



You are a geologist. You have been asked to prepare a short presentation. It will be about finding evidence for the origin of the Earth and the evolution of life on it.

Teacher information

Gallery visited	 From the Beginning
Suitable for	 Key Stage 4 (ages 14 to 16)
Curriculum links	Data, evidence theories and explanations Organisms and health Environment, Earth and universe
Example page	www.nhm.ac.uk/evolution-on-earth-ks4
Pre-visit preparation	<p>Vocabulary: universe, solar system, Milky Way, meteorites, radioactive, isotopes, atmosphere, fossil, microfossil, greenhouse and icehouse phases, various types of organism such as single-cell and multicellular organism, fern, horsetail, trilobite, ammonite, belemnite, mass extinction, mammal diversification.</p> <p>Concepts: The big bang theory of the creation of the universe, different types of crust on Earth, evolution and more complex life-forms developing as time went on, adaptations, measuring the passing of time in geological periods, the development of modern humans.</p>
Post-visit work	Pupils can combine information gathered from the gallery with their own research work to complete the Final report task at the end of this guide.

1 The solar system

The three stages of when the universe began are

- 1 The big bang
- 2 Matter develops
- 3 Stars and galaxies form

300,000 years

Our galaxy is called the Milky Way.

It formed 10,000 million years ago.

Discussion point on the evidence which can be used to prove the age of the Earth

Answers will vary, but should mention that meteorites, which are debris from the formation of the solar system, are the same age as the Earth. Meteorites have not melted since their formation, so they can be dated to reveal the age of the Earth.

2 How the Earth was formed

The continued, intense bombardment of the Earth with rocky lumps, (when kinetic energy was converted to heat energy) and the release of internal radioactive heat, contributed to the Earth being very hot.

The Earth's crust formed when the initial intense bombardment of the Earth slowed down. Gradually, the surface cooled and solid crust formed.

4,000 million years

- 1 Oceanic crust
- 2 Continental crust

Continental crust is lighter because it is less dense.

3 The development of life on Earth

The essential ingredients for life are: energy, oxygen, phosphorus, carbon, hydrogen, nitrogen and water.

Microfossils are the earliest evidence of life.

Life has shaped the atmosphere by producing large volumes of oxygen. Answers may also mention cyanobacteria, early photosynthesizing organisms.

Student answers should be roughly the dates given in the table below.

Event	Million years ago
Multicellular animals appear	580
Animals with shells and skeletons appear	545
Land plants appear	455
Reptiles appear	300
Mammals appear	230
Birds appear	148

Discussion point on detecting a pattern in the complexity of the organisms as time passes

Answers will vary but should refer to increasing complexity of organisms. They may also refer to increasing diversity of organisms.

4 Dating the past and exploring evidence for evolution

It is difficult to date layers of rocks because:

- 1 A single, complete sequence of rock layers does not exist.
- 2 Many different types of rock form in different places at the same time.
- 3 The same rock type may occur at different times in Earth's past.

Techniques that scientists use to date rocks accurately include measuring radiation from radioactive isotopes, which act as precise geological clocks because they decay at a steady rate. Answers may also mention that the rate of decay is measured by a time span called a half-life.

Descriptions may include references to height, arrangement of leaves and reproduction.

Plant group	Description	Extinct?
Lycopsid	Trees up to 36 metres high, with leaves arranged in spirals on the trunk.	No
Cordaite	Gymnosperm (therefore seed-producing) trees up to 30 metres high.	Yes
Horsetail	Erect, jointed stems bearing whorls of thin leaves, up to 18 metres high.	No
Fern	Short stems with large conspicuous leaves (fronds), reproduced using spores.	No
Seed-fern	Abundant in carboniferous forests, reproduced using seeds yet retain fern-like leaves.	Yes

	Amphibians	Reptiles
Lays egg in water	Yes	No
Eggs are waterproof	No	Yes
Able to live away from water	No	Yes
Breathes partly through moist skin	Yes	No

5 Mass extinctions and what might have caused them

What period?	When? (millions of years ago)	What might have caused this mass extinction?	Groups containing species that became extinct
End of Ordovician	445	<ul style="list-style-type: none"> • falling sea levels • global cooling 	70% of marine species, including: <ul style="list-style-type: none"> • reef communities and some graptolites • bryozoans • brachiopods • trilobites • nautiloids
Late Devonian	375	<ul style="list-style-type: none"> • falling sea levels • global cooling • lack of oxygen in deep waters 	<ul style="list-style-type: none"> • reef communities • some brachiopods • some trilobites • some ammonoids • some gastropods • some conodonts
End of Permian	248	<ul style="list-style-type: none"> • falling sea levels 	<ul style="list-style-type: none"> • trilobites • some ammonoids • some mammal-like reptiles
Late Triassic	200	<ul style="list-style-type: none"> • falling sea levels • volcanic eruptions 	<ul style="list-style-type: none"> • all conodonts • some ammonoids • some brachiopods • some gastropods • some bivalves
End of Cretaceous	65	<ul style="list-style-type: none"> • falling sea levels • asteroid impact • volcanic eruptions 	<ul style="list-style-type: none"> • dinosaurs • ammonites • belemnites

What do you think might cause the next mass extinction?
 Answers will vary but may mention ideas seen in the media such as destruction caused by human-made weapons in conflict, problems due to the balance of eco-systems being upset by climate change, even the possible devastation caused by impact of a meteorite or by a super-volcano erupting.

6 Human evolution

Dinosaur extinction helped mammals to diversify because there were many habitats (land, sea and air) left for them to take advantage of, less risk of predation and less competition for resources.

Pupil estimations should roughly correspond to the times given below.

Australopithecines: 2.5 million years ago
Homo habilis: 2.3 million years ago
Homo erectus: 2 million years ago
Homo heidelbergensis: 700,000 years ago

Build	Description of body proportions
Hot build	Tall, with long slender limbs and narrow hips.
Cold build	Short and wide with stocky limbs.

Discussion on how humans can survive extreme heat and cold
Answers will vary as to how present day humans are able to survive extreme heat and cold but should include use of special shelters and clothing. It may also be noted that more extreme environments are only sparsely populated. They are generally not permanent homes, but visited by humans to hunt in or to make use of resources.