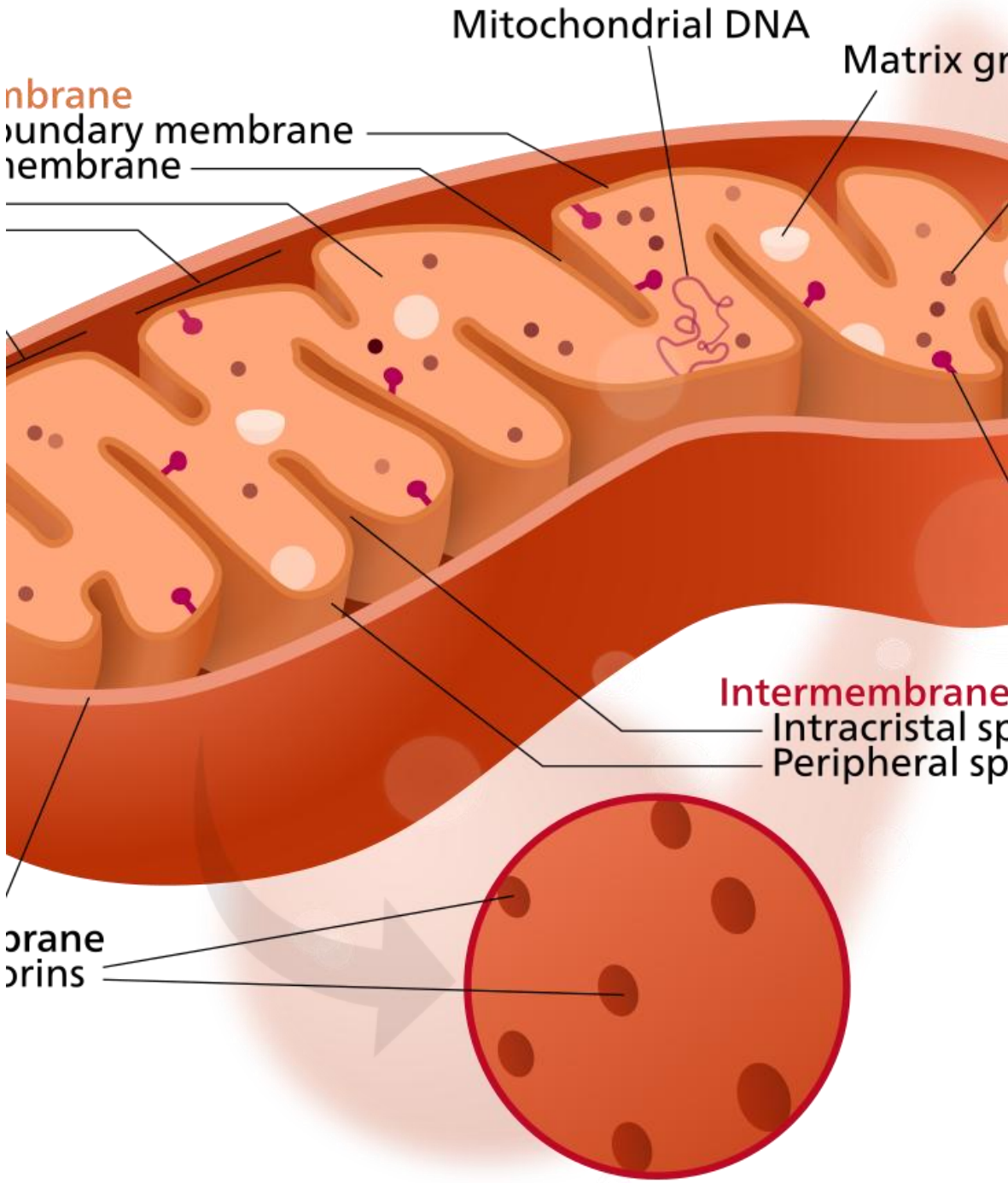
DP Biology – B2.2 (HL extension)

Organelles built for the job

- How does the structure of each organelle suit its function?
- Why is it useful for cells to have separate compartments?



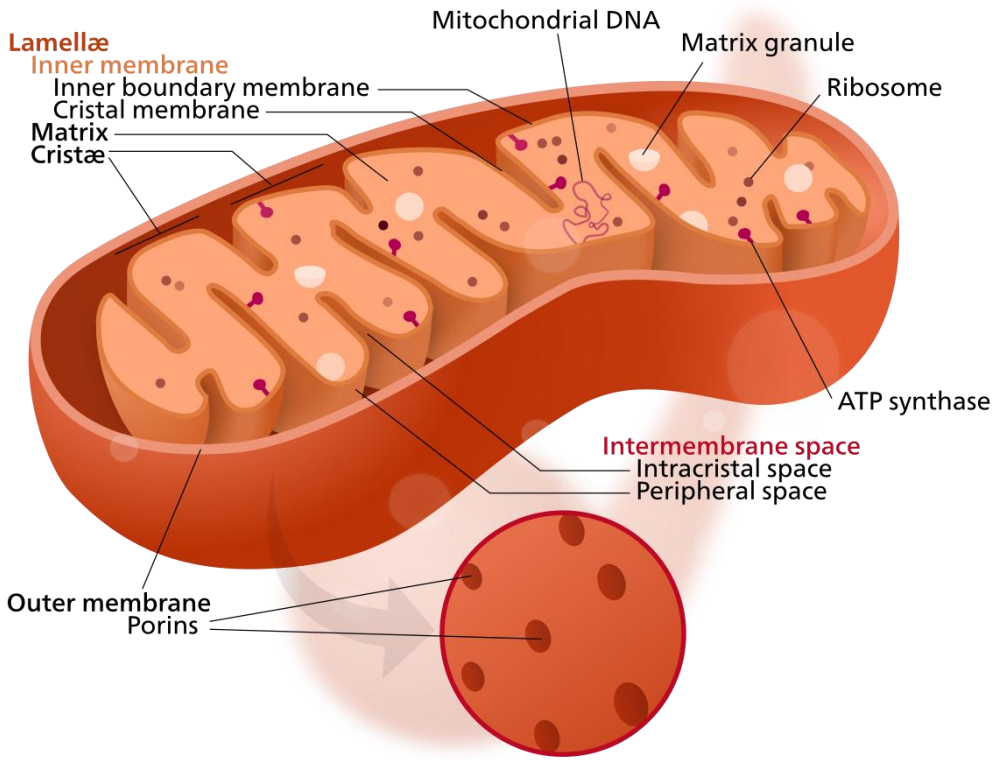
HL statements B2.2.4–9. Textbook pp. 248–255.
Image: a mitochondrion. Kelvinsong, modified by Sowlos, CC BY-SA 3.0.

Objectives for each class

Class	Statements	By the end of the class, you can...
1	B2.2.4–6	Explain how mitochondria, chloroplasts and the nuclear envelope are adapted to their functions
2	B2.2.7–9	Explain how free ribosomes, rough ER, the Golgi apparatus and vesicles produce and move proteins

The mitochondrion: built to make ATP

B2.2.4



Mitochondrion. Kelvinsong, modified by Sowlos, CC BY-SA 3.0.

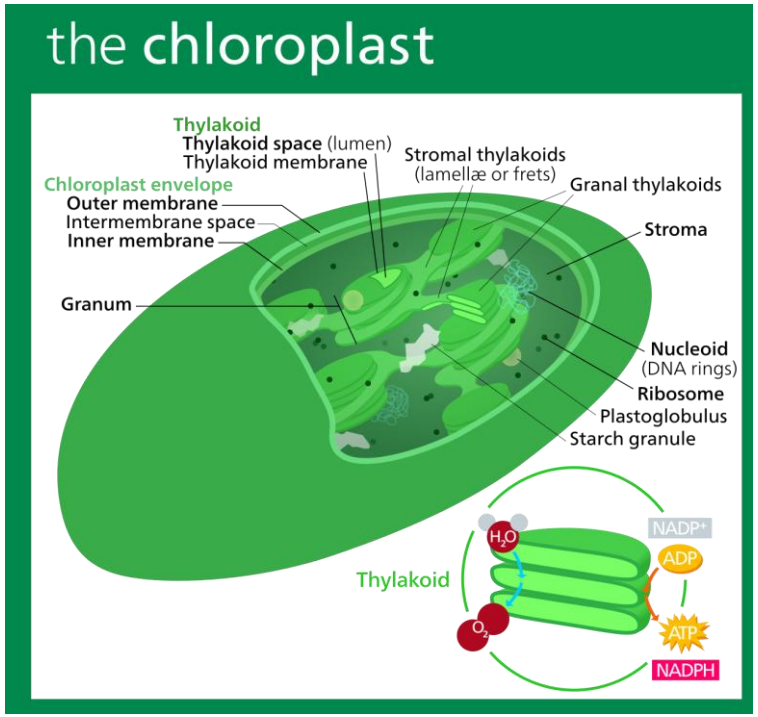
Structure	Adaptation
Double membrane	Separates the reactions of respiration from the cytoplasm
Small intermembrane space	Protons pumped into it build a steep gradient quickly
Cristae	Large surface area for electron transport chains and ATP synthase
Matrix	Holds the enzymes and substrates of the Krebs cycle at the right pH

Key idea

Compartments let the cell keep different conditions side by side: a high proton concentration in the intermembrane space, and the Krebs cycle enzymes concentrated in the matrix.

The chloroplast: built for photosynthesis

B2.2.5



Chloroplast. Kelvinsong, CC BY 3.0.

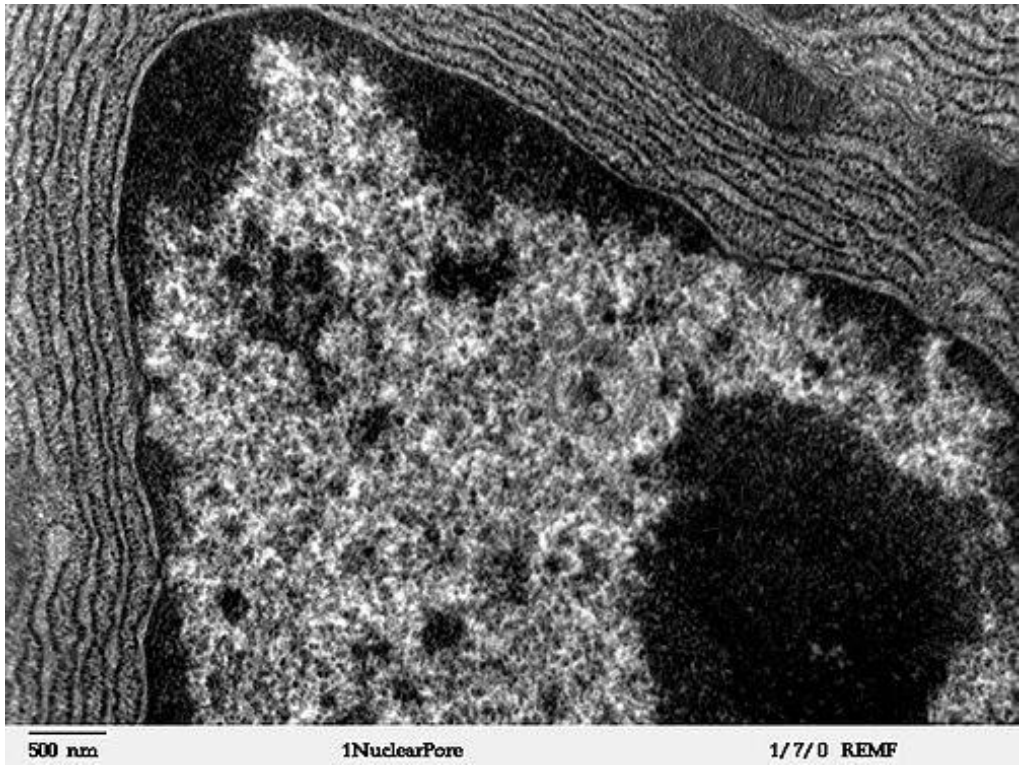
Structure	Adaptation
Thylakoid membranes in grana	Large surface area holding many photosystems, so much light is absorbed
Small volume inside thylakoids	Protons pumped in quickly build a steep gradient for ATP synthase
Stroma	Holds Calvin cycle enzymes, such as rubisco, and their substrates
Double membrane	Keeps photosynthesis separate from the rest of the cell

Compare

Find three similarities with the mitochondrion.

Why the nucleus has a double membrane

B2.2.6



Nucleus edge with rough ER (TEM). Louisa Howard, public domain.

- **Pores** in the envelope control traffic: mRNA out; nucleotides, proteins and ATP in
- A pore complex bridges both membranes, where they join
- The outer membrane is continuous with the rough ER
- DNA is kept apart from the cytoplasm, so transcription and translation are separated

In cell division

At the start of mitosis and meiosis the envelope breaks into small vesicles. This lets spindle microtubules reach the chromosomes. Afterwards the vesicles fuse again around each set of chromosomes.

Two powerhouses compared

B2.2.4–6

	Mitochondrion	Chloroplast
Where protons build up		
Membrane with ATP synthase		
Fluid with a cycle of enzymes		
How surface area is increased		
Source of energy for pumping protons		

Activity

Complete the table in pairs. Then explain why a small space for protons makes ATP production faster.

Free ribosomes and rough ER

B2.2.7

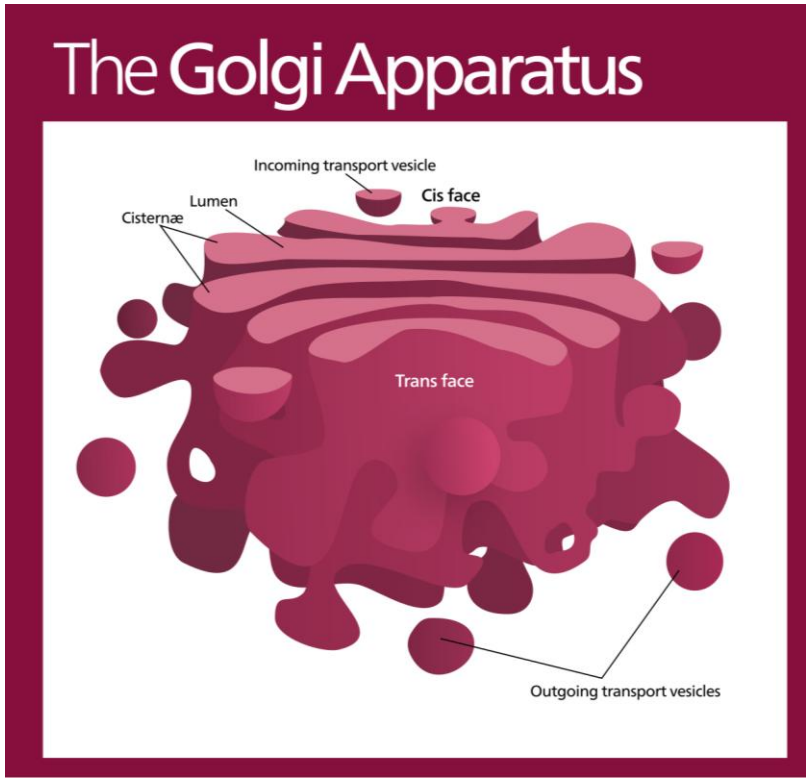
	Free ribosomes	Ribosomes on rough ER
Where	Loose in the cytoplasm	Bound to the ER membrane
Proteins made	Proteins kept in the cytoplasm, such as enzymes of glycolysis	Proteins for secretion, lysosomes or the plasma membrane
Where the protein goes	Released into the cytoplasm (or imported into the nucleus, mitochondria, chloroplasts)	Into the ER lumen, then by vesicles to the Golgi
Ribosome type	80S, the same as bound ones	80S

Polysomes

Several ribosomes can translate one mRNA at the same time, so many copies of the protein are made quickly.

The Golgi apparatus

B2.2.8



Golgi apparatus. Kelvinsong, CC BY 3.0.

- A stack of flattened membrane sacs (**cisternae**)
- Vesicles from the rough ER fuse with the side facing the ER
- Proteins pass from one cisterna to the next; enzymes in each modify them, for example by adding sugars (glycosylation) or phosphate
- Modifications act as labels that send proteins to the right place
- Vesicles bud off the far side, carrying proteins to the plasma membrane or lysosomes

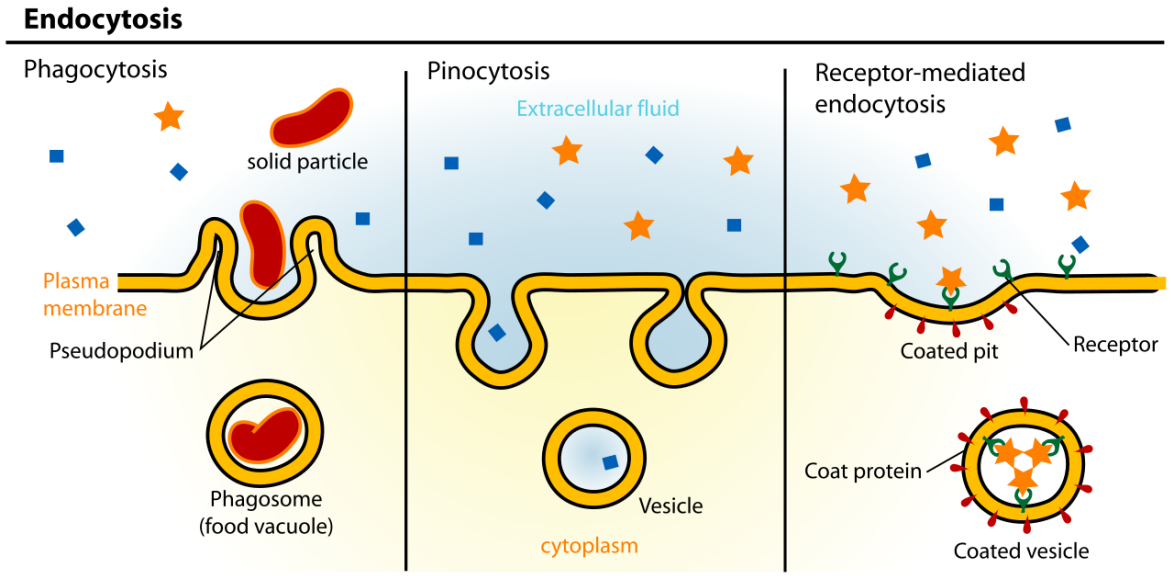
Example

In the pancreas, digestive enzymes are made on rough ER, processed in the Golgi apparatus and secreted by exocytosis.

Vesicles and clathrin

B2.2.9

A substance binds receptors in the plasma membrane → **Clathrin proteins link into a cage on the inner face** → The membrane is pulled inwards into a coated pit → The pit pinches off as a coated vesicle → The clathrin coat comes off; the vesicle moves into the cell



Phagocytosis, pinocytosis and receptor-mediated endocytosis. M. Ruiz Villarreal, public domain.

Uses

Cells take in cholesterol (in LDL), iron and some hormones this way. Many viruses and toxins use it to get in. Vesicles also carry proteins from the rough ER to the Golgi apparatus, and from the Golgi apparatus to the plasma membrane.

Follow a protein out of the cell

B2.2.7–9

1. Draw the route of an antibody from its gene to the outside of a plasma cell. Name each organelle and how the protein moves between them.
2. **Predict** where a protein would end up if its gene lost the signal that sends the ribosome to the ER.
3. **Suggest** why cells that secrete a lot of protein have large amounts of rough ER and Golgi apparatus.

Route

Nucleus (mRNA) → ribosome on rough ER → ER lumen → vesicle → Golgi apparatus → secretory vesicle → exocytosis.

Check that you can explain

1. Three adaptations of the mitochondrion for ATP production
2. Three ways the chloroplast is suited to photosynthesis
3. Two benefits of the double nuclear membrane, including pores and cell division
4. How the destination of a protein depends on where it is made
5. How the Golgi apparatus processes and sorts proteins
6. The role of clathrin in forming vesicles

Exit activity: 5 minutes

On your own and without notes. Hand this in as you leave.

1. State why a small intermembrane space helps ATP production.
2. Distinguish between proteins made by free ribosomes and by ribosomes on the rough ER.
3. Outline the role of clathrin.

Image credits

Mitochondrion structure.svg – Kelvinsong; modified by Sowlos – CC BY-SA 3.0

Chloroplast II.svg – Kelvinsong – CC BY 3.0

Mammalian pancreatic tissue, nuclear pores and rough endoplasmic reticulum.jpg – Louisa Howard – Public domain

Golgi apparatus (standalone version)-en.svg – Kelvinsong – CC BY 3.0

Endocytosis types.svg – Mariana Ruiz Villarreal LadyofHats – Public domain

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