

Cell Compartmentalization

Learning objectives 2.9.A Describe the membrane-bound structures of the eukaryotic cell. 2.9.B Explain how internal membranes and membrane-bound organelles contribute to compartmentalization of eukaryotic cell functions.

Name:Date:Period:

Use the tool **Why Cells Have Rooms**. Work on the **Run the experiment** tab for Parts 1 and 2, **More surface, same volume** for Part 3, and **Different conditions inside** for Part 4. This topic asks you to argue from evidence, so record the numbers — you will need them. Predicting: wherever a Part asks you to predict, write a specific number or word and one reason before you touch the tool, in the form “I think ... because ...”. A wrong prediction costs nothing; a prediction made after looking is not a prediction.

switch tab

scroll down

predict first

record from the tool

score yourself

The purple bar in the margin names the AP science practice a question uses.

Part 1 • The experiment

Run the experiment

More surface, same volume

Different conditions inside

Use the **Run the experiment** tab. It is the one showing when the tool opens.

One substrate, two enzymes of equal speed: one makes the product the cell wants, the other destroys the substrate. The only variable is how much substrate is shut inside a compartment with the wanted enzyme. **Predict the 100% row before you slide the slider.**

Enclosed	Product (predict)	Product (actual)	Waste	Substrate left
0%				
25%				
50%				
75%				
100%				

1. At 0% enclosed the product and the waste were equal. Explain why they had to be, given that the two enzymes work at the same rate.

Part 2 · Argue from the result



Stay on the **Run the experiment** tab.

2. Add product, waste and substrate left for any one row of your table. Do the same for another row. State what you notice and explain why it must be true.

3. Enclosing the substrate roughly doubled the product, with the same substrate, the same enzymes and the same time. Explain where the extra product came from.

4. At 0% enclosed the compartment model gives exactly the same answer as a cell with no compartments at all. Explain why that makes the comparison a fair test.

5. Use this result to explain, in general terms, why compartmentalization allows a cell to carry out incompatible reactions at the same time.

Part 3 · Surface without size

Run the experiment

More surface, same volume

Different conditions inside

-  Click the **More surface, same volume** tab at the top of the tool.
-  Click through all four configurations.

Configuration	Total membrane area	Volume	Area per unit volume
No internal membranes			
A few internal membranes			
Extensive internal membranes			
Mitochondrial cristae			

6. State what happened to the volume as the membrane area increased, and explain why that matters for a cell.

7. Explain how internal membranes increase the surface area available for reactions. Name one organelle where this is obvious.

8. This is the same geometric argument you met in Topic 2.2. State the difference between how it was used there and how it is used here.

Part 4 · Conditions unlike the cytosol

Run the experiment

More surface, same volume

Different conditions inside

-  Click the **Different conditions inside** tab at the top of the tool.
-  Click through every compartment. The cytosol is at pH **7.2**.

Compartment	Internal pH	Difference from cytosol	What it holds
Lysosome			
Mitochondrion (matrix)			
Chloroplast (stroma)			
Nucleus			
Cytosol			

9. Explain why a lysosome has to be enclosed by a membrane. Give two separate reasons.

10. Explain how a membrane makes it possible for a compartment to hold a concentration of a substance that is different from the cytosol's.



Scroll down to **The three advantages** on the same tab. For each claim, pick the result that is evidence for it and click **Check my evidence**. Then answer question 11.

11. A cell's internal membranes are damaged so that its compartments leak. Predict three specific consequences, one for each of the three advantages of compartmentalization.

Part 5 · Learning check self-report



Scroll down to the **Learning check** at the bottom of the tool. Type each answer in your own words, check it, and tick the points you earned. Then record your score here and, for every point you did not earn, write what the rubric asked for that your answer left out.

Question	Points possible	Points I earned	Missed opportunities (what the rubric wanted that I left out)
1	2		
2	2		
3	2		
4	2		
Total	8		

What the model simplifies

The competing-reaction model uses two enzymes with equal rate constants acting on one substrate. Real competing pathways differ in rate, and a real cell has many more than two.

Enclosure is modeled as a clean fraction: substrate is either shut in with the wanted enzyme or out in the cytosol with both. Real compartments leak, and substrates are imported and exported continuously.

Membrane area is expressed as a multiple of the plasma membrane area. The figures for internal membrane are illustrative, though the direction and order of magnitude are right — a liver cell really does have many times more internal membrane than plasma membrane.

pH values are representative resting figures. They vary between cell types, between organisms, and with what the compartment is doing at the time.