IB BIOLOGY | B2.2 | SL AND HL

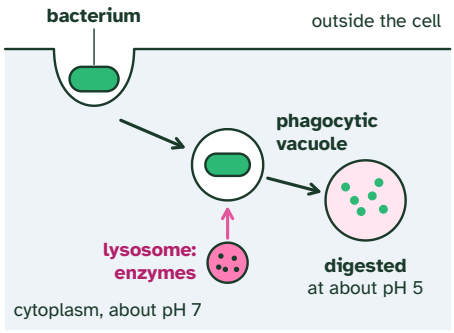
REVISION ON TWO PAGES

A cell of *rooms*

What to know, what to draw and what to say. Nothing else.

THE ONE IDEA

Membranes split a eukaryotic cell into compartments: enzymes kept close, clashing processes kept apart.



Lysosomes show both advantages. Enzymes held concentrated and acid, sealed off from the cytoplasm.

B2.2.3 START HERE

Why compartments *help*

- Membranes divide the cytoplasm of a eukaryote into **compartments**, each holding its own enzymes and conditions.
- **Lysosomes:** sacs of digestive enzymes that work at about pH 5. Loose in the cytoplasm they would digest the cell.
- A white blood cell wraps a bacterium in a **phagocytic vacuole**; lysosomes **fuse with it** and digest the bacterium there, sealed off.

ADVANTAGE 1

Concentration

Enzymes and substrates packed into a small space meet more often, so **reactions run faster**.

ADVANTAGE 2

Separation

Incompatible processes are kept apart, and each compartment keeps its own conditions, such as pH.

B2.2.1

What counts as an *organelle*

- An **organelle** is a discrete part of a cell, its structure **adapted** to a specific job.
- **Fractionation:** cells are broken in **cold, isotonic buffer**, then spun faster and faster; the largest, densest parts (nuclei) pellet first.
- **Nature of science:** the **ultracentrifuge** let each organelle be studied on its own. New techniques drive progress.

Organelles discrete units

Nucleus, mitochondria, chloroplasts, ER, Golgi, lysosomes, vesicles, **ribosomes** and the **plasma membrane**.

Not organelles not separate units

Cytoplasm (everything inside), **cytoskeleton** (runs through the whole cell), **cell wall** (outside the membrane).

B2.2.2

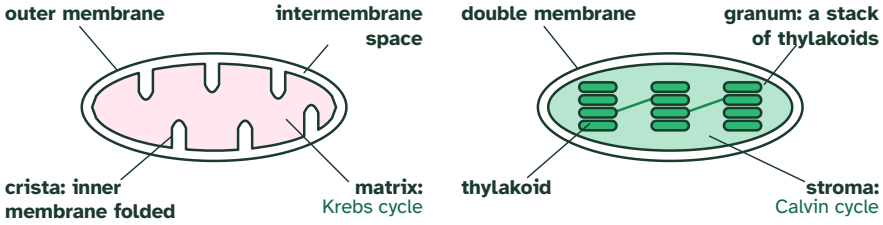
Genes behind a *wall*

- Transcription copies a gene into mRNA; translation reads the mRNA at a ribosome.
- The nuclear envelope **separates transcription from translation**.
- So the mRNA can be **modified before it meets a ribosome**: only finished mRNA is read, and the right protein is made.

	PROKARYOTE	EUKARYOTE
Transcription	In the cytoplasm	In the **nucleus**
Translation	At once, on mRNA still being made	In the **cytoplasm**, later
mRNA edited first?	No: ribosomes may meet it at once	Yes: **introns** cut out, ends protected

B2.2.4 and 5 HIGHER LEVEL

Mitochondrion and chloroplast: one *design*



- Both have a **double membrane**.
- In both, pumped protons build a steep gradient that drives **ATP synthase**.

ADAPTATION	MITOCHONDRION: AEROBIC RESPIRATION	CHLOROPLAST: PHOTOSYNTHESIS
Small inner space	A tiny **intermembrane space**: pumped protons build a **steep gradient** fast.	A tiny space **inside each thylakoid**: the same steep gradient, fast.
Large membrane area	Inner membrane folded into **cristae**: room for many electron transport chains and ATP synthases.	Many **thylakoid membranes**, stacked in grana: room for many photosystems, so more light caught.
Enzymes kept together	The **matrix** holds the **Krebs cycle** enzymes and substrates, so they meet often.	The **stroma** holds the **Calvin cycle** enzymes (Rubisco most of all) and substrates.

From the nucleus to *exocytosis*

B2.2.6 HIGHER LEVEL

Two membranes, many *doors*

- A **double membrane** keeps the genes in their own compartment; the outer one runs on into the rough ER.
- **Nuclear pores**, each a complex of proteins, control what crosses.
- **In mitosis and meiosis** the envelope **breaks into vesicles** so the spindle can reach the chromosomes; the vesicles fuse again afterwards.

OUT THROUGH PORES	IN THROUGH PORES
mRNA and ribosome subunits, to the cytoplasm.	**Enzymes** for copying DNA and making mRNA.

B2.2.7 HIGHER LEVEL

Made here, sent *there*

- A ribosome has a **small and a large subunit**, each of RNA and protein; eukaryote ribosomes are **80S**.
- All start in the cytoplasm. A **signal sequence** at the start of a new protein takes its ribosome to the rough ER.

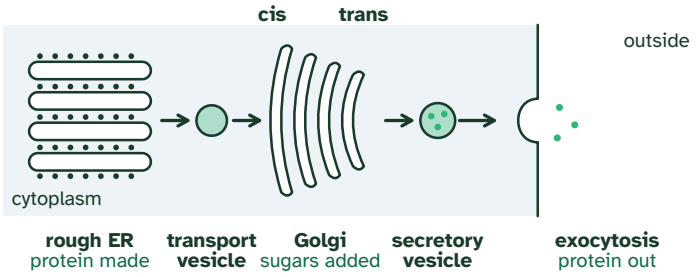
Free ribosomes in the cytosol
Make proteins **kept in the cell**, such as the enzymes of glycolysis.

Bound ribosomes on the rough ER
Thread the protein into the ER lumen, for **secretion**, a membrane or a lysosome. Secreting cells are full of rough ER.

B2.2.8 HIGHER LEVEL

Finish, label, *ship*

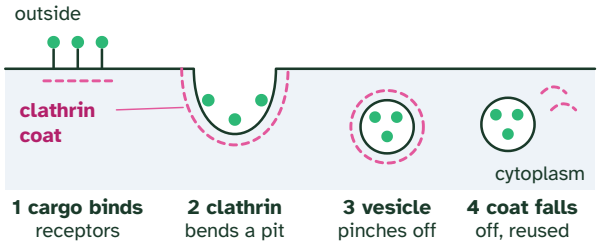
- A stack of flattened, curved sacs of membrane: the **cisternae**.
- **In:** vesicles from the rough ER fuse with the receiving (cis) face.
- **Processed:** sugars are added to make **glycoproteins**; some proteins are trimmed or folded further.
- **Out:** sorted at the far (trans) face into vesicles; a **secretory vesicle** releases its protein by **exocytosis**.



B2.2.9 HIGHER LEVEL

Bubbles that *carry*

- A **vesicle** is a small sac of membrane. It buds from one membrane and fuses with another: ER to Golgi, Golgi to surface or lysosome.
- Its membrane joins the one it fuses with, so exocytosis **adds membrane** to the surface.
- **Clathrin** links into a cage on the cytoplasmic face, **bending the membrane into a pit** that pinches off.



WATCH OUT

Six mistakes that *cost marks*

- ✕ **An organelle needs no membrane round it.** Ribosomes have none; the plasma membrane is one. Both count.
- ✕ **Lysosomes do not empty their enzymes into the cytoplasm.** Digestion stays inside membrane, in the vacuole they fuse with.
- ✕ **Mitochondria do not make energy.** They transfer energy from food to ATP.
- ✕ **The light-dependent reactions are on the thylakoid membranes.** The Calvin cycle is in the stroma.
- ✕ **Free and bound ribosomes are the same kind.** A ribosome binds the ER only while making a protein with the signal.
- ✕ **The Golgi does not make proteins.** It receives them from the rough ER, then modifies and sorts them.

COVER THE SHEET

Can you *answer these?*

1. State two organelles, and two cell parts that are not.
2. Explain why separating nucleus and cytoplasm helps.
3. Outline how lysosomes show both advantages.
4. Explain how the mitochondrion is adapted to make ATP. HL
5. Outline the adaptations of the chloroplast. HL
6. Explain the pores and breakdown of the nuclear envelope. HL
7. Distinguish proteins made by free and bound ribosomes. HL
8. Outline the role of the Golgi in secretion. HL
9. Describe the role of clathrin in forming a vesicle. HL

IN THE EXAM

Tie each structure to its job with "so" ("cristae give a large surface for ATP synthase, so more ATP is made"); for compartments, name **both** advantages: concentration and separation.

GO FURTHER

Animated figures, a film of one protein leaving the cell and a quick check in every chapter are in the full guide online.