Where did life begin? Evidence sheet.

Name: Class: Date:

Use this sheet alongside the lesson. Rate the two models before you look at any evidence, link each piece of evidence to both models as you meet it, and weigh it all up at the end.

SCREEN 1 Two models

MODEL A A shallow pool struck by lightning
Life began in shallow water at the surface, where lightning and sunlight drove the chemistry.

MODEL B A hydrothermal vent on the ocean floor
Life began on the dark ocean floor, where hot water from hydrothermal vents drove the chemistry.



Model A, on the left: a shallow pool on a volcanic island, struck by lightning. Model B, on the right: a black smoker on the dark ocean floor. Drawings, not to scale.

SCREENS 1 AND 10 How believable is each model?

Circle a number for each model: 1 is not at all believable and 10 is very believable.

BEFORE ANY EVIDENCE (SCREEN 1)	**Model A**	1 2 3 4 5 6 7 8 9 10
	Model B	1 2 3 4 5 6 7 8 9 10
AFTER ALL THE EVIDENCE (SCREEN 10)	**Model A**	1 2 3 4 5 6 7 8 9 10
	Model B	1 2 3 4 5 6 7 8 9 10

SCREENS 1, 3 TO 7 AND 9 Four kinds of link

Link each piece of evidence to each model in one of four ways. Different links can be fair if your reason holds up.

- Strongly supports
- Supports
- Has nothing to do with
- Contradicts

Tick one link for each model, then give your reason. On screen 10 you can change any link you now see differently.

1 No oxygen in the air

SCREEN 1

Until about 2,400 million years ago the air held almost no free oxygen: less than a millionth of today's amount at the surface (Catling and Zahnle, 2020).

Model A	☐ Strongly supports	☐ Supports	☐ Has nothing to do with	☐ Contradicts
Model B	☐ Strongly supports	☐ Supports	☐ Has nothing to do with	☐ Contradicts

Why did you choose these links?

2 Sparks make amino acids

SCREEN 3

Sparks passed through methane, ammonia, hydrogen and water vapour made amino acids (Miller, 1953). With the carbon dioxide and nitrogen most scientists now expect, yields were low until the molecules were protected from oxidation (Cleaves and others, 2008).

Model A	☐ Strongly supports	☐ Supports	☐ Has nothing to do with	☐ Contradicts
Model B	☐ Strongly supports	☐ Supports	☐ Has nothing to do with	☐ Contradicts

Why did you choose these links?

3 Vents supply energy and minerals

SCREEN 4

Vents pour out hot water carrying hydrogen and other gases that microbes use for energy (WHOI). A reactor built to copy an alkaline vent appeared to make low yields of simple organic molecules (Herschy and others, 2014).

Model A	☐ Strongly supports	☐ Supports	☐ Has nothing to do with	☐ Contradicts
Model B	☐ Strongly supports	☐ Supports	☐ Has nothing to do with	☐ Contradicts

Why did you choose these links?

4 Life in the dark today

SCREEN 5

Whole communities of animals live around vents today on chemical energy from microbes, without sunlight (WHOI). One vent microbe grows at 122 °C under high pressure (Takai and others, 2008).

Model A	☐ Strongly supports	☐ Supports	☐ Has nothing to do with	☐ Contradicts
Model B	☐ Strongly supports	☐ Supports	☐ Has nothing to do with	☐ Contradicts

Why did you choose these links?

5 Drying joins molecules into chains

SCREEN 6

In the laboratory, cycles of drying and wetting again join small molecules into chains, wrapped in fatty membranes, as the edge of a hot spring pool dries and refills (Damer and Deamer, 2020).

Model A	☐ Strongly supports	☐ Supports	☐ Has nothing to do with	☐ Contradicts
Model B	☐ Strongly supports	☐ Supports	☐ Has nothing to do with	☐ Contradicts

Why did you choose these links?

6 Hot springs in the Dresser Formation

SCREEN 7

Hot spring deposits about 3,480 million years old in the Dresser Formation of the Pilbara hold stromatolites and other signs of microbes: the earliest signs of life on land (Djokic and others, 2017).

Model A	☐ Strongly supports	☐ Supports	☐ Has nothing to do with	☐ Contradicts
Model B	☐ Strongly supports	☐ Supports	☐ Has nothing to do with	☐ Contradicts

Why did you choose these links?

7 Filaments at Sulphur Springs

SCREEN 7

Pyrite in a 3,235 million year old deep-sea vent deposit at Sulphur Springs, in the Pilbara, holds filaments that are probably fossil microbes that lived in hot water beneath the sea floor (Rasmussen, 2000).

Model A	☐ Strongly supports	☐ Supports	☐ Has nothing to do with	☐ Contradicts
Model B	☐ Strongly supports	☐ Supports	☐ Has nothing to do with	☐ Contradicts

Why did you choose these links?

8 The oldest genes

SCREEN 9

Genes shared by living things suggest their last common ancestor lived without oxygen, used hydrogen and liked heat, and the authors say this supports an origin of life in a hydrothermal setting (Weiss and others, 2016). A newer study puts it about 4,200 million years ago, as part of a community (Moody and others, 2024).

Model A	☐ Strongly supports	☐ Supports	☐ Has nothing to do with	☐ Contradicts
Model B	☐ Strongly supports	☐ Supports	☐ Has nothing to do with	☐ Contradicts

Why did you choose these links?

SCREEN 2 A Pilbara river through a year

With the groundwater on, play a year with a cyclone and a year without one, and record the model's numbers.

MONTH	CYCLONE: POOLS WITH WATER	CYCLONE: POOLS WITH FISH	NO CYCLONE: POOLS WITH WATER	NO CYCLONE: POOLS WITH FISH
January				
March				
May				
July				
September				
November				

Which pool still holds water at the end of each year, and why does that matter for the whole river?

SCREEN 5 Life around a vent

Set the vent flow to strong. Move the probe to each distance and record the temperature and who lives there.

DISTANCE FROM THE CHIMNEY	TEMPERATURE (MODEL)	WHO LIVES THERE
At the chimney		
2 m		
5 m		
9 m		
15 m		

Set off an eruption. In what order does the community come back?

SCREEN 6 A hot spring channel

Set the spring to 90 °C and medium flow, then move the probe down the channel and fill in the table.

TEMPERATURE	COLOUR OF THE MATS	WHO LIVES THERE
Above 80 °C		
72 to 80 °C		
60 to 72 °C		
50 to 60 °C		
Below 50 °C		

How far down the channel do the photosynthetic mats begin, and why don't they begin at the source?

SCREEN 8

Fossil or not?

For each specimen, run the four checks in the model. Mark each check ✓ (passes), × (fails) or ? (disputed), add a few words, then give your judgement.

CHECK	APEX CHERT FILAMENT	NUVVUAGITTUQ TUBE	CHEMICAL GARDEN
Size and shape like a microbe?			
Carbon from living things?			
A setting where microbes could live?			
Could anything else have made it?			
My judgement: convincing, or not yet?			

Why can't the shape of a filament alone show that it was once alive?

SCREEN 10

My model-evidence link diagram

Draw an arrow from each piece of evidence to each model, using the four kinds of link. Copy your links from pages 2 and 3, changing any you now see differently.

Model A

A shallow pool struck by lightning

1. **No oxygen in the air**
2. **Sparks make amino acids**
3. **Vents supply energy and minerals**
4. **Life in the dark today**
5. **Drying joins molecules into chains**
6. **Hot springs in the Dresser Formation**
7. **Filaments at Sulphur Springs**
8. **The oldest genes**

Model B

A hydrothermal vent on the ocean floor

SCREEN 10

My argument

My claim Which model does the evidence support better?

Evidence for my claim Give at least two of your links, and explain how each supports the model.

Evidence against my claim Give at least one link that counts against the model you favour.

How sure I am How sure are you, and what evidence would change your mind?

SCREEN 10

Judging a headline

A made-up headline reads: “Scientists prove life began at deep-sea vents”. Using your diagram, explain what is wrong with it, and rewrite it so that it matches the evidence.

SCREEN 10

Looking back

How did your ratings of the two models change between screen 1 and now, and which evidence changed them most?

Choose one community from this lesson: a Pilbara pool, a vent or a hot spring. Explain how temperature and water shaped it, and how it changes over time.