Before life HL

60 minutes • A2.1.1 to A2.1.4 • Chapters 1, 2, 3

Living and non-living, why viruses are counted as non-living, conditions on early Earth and the Miller-Urey experiment

BY THE END, STUDENTS CAN

- [ ] Describe the conditions on early Earth and how they may have let carbon compounds form without life A2.1.1
- [ ] Distinguish living from non-living, and explain why viruses are usually counted as non-living A2.1.2
- [ ] Explain why the spontaneous origin of cells is hard to explain, and what had to arise first A2.1.3
- [ ] Evaluate the Miller-Urey experiment as evidence for the origin of carbon compounds A2.1.4

TIMING

0–8	8 min	**Do now: alive or not?**	
8–17	9 min	**What counts as alive**	
17–39	22 min	**Spontaneous origins: jigsaw**	
39–54	15 min	**Lightning in a flask**	
54–60	6 min	**Exit**	
	60 min	**One lesson**	

STARTER

8 min

Do now: alive or not?

Cards of a virus, a seed, a red blood cell, a flame, a crystal and a mule. Pairs sort them into alive, not alive and not sure, then defend one card each.

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 **What counts as alive?** CHAPTER 01 IN THE SLIDES

Switch the figure through A cell and A virus, and have the class say what will change before each.

> **Predict box:** Which feature of a virus is the strongest reason for calling it non-living? Hands up or mini whiteboards first.
> **Answer B: It has no metabolism of its own and can only be copied by the machinery of a host cell**

02 **A world without oxygen** CHAPTER 02 IN THE SLIDES

Switch the figure through Four billion years ago and Today, and have the class say what will change before each.

> **Predict box:** Why could amino acids build up in the early sea but not in today's? Hands up or mini whiteboards first.
> **Answer B: There was no oxygen to break them down and no living things to consume them as food**

03 Lightning in a flask

CHAPTER 03 IN THE SLIDES

Play the animation, The Miller-Urey experiment. It loops; pause it on each moment below and ask what is happening (in the lesson slides it is a video).

1. **Heat**: water boils in the small flask, standing in for the early oceans. Its vapour carries methane, ammonia and hydrogen round a sealed loop of glass.
2. The gases pass a **spark** between two electrodes, standing in for lightning. Its energy breaks bonds, and new, reactive molecules form, such as hydrogen cyanide (going deeper).
3. The **condenser** cools the vapour, like rain. Water, and anything dissolved in it, drips into the trap, and the cycle goes round again.
4. **A week on**, the liquid in the trap has turned pink, then brown, as new compounds build up.
5. **Tested** by chromatography beside known amino acids, the liquid holds **amino acids**, glycine and alanine most of all: carbon compounds of life, made with no life present.
6. **Evaluating** it: amino acids formed from simple molecules with no life present. But the early air was probably mostly carbon dioxide and nitrogen, and amino acids are a long way from a cell.

> **Predict box:** The experiment is repeated with nitrogen, carbon dioxide and water instead of methane, ammonia and hydrogen. What would you predict? Hands up or mini whiteboards first.
>
> **Answer B: Far fewer amino acids, because those gases are less ready to react when given the spark's energy**

THE LESSON

9 min

What counts as alive

Chapter 1 and its figure. Students list the functions of life and tick which a virus carries out by itself.

22 min

Spontaneous origins: jigsaw

The information sheets below, one to each expert group, then home groups pool them.

15 min

Lightning in a flask

Chapters 2 and 3 and the film. Students run it with the spark off and with today's air, then write one strength and two limits of the experiment.

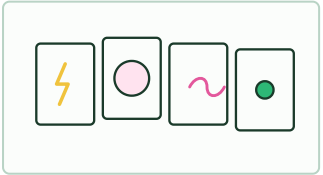
ACTIVITIES

CARD SORT

Alive or not?

Six to eight cards: a virus, a seed, a red blood cell (no nucleus), a flame (it "grows" and "feeds"), a salt crystal (it "grows"), a mule (it cannot reproduce), a prion. Pairs sort them, then try to write a definition of life that puts every card in the right pile. The flame and the mule show why one function alone is not the test.

Needs: the cards cut up.



JIGSAW

Spontaneous origins

Four information sheets: conditions on early Earth, pre-biotic carbon compounds and Miller-Urey, vesicles and compartments, RNA and the first genetic material. Each expert group reads one and makes a five-line summary with one piece of evidence and one doubt. Home groups of four then teach each other and build one flow chart from early Earth to the first cell.

Needs: the information sheets, one set a group.

PLENARY

6 min

Exit

Why did Miller run the apparatus without a spark as well?

WHAT STUDENTS GET WRONG

"Viruses are alive because they reproduce." They are copied by a host cell; they do nothing by themselves.

"Miller-Urey made life." It made amino acids, a long way from a cell.

"Early Earth had an ozone layer." No oxygen means no ozone, so UV reached the surface.

STRETCH AND SUPPORT

Support: give the captions of each figure and the film as a cut-up storyboard to put in order, and use the key terms (tap the dotted words) as a glossary.

Stretch: meteorites such as Murchison hold amino acids. Does that support or weaken the case that amino acids formed on Earth?

IN THE GUIDE

1 What counts as alive?

2 A world without oxygen

3 Lightning in a flask

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 A2.1 at higher level each time, marked as students go and saved to their Exam practice when they are signed in.

biologybybradford.com/exam-maker/sit?topics=A2.1&level=HL&paper=quiz&marks=15&src=ep

PRACTISE AND REVISE

BUILD FOR YOUR CLASS

- Tarsia puzzle, dominoes and picture reveal on A2.1, built from its key terms and ready to print
- A pub quiz with rounds on A2.1, to present or run with no projector
- An escape room built from the question bank on A2.1

ALREADY ON THE SITE FOR A2.1

- Quiz: Origins of Cells (HL)
- Revision map: A2.1 Origins of cells, to fill in
- Exam questions: A2.1 in the exam maker, a paper with its markscheme

CARD SETS ON SPLYCR

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

- A2.1 Origins of Cells (HL)

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.