AP BIOLOGY · UNIT 2 · TOPIC 2.10

Origins of Cell Compartmentalization

Learning objective 2.10.A Describe similarities and/or differences in compartmentalization between prokaryotic and eukaryotic cells.

Name: Date: Period:

Use the tool **The Endosymbiosis Case**. Work on the **Examine an organelle** tab for Parts 1 and 2, **Judge the evidence** for Part 3, Order the steps for Part 4, and **Build the argument** for Part 5. Most questions ask you to support a claim with evidence, so each answer needs reasoning as well as a fact.

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 · Two explanations, two sets of predictions

Examine an organelle | Judge the evidence | Order the steps | Build the argument

Use the **Examine an organelle** tab. It is the one showing when the tool opens.

Open both explanations at the top of the tool and read what each one predicts. Circle each prediction in the table.

	Engulfed a whole cell	**Folded in from the plasma membrane**
How many membranes? *circle one*	one / two	one / two
Its own DNA? *circle one*	yes / no	yes / no
Its own ribosomes? *circle one*	yes / no	yes / no
How does it divide? *circle one*	on its own, like a bacterium / only with the rest of the cell	on its own, like a bacterium / only with the rest of the cell

1. Describe the endosymbiotic theory.

Part 2 · Collect the evidence

Stay on the **Examine an organelle** tab.

Click each of the five organelles in turn. For each one, make the prediction the tool asks for, then record how many observations point each way. Open each observation to read the reasoning.

Organelle	**Points to engulfing**	**Points to infolding**	**Best supported by** *circle one*
Mitochondrion			engulfing / infolding
Chloroplast			engulfing / infolding
Lysosome			engulfing / infolding
Golgi complex			engulfing / infolding
Endoplasmic reticulum			engulfing / infolding

2. (a) Identify the two organelles that the evidence shows are best explained by engulfing.

(b) Identify the number of lines of evidence that support engulfing for each of these organelles.

SP 6 · ARGUMENTATION

3. For every organelle, all of the evidence pointed the same way. Explain why this makes the conclusion stronger than if the evidence had been mixed.

Part 3 · What counts as evidence

Examine an organelle | **Judge the evidence** | Order the steps | Build the argument

Click the **Judge the evidence** tab at the top of the tool.

Work all ten cards. Each card gives one observation. Two of the observations are not evidence for either explanation.

SP 6 · ARGUMENTATION

4. Describe the condition that an observation must meet to be evidence for one hypothesis over another.

5. The statement “Mitochondria are surrounded by membranes” is true. Explain why this statement is not evidence for the endosymbiotic theory.

6. (a) Identify the strongest line of evidence for the endosymbiotic theory. Provide reasoning to justify your identification.

(b) Identify the weakest line of evidence for the endosymbiotic theory. Provide reasoning to justify your identification.

Part 4 · Put the steps in order

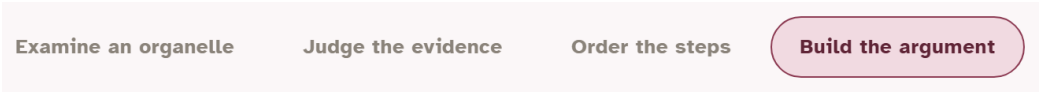


Click the **Order the steps** tab at the top of the tool.

Move the five steps into order with the arrows and match each step to its evidence (A to E), then check. Record your final order and letters here, then do the **How do we know mitochondria came first?** check below it.

Step (shuffled, as in the tool)	**Order (1 to 5)** *circle one*	**Evidence (A to E)** *circle one*
Over many generations the engulfed cell becomes the mitochondrion. It still carries its own circular DNA and prokaryote-like ribosomes, and still divides by fission.	1 / 2 / 3 / 4 / 5	A / B / C / D / E
A prokaryote's plasma membrane folds inward. The infolded membrane becomes the nuclear envelope and the ER: the first internal compartments.	1 / 2 / 3 / 4 / 5	A / B / C / D / E
The cyanobacterium becomes the chloroplast. The cells that carry it are the ancestors of the algae and plants.	1 / 2 / 3 / 4 / 5	A / B / C / D / E
The cell engulfs a smaller, oxygen-using prokaryote and does not digest it. The two live together: the host shelters it and takes the ATP it releases.	1 / 2 / 3 / 4 / 5	A / B / C / D / E
A cell that already has mitochondria engulfs a photosynthetic prokaryote, a cyanobacterium.	1 / 2 / 3 / 4 / 5	A / B / C / D / E

Part 5 · Build the argument



Click the **Build the argument** tab at the top of the tool.

Read the argument on that tab. Then answer questions 7 to 10 without copying the tool's wording.

7. Scientists claim that mitochondria originated as free-living prokaryotic cells.
(a) Identify three lines of evidence that support this claim.

(b) For each line of evidence in part (a), explain why the infolding explanation does not predict it.

8. (a) Based on the endosymbiotic theory, describe the origin of each of the two membranes of a mitochondrion.

(b) Explain why a double membrane is evidence for engulfing rather than infolding.

9. Using evidence from the tool, explain why the lysosome is thought to have arisen by infolding rather than by engulfing.

10. Justify the claim that mitochondria were acquired before chloroplasts.

Part 6 · Learning check self-report

Scroll down to the **Learning check** at the bottom of the tool. Type an answer to each question, check it against the rubric, and check off 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	3		
3	2		
4	2		
Total	**9**		

What the model simplifies

The two hypotheses are presented as a clean pair. The real history is messier: there is active research on how many engulfing events there were, in what order, and how much of the original genome moved to the nucleus.

Evidence is scored by counting lines. Real scientific arguments weigh evidence rather than counting it, which is why the tool and this handout also ask which line is strongest and which is weakest.

The infolding account for the endomembrane system is well supported but less directly than endosymbiosis, because there is no surviving free-living relative to compare against.

The tool draws a mitochondrion and a chloroplast at similar sizes for clarity. A chloroplast is usually considerably larger.