Rooms with jobs

60 minutes • 2.9.A, 2.9.B • Chapters 1, 2, 3, 4 • The dry lab

Compartmentalization, lysosomes and the nucleus, folded membranes for surface area, the endomembrane system and the route of a secreted protein, with the pulse-chase lab

BY THE END, STUDENTS CAN

- [ ] Explain how membranes and membrane-bound organelles compartmentalize a eukaryotic cell's reactions 2.9.A
- [ ] Describe the endomembrane system and the route of a secreted protein through it 2.9.A
- [ ] Explain how internal membranes minimize competing interactions and increase the surface area where reactions happen 2.9.B

TIMING

0–5	5 min	**Do now: the kitchen**	
5–14	9 min	**Keep it apart**	
14–21	7 min	**Folded for surface**	
21–30	9 min	**A route out**	
30–52	22 min	**Follow the label**	
52–60	8 min	**Exit**	
	60 min	**One lesson**	

STARTER

5 min

Do now: the kitchen

"A kitchen keeps the bleach under the sink and the food in the fridge. Name two reasons." Pairs write theirs, then say which a cell might need too.

ON THE BOARD, FROM THE GUIDE

Open the guide on the projector at each chapter (the links work in this PDF). Every figure plays from its own buttons, and the lesson's slides have the same figures, step by step, in the order of this plan.

01 Keep it apart

CHAPTER 01 IN THE SLIDES

Step through the figure (4 steps, the arrow keys on a projector). Stop on each caption and ask what changed before you go on.

1. A white blood cell's membrane flows round a **bacterium**.
2. The bacterium is inside, in a **phagocytic vacuole**. Lysosomes are close by.
3. **Lysosomes fuse** with the vacuole, adding their enzymes in an acid compartment.
4. The bacterium is **digested**; the small molecules made are used by the cell.

> **Predict box:** A lysosome's enzymes work best at pH 5, and the cytoplasm is about pH 7.2. A lysosome leaks a little. What happens? Hands up or mini whiteboards first.
>
> **Answer B: Little harm is done, because the enzymes work poorly at the cytoplasm's pH**

02 Genes behind a wall

CHAPTER 02 IN THE SLIDES

Switch the figure through Prokaryote and Eukaryote, and have the class say what will change before each.

> **Predict box:** Why can a bacterium start making a protein from an mRNA before the mRNA is even finished? Hands up or mini whiteboards first.
>
> **Answer B: Its DNA and ribosomes are in the same compartment, so ribosomes can reach the growing mRNA**

03 Folded for surface

CHAPTER 03 IN THE SLIDES

Step through the figure (3 steps, the arrow keys on a projector). Stop on each caption and ask what changed before you go on.

1. A **flat membrane** across a compartment has room for six enzymes.
2. Fold the same membrane into the **same space** and it holds three times as many.
3. More membrane, more enzymes, **more reactions at once**: cristae and thylakoids.

> **Predict box:** Heart muscle cells have mitochondria with many more cristae than the mitochondria of skin cells. What does this suggest? Hands up or mini whiteboards first.
>
> **Answer B: Heart cells make more ATP, because more inner membrane carries more of the proteins that make it**

04 A route out of the cell

CHAPTER 04 IN THE SLIDES

Play the animation, From gene to outside. It loops; pause it on each moment below and ask what is happening (in the lesson slides it is a video).

1. A pancreas is full of clusters of **acinar cells** round a duct. Each makes digestive enzymes and secretes them into the duct.
2. Inside one cell: the **nucleus**, sheets of **rough ER**, the **Golgi complex** and vesicles of enzyme waiting at the tip.
3. In the nucleus the gene for the enzyme is **transcribed**: an mRNA copy is made.
4. Still inside the nucleus, the mRNA is **modified**: stretches are cut out. No ribosome can reach it until this is done.
5. The finished mRNA leaves through a **nuclear pore**, and a free **ribosome** binds it in the cytoplasm.
6. The first part of the new protein is a **signal sequence**. It leads the ribosome to the **rough ER**, where it binds.
7. The growing chain is threaded through the membrane into the ER's **lumen**, where the signal is cut off and the protein folds.
8. The protein moves through the lumen, and a piece of ER membrane buds off round it: a **transport vesicle**.
9. The vesicle crosses to the near face of the **Golgi complex** and fuses with it.
10. Cisterna by cisterna the protein is **modified**: here, chains of sugar are added.
11. At the far face it buds off in a **secretory vesicle**, one of many waiting near the tip of the cell.
12. The vesicle reaches the **plasma membrane** and fuses with it, releasing the enzyme into the duct: **exocytosis**.
13. Nucleus, rough ER, Golgi, vesicle, out: every protein for secretion takes this route. Proteins kept in the cytosol are made by free ribosomes instead.

> **Predict box:** Cells that secrete a lot of protein, such as those making digestive enzymes, have lots of which structures? Hands up or mini whiteboards first.
>
> **Answer B: Rough ER and Golgi, because those are where proteins for export are made and then processed**

THE LESSON

9 min

Keep it apart

Chapter 1's lysosome figure step by step, then chapter 2's nucleus figure switched between the two cells. Ask what would go wrong if each membrane vanished.

7 min

Folded for surface

Chapter 3's figure. Hand out a strip of paper to fold into a box: how much more strip fits in? Link to cristae and thylakoids, then chapter 3's predict box on heart cells.

9 min

A route out

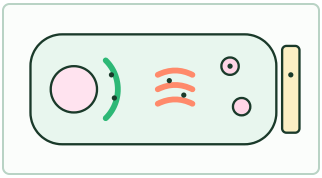
Chapter 4's film, paused at each stop. Students write the route on a mini whiteboard as a chain of organelles, then name what happens at each stop.

22 min

Follow the label

The dry lab on the Lab tab (activity below): groups each take two chase times, pool the class's results on the board, and graph them. Then each group predicts and runs one drug and explains where the label piled up.

ACTIVITIES



DRY LAB

Follow the label

The pulse-chase experiment on the Lab tab: a 3 minute pulse of radioactive amino acid, then a chase of 0 to 117 minutes, and the silver grains counted over each part of the cell. Each group runs two chase times and adds them to a class table, so the whole route builds up on the board, then tests a drug that blocks one step.

Needs: a device per group, a class results table on the board, graph paper.

PLENARY

8 min

Exit

On paper: "Explain how the rough ER and the Golgi complex work together to secrete a digestive enzyme" (3 points).

WHAT STUDENTS GET WRONG

"Compartments are sealed off." Their membranes let some things through, and vesicles link them.

"The Golgi makes proteins." Ribosomes on the rough ER make them; the Golgi modifies and sorts them.

"Folds make the organelle bigger." They put more membrane in the same space.

"Prokaryotes have no organization." They have regions, such as the nucleoid, without membranes.

STRETCH AND SUPPORT

Stretch: predict the pulse-chase results for a protein that stays in the lysosome, and explain the difference from a secreted one.

Support: a blank cell outline with the route drawn as numbered arrows to label.

For revision: students can drill this unit's key terms on Cramly.

IN THE GUIDE

1 Keep it apart
2 Genes behind a wall
3 Folded for surface
4 A route out of the cell
Lab Dry lab: Follow the label
All The whole guide, with the figures that play
PPTX This lesson's slides, in the order of this plan

EXAM PRACTICE

Check yourself

Set it for homework: a fresh paper of exam-bank questions on 2.9, 2.10 each time, marked as students go and saved to their Exam practice when they are signed in.

biologybybradford.com/exam-maker/sit?program=ap&units=U2&ced=2.9,2.10&paper=quiz&marks=15&src=ep

PRACTISE AND REVISE

BUILD FOR YOUR CLASS

- Tarsia puzzle, dominoes and picture reveal on Unit 2, built from its key terms and ready to print
- A pub quiz with rounds on Unit 2, to present or run with no projector
- The Cell Factory Lockdown escape room, or an escape room built from the question bank on Unit 2

ALREADY ON THE SITE FOR UNIT 2

- Lesson: Active & Bulk Transport
- Lesson: The Endomembrane System in Action
- Lab: The Endomembrane System
- Quiz: Cell Compartmentalization & Its Origins
- Exam questions: Unit 2 in the exam maker, a paper with scoring guidelines

CARD SETS ON SPLYCR

Open a set to host it as a class game, or make a copy to edit.

- Unit 2: Cell Structure and Function (part 1)
- Unit 2: Cell Structure and Function (part 2)
- Unit 2: Cell Structure and Function (part 3)

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.