

Year 12 HL

IB BIOLOGY

1.5 The Origin of Cells

Name:

Teacher:

1.5 The Origin of Cells

Essential idea: There is an unbroken chain of life from the first cells on Earth to all cells in organisms alive today.

Nature of science: Testing the general principles that underlie the natural world—the principle that cells only come from preexisting cells needs to be verified.

Understandings:

- Cells can only be formed by division of pre-existing cells.
- The first cells must have arisen from non-living material.
- The origin of eukaryotic cells can be explained by the endosymbiotic theory.

Applications and skills:

- Application: Evidence from Pasteur's experiments that spontaneous generation of cells and organisms does not now occur on Earth.

The Origin of Life

Watch the video *"Can Science Explain the Origin of Life"*

<https://www.youtube.com/watch?v=fgQLyqWaCbA> and answer these questions:

<https://edpuzzle.com/media/5d762a6be6fcb7410fa05f64>

1. Briefly outline how evolution has allowed simple life forms to evolve into more complex life forms.
2. How does the fossil record support Darwin's theory of evolution?
3. What do the records suggest that all life on Earth originated from and when?
4. Why could the first reproducing creature not have developed through biological evolution?
5. What is the current theory of the origin of life?
6. In what two ways is the chemistry of life special?

7. What is “the vital force” and why did scientists suggest this idea?
8. What did Wohler produce accidentally in 1828 and why was this significant?
9. What are meteorites and why are they important in the study of the origin of life?
10. Describe “chemical evolution”.
11. What is self-assembly? What sort of biological molecules may build in this way?
12. Can science currently explain the origin of life? Explain your answer.

Conditions needed for life on Earth and Miller and Urey Experiment

<https://www.youtube.com/watch?v=NNijmxsKGbc>

What four processes are needed for spontaneous life to occur on Earth?

Where might some of the molecules necessary for life have come from?

What two things are needed for organic molecules to be formed?

In what type of places are these conditions likely to be found?

What gases were in the early atmosphere?

When did oxygen appear on Earth?

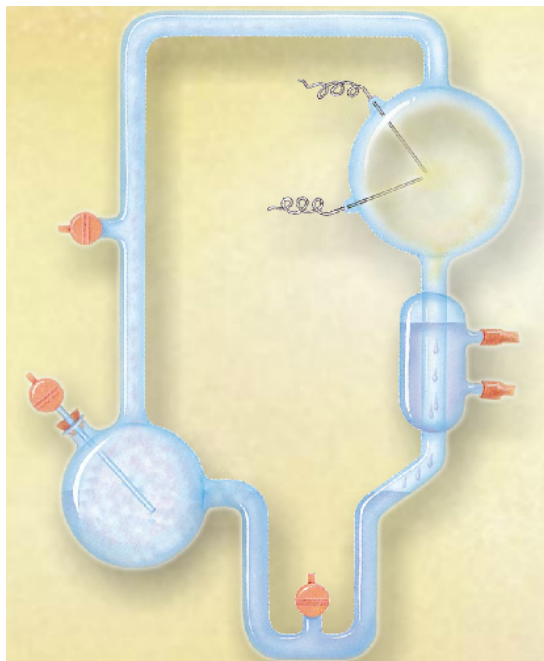
What two sources of energy might be responsible for converting the simple gases into organic molecules?

What did the researchers find in the water after 1 week?

What happened to these simple compounds?

What conclusion can be drawn from this and other similar experiments?

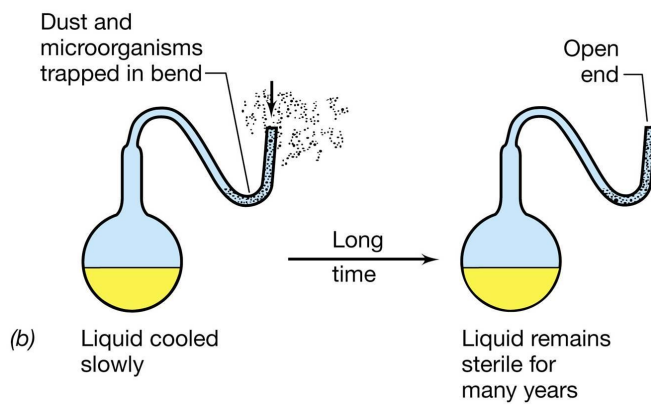
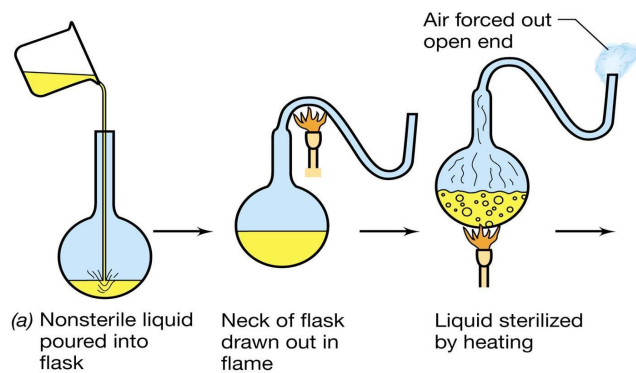
Annotate the diagram of Miller and Urey's apparatus below. Why is each part necessary?



Pasteur and Spontaneous Generation

<https://www.youtube.com/watch?v= ZzJ6NcmiKU>

Use the diagrams below to explain Pasteur's experiment and his findings:



The Endosymbiont Theory

Watch the video *"Endosymbiont Theory in Plain English"*

<https://www.youtube.com/watch?v=bBjD4A7R2xU> and then answer the questions:

What is the meaning of these words?

Endo

Symbiosis

Endosymbiosis

List some examples of symbiosis seen in the video:

What do the following represent?

Big Tony

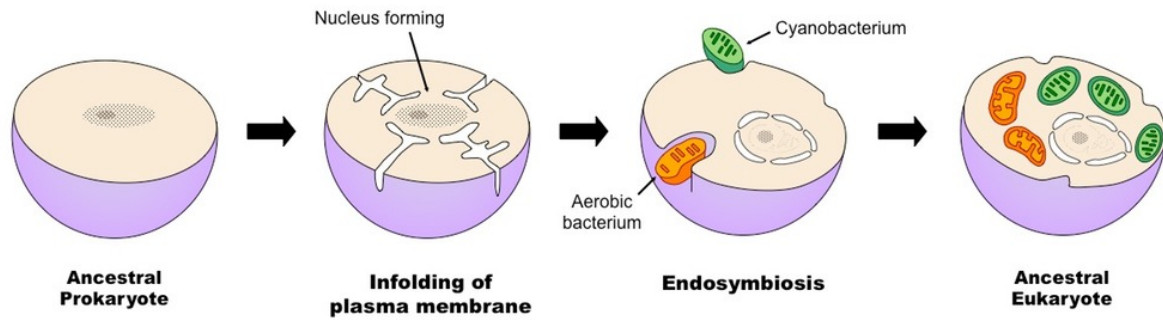
Little Jon

Little Jim

What benefit does endosymbiosis give to each of the cells in the relationship?

What is the evidence for this theory?

Use the diagram below to explain how endosymbiosis was believed to have occurred:



Look at the animation here: <http://www.sumanasinc.com/webcontent/animations/content/organelles.html>

List 4 pieces of evidence which suggest that mitochondria and chloroplasts were once free-living prokaryotes:

1. Which statement is part of the cell theory?
- A. Cells are composed of organic molecules.
 - B. Cells have DNA as their genetic material.
 - C. Cells have cytoplasm surrounded by a membrane.
 - D. Cells come from pre-existing cells.

(Total 1 mark)

2. Which of the following is a characteristic of organelles?
- A. They are only found in eukaryotic cells
 - B. They are only found in prokaryotic cells
 - C. They are sub-cellular structures
 - D. They are all membrane bound

(Total 1 mark)

3. Which type of cell is likely to have arisen first?
- A. Prokaryote
 - B. Animal cell
 - C. Plant cell
 - D. Virus

(Total 1 mark)

4. The spontaneous origin of life on Earth is thought to have involved the non-living synthesis of simple organic molecules.

(a) List **two** other processes needed for the spontaneous origin of life.

.....

.....

.....

(2)

(b) Outline the evidence that the spontaneous generation of cells does not now occur.

.....

.....

.....

.....

.....

(3)

5. (a) State **two** properties of RNA that would allow it to play a role in the origin of life.

.....

.....

.....

(2)

(b) Outline the experiment of Miller and Urey into the origin of organic compounds.

.....

.....

.....

.....

.....

(3)

6. Discuss the endosymbiotic theory for the origin of eukaryotes.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total 6 marks)

1. D [1]

2. C [1]

3. A [1]

4. (a) simple molecules must polymerize/assemble into polymers;
origin of self-replicating molecules / formation of self-replicating molecules;
simple molecules must become isolated from the surroundings/enclosed in
membranes;
2 max

(b) Pasteur's experiments;

Sterilised broth;
The container was designed to not allow contamination;
No growth occurred in the uncontaminated container / growth only occurred in the container that allowed contamination; 3 max

5. (a) RNA can replicate;
can act as a catalyst;
can code for information; 2 max

- (b) simulated conditions of pre-biotic earth (in closed container);
water vapour;
mixture of ammonia, methane, hydrogen / reducing atmosphere;
sparks/electric (discharge to simulate lightning);
condenser / cooling of mixture;
obtained amino acids; 3 max

6. eukaryotes evolved from prokaryotes;
mitochondria/chloroplasts evolved from (independent) prokaryotic cells;
taken in by larger (heterotrophic) cell by endocytosis;
theory supported by characteristics of chloroplasts/mitochondria;
[2 max] for mitochondria/chloroplast characteristics:
mitochondria/chloroplasts have naked DNA;
mitochondria/chloroplasts divide/carry out fission;
mitochondria/chloroplasts have 70S ribosomes / synthesise own proteins;
mitochondria/chloroplasts have double membranes;
cristae similar to mesosomes / thylakoid have similar structures in prokaryotes;
but theory cannot be falsified as it predicts something occurring in the past;
theory does not explain the origins of cilia/flagella/linear chromosomes/meiosis;
weaker evidence that cilia/flagella evolved from attached bacteria/spirochetes; 6 max