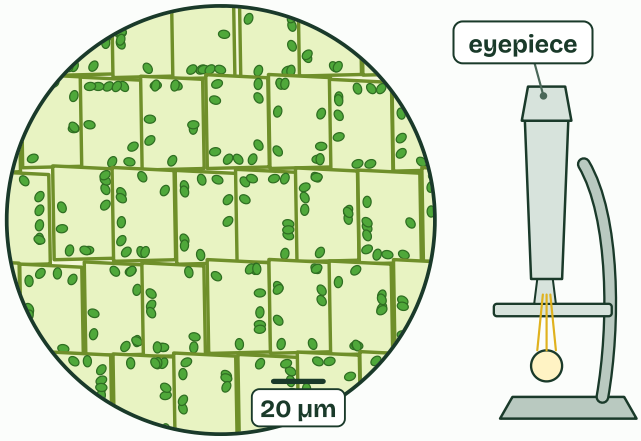
Your own notes

ANNOTATE THE FIGURE

The figure shows it as Light, Electron, Freeze fracture, Cryo-EM and Fluorescence. Note what changes each time.

Light microscope: up to about ×1500

living cells, in colour;
detail down to about 0.2 µm



SPOT THE MISTAKE

What do students often get wrong about developments in microscopy? Write the mistake, then put it right.

The mistake

Put it right

SUMMARY

Sum up section 03 in two or three sentences of your own.

04 What every cell has

A2.2.4

CUES

Predict: Why is the plasma membrane made of lipids rather than proteins or carbohydrates?

What is meant by plasma membrane?

What is meant by ribosomes?

NOTES

1 _____ is the genetic material.

2 It holds the instructions for making the cell's proteins, and it is copied each time the cell divides, so each new cell gets a set. _____ fills the cell.

3 A _____ encloses the cytoplasm.

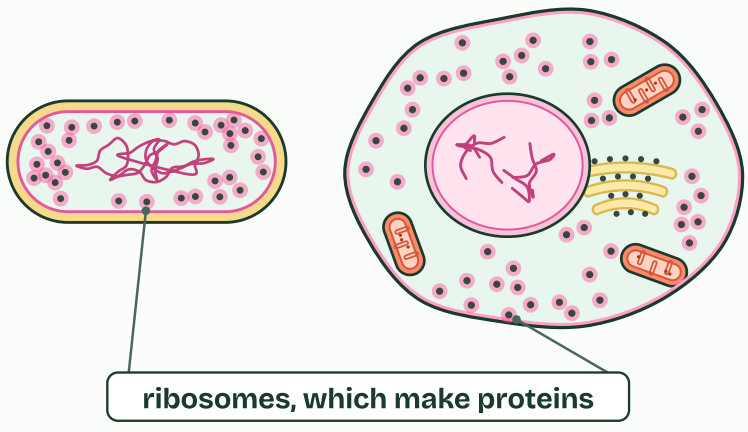
4 Nearly every cell also has _____ to make proteins, though the guide treats them with each type of cell.

5 _____, made of lipids: a barrier that encloses the cell and controls what crosses.

Your own notes

ANNOTATE THE FIGURE

Number the 4 steps on the figure and note what happens at each: 1 plasma membrane; 2 cytoplasm; 3 DNA; 4 ribosomes.



SPOT THE MISTAKE

What do students often get wrong about structures common to cells in all living organisms? Write the mistake, then put it right.

The mistake

Put it right

SUMMARY

Sum up section 04 in two or three sentences of your own.

05 The prokaryote: small, and no nucleus

A2.2.5

CUES

Predict: An antibiotic stops 70S ribosomes working. Why does it harm bacteria much more than the human cells around them?

What is meant by prokaryotes?

What is meant by binary fission?

What is meant by peptidoglycan?

What is meant by naked DNA?

What is meant by nucleoid?

NOTES

1 _____ are the bacteria and archaea.

2 Most are 1 to 5 μm long, and they divide by _____.

3 Outside is a _____ of _____, thick in Gram-positive bacteria.

4 Inside the wall is the _____, then the _____.

5 The DNA is one loop, not wound round proteins, so it is called _____.

6 It sits in a region called the _____, with no membrane round it.

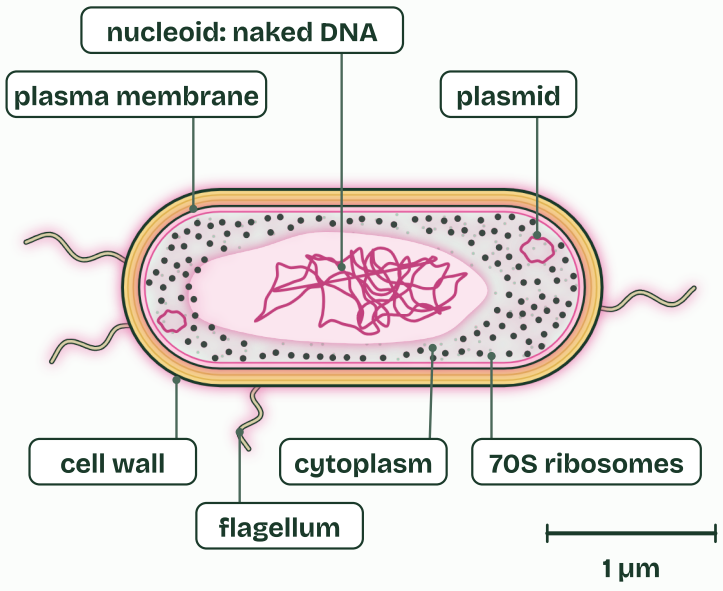
7 Cell wall (_____), plasma membrane, cytoplasm.

8 _____ in a loop, in the nucleoid: no nucleus.

Your own notes

ANNOTATE THE FIGURE

Label each part and say what it does: flagellum, cell wall, plasma membrane, cytoplasm, nucleoid, plasmid, 70S ribosomes.



SPOT THE MISTAKE

What do students often get wrong about prokaryote cell structure? Write the mistake, then put it right.

The mistake

Put it right

SUMMARY

Sum up section 05 in two or three sentences of your own.

06 The eukaryote: a cell of compartments

A2.2.6

CUES

Predict: A cell is 40 µm across, has 80S ribosomes and a cytoskeleton, but in this electron micrograph no nucleus can be seen. Which is the best conclusion?

What is meant by eukaryotes?

What is meant by compartments?

What is meant by histones?

What is meant by lysosomes?

What is meant by cytoskeleton?

NOTES

1 _____ are animals, plants, fungi and protists.

2 Their cells are usually 10 to 100 µm across, and their cytoplasm is divided by membranes into _____.

3 The _____ holds the chromosomes, each one long DNA molecule wound round proteins called _____.

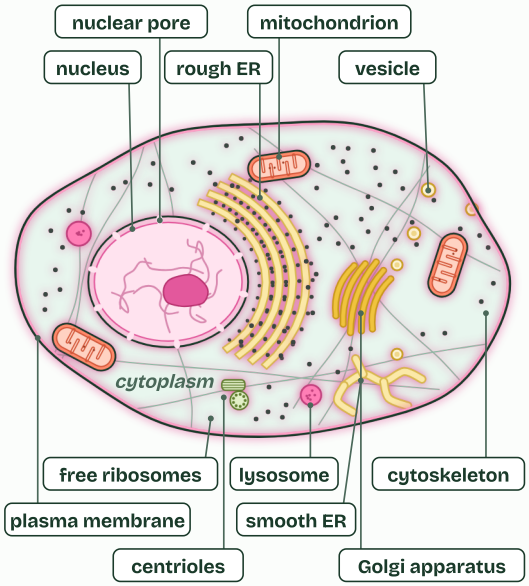
4 In the cytoplasm are _____ and membrane-bound organelles: _____ for respiration, the _____ (rough, with ribosomes, and smooth), the _____, and many _____ and vacuoles, including _____.

5 A _____ of microtubules and microfilaments holds the shape and moves things around.

Your own notes

ANNOTATE THE FIGURE

Label each part and say what it does: cytoskeleton, nucleus, rough endoplasmic reticulum, golgi apparatus, smooth endoplasmic reticulum, mitochondrion, lysosome, vesicle, centrioles, free ribosomes, plasma membrane.



REMEMBER IT

Prokaryote against eukaryote

N	R	D	O	S
Never	Ride	Dragons	Over	Seas
N	R	D	O	S

SPOT THE MISTAKE

A student writes: "Prokaryotes have no organelles." Spot the mistake, then put it right.

The mistake

Put it right

SUMMARY

Sum up section 06 in two or three sentences of your own.

07 One cell, every job

A2.2.7

CUES

Predict: A Paramecium is moved from pond water into a salt solution as concentrated as its cytoplasm. What happens to its contractile vacuoles?

What is meant by homeostasis?

What is meant by excretion?

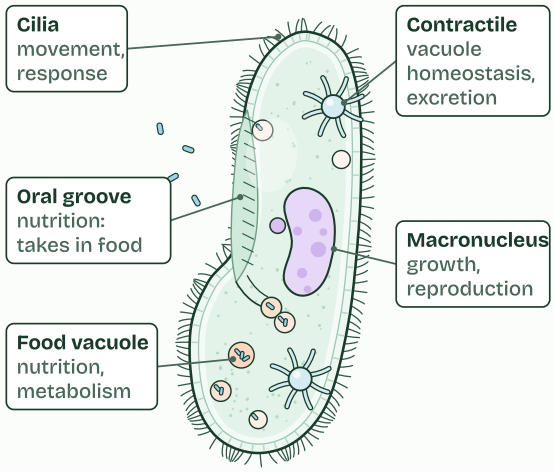
NOTES

1 _____: all the chemical reactions in it. _____: getting food, by eating or by photosynthesis. _____: getting bigger. _____: making more of itself. _____: getting from place to place. _____: reacting to changes around it. _____: keeping its inside steady. _____: getting rid of the waste of metabolism.

Your own notes

ANNOTATE THE FIGURE

The figure shows it as Paramecium and Chlamydomonas. Note what changes each time.



Paramecium: eats bacteria

REMEMBER IT

The eight functions of life

M	H	N	M	E	G	R	R
Many	Hungry	Newts	Munch	Eggs	Grubs	Roots	Rice
M	H	N	M	E	G	R	R

SPOT THE MISTAKE

What do students often get wrong about processes of life in unicellular organisms? Write the mistake, then put it right.

The mistake

Put it right

SUMMARY

Sum up section 07 in two or three sentences of your own.

08 Plant, fungus, animal: spot the difference

A2.2.8

CUES

Predict: A cell has a cell wall, a large vacuole and no chloroplasts. What could it be?

What is meant by chitin?

What is meant by sap vacuole?

What is meant by plastids?

NOTES

1 **Cell walls.** Plant cells have a wall of cellulose and fungal cells a wall of _____.

2 Animal cells have no wall. _____ A plant cell has one large, permanent _____ that stores sugars and salts and keeps the cell firm.

3 Animal cells have only small, temporary ones. _____ Only plants have _____: chloroplasts in green tissue, and amyloplasts that store starch, as in a potato.

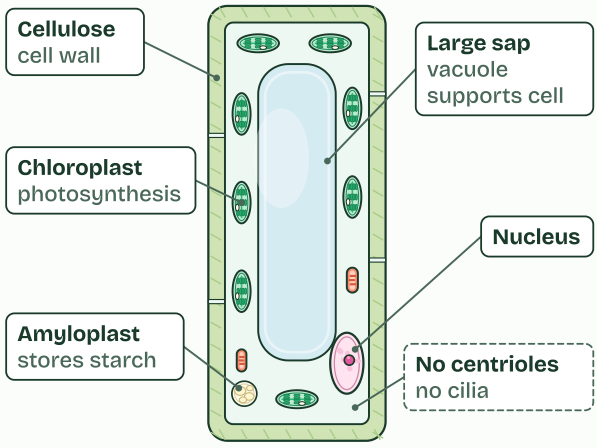
4 Walls: cellulose in plants, _____ in fungi, none in animals.

5 _____ only in plants; centrioles, cilia and flagella mainly in animals.

Your own notes

ANNOTATE THE FIGURE

The figure shows it as Plant, Fungus and Animal. Note what changes each time.



Plant cell

SPOT THE MISTAKE

What do students often get wrong about differences in eukaryotic cell structure between animals, fungi and plants? Write the mistake, then put it right.

The mistake

Put it right

SUMMARY

Sum up section 08 in two or three sentences of your own.

09 Cells that break the rules

A2.2.9

CUES

Predict: A mature red blood cell cannot make new proteins. Why?

What is meant by aseptate hyphae?

What is meant by companion cell?

NOTES

1 **Many nuclei.** Some fungi grow as _____: long tubes with no cross walls, so hundreds of nuclei share one stretch of cytoplasm.

2 A _____ forms when many cells fuse, so one fibre can be several centimetres long, with many nuclei pressed against its membrane.

3 **No nucleus.** A mammal's _____ loses its nucleus as it matures.

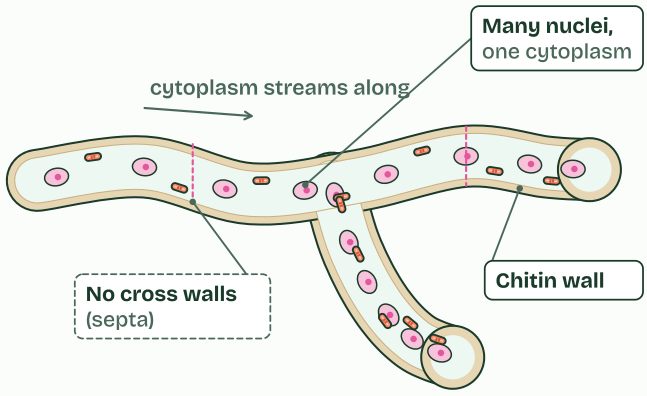
4 A _____ loses its nucleus and most organelles, leaving an open tube for sap to flow through.

5 A _____ beside it keeps it alive.

Your own notes

ANNOTATE THE FIGURE

The figure shows it as Hypha, Muscle, Red blood cell and Phloem. Note what changes each time.



Aseptate fungal hypha

Many nuclei and no cross walls: one long cell.

SPOT THE MISTAKE

What do students often get wrong about atypical cell structure in eukaryotes? Write the mistake, then put it right.

The mistake

Put it right

SUMMARY

Sum up section 09 in two or three sentences of your own.

10 Reading a micrograph

A2.2.10 A2.2.11

CUES

Predict: In an electron micrograph you see a stack of curved, flattened sacs with small round vesicles at their edges and no dots on them. What is it?

What is meant by micrograph?

NOTES

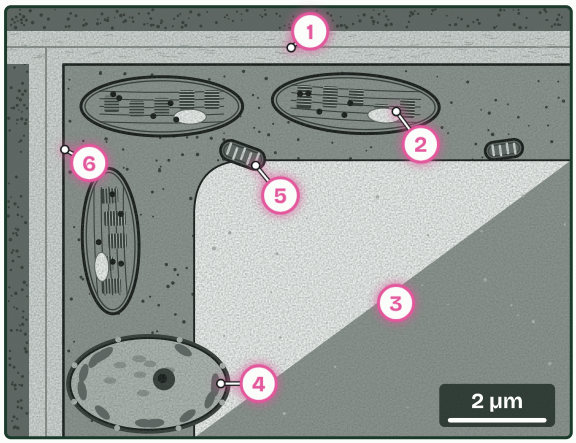
1 A _____ is a photograph through a microscope.

2 Label with ruled lines that do not cross, and _____: add the function of each part beside its name.

Your own notes

ANNOTATE THE FIGURE

Label each part and say what it does: 1 Cell wall, 2 Chloroplast, 3 Sap vacuole, 4 Nucleus, 5 Mitochondrion, 6 Plasma membrane.



Part of a leaf cell
drawn as seen in an electron microscope

SPOT THE MISTAKE

What do students often get wrong about micrographs: identifying, drawing and annotating? Write the mistake, then put it right.

The mistake

Put it right

SUMMARY

Sum up section 10 in two or three sentences of your own.

11 The cell that swallowed a bacterium

A2.2.12 HL

CUES

Predict: If a cell lost all its mitochondria, could it make new ones from its own nuclear genes and membranes?

What is meant by endosymbiosis?

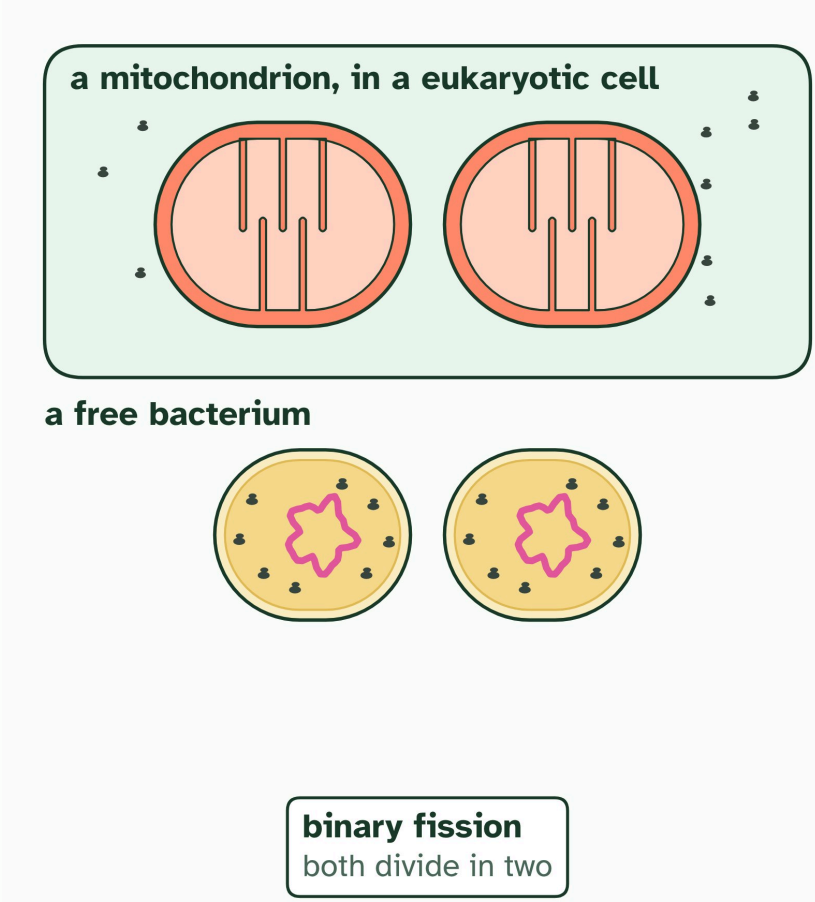
NOTES

1. The theory of _____ says that this ancestor took in an aerobic bacterium by engulfing it, and did not digest it.
2. The evidence is that mitochondria and chloroplasts still look like bacteria. They have _____, like prokaryotes, not the 80S ones in the cytoplasm around them.
3. They have their own _____.
4. They _____: a cell cannot make one from scratch, only by splitting an existing one.
5. They also have _____, the inner one their own and the outer one from the engulfing.

Your own notes

ANNOTATE THE FIGURE

Annotate this still from the animation (Taking in a partner): what is happening, and why?



REMEMBER IT

The evidence for endosymbiosis

D Dad's	R Rusty	D Diesel	D Delivers
D	R	D	D

SPOT THE MISTAKE

What do students often get wrong about origin of eukaryotic cells by endosymbiosis? Write the mistake, then put it right.

The mistake

Put it right

SUMMARY

Sum up section 11 in two or three sentences of your own.

12 Same genes, different cells

A2.2.13 HL A2.2.14 HL

CUES

Predict: Plants and animals are both multicellular. Does that mean their last common ancestor was multicellular?

What is meant by differentiation?

What is meant by gene expression?

NOTES

1 The difference is in which genes are used. _____ happens because different cells have different patterns of _____: some genes switched on, the rest off.

2 And its cells can _____, each doing one job well, while others do the rest.

3 _____: the same genes, different ones expressed, often triggered by the cell's environment.

4 A cell carries _____, none of them yet switched on for a special job.

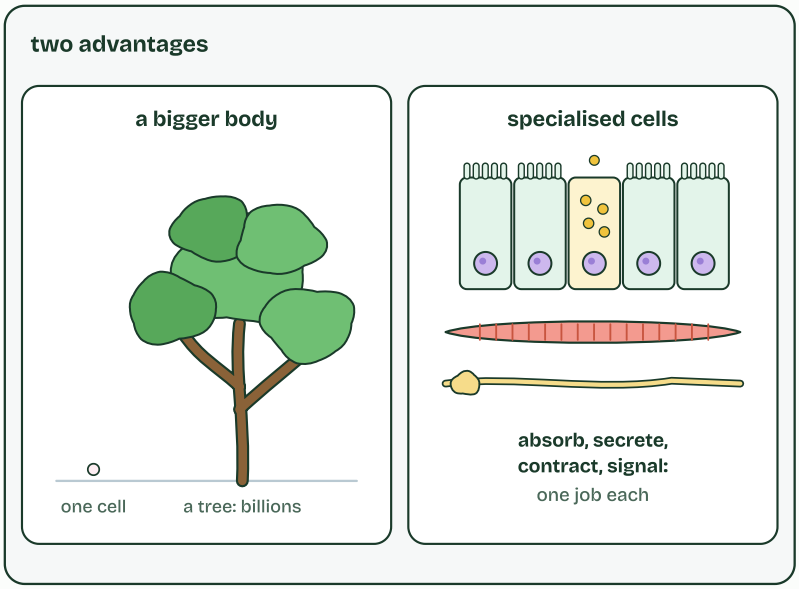
5 Its daughters end up in different places, and a _____ from outside reaches some of them.

6 Each switches on a _____, and becomes a nerve, muscle or gland cell.

Your own notes

ANNOTATE THE FIGURE

Number the 5 steps on the figure and note what happens at each: 1 every gene; 2 signal; 3 different set of genes; 4 evolved separately; 5 bigger body, specialised cells.



SPOT THE MISTAKE

What do students often get wrong about cell differentiation and the evolution of multicellularity? Write the mistake, then put it right.

The mistake

Put it right

SUMMARY

Sum up section 12 in two or three sentences of your own.

Check yourself

The check for this guide is online: a fresh paper of past-paper style questions from the exam bank on A2.2 each time, marked as you go, and saved to your Exam practice progress when you are signed in. Scan the code, or type the link.

biologybybradford.com/exam-maker/sit?topics=A2.2&level=HL&paper=quiz&marks=15&src=ep

How this was made. The course structure, the activities and the teaching choices come from my own classroom, my presentations and my years of teaching IB and AP Biology. I use Claude, an AI, to help write and build the interactive guides, lesson plans, slides and practice questions, and to draw the diagrams and code the interactives. I direct the work and review it against the IB and AP specifications before it goes live.