

# The Universe in my Pocket



## The Earth



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## Earth: a planet with life

Earth is the planet on which we live. Its extraordinary characteristic is that it harbors life – in the most varied forms. There are Earth-like planets in the Solar System and others that revolve around more distant stars, but life has not yet been discovered on any of them. The Earth is shaped like a sphere. It is enveloped in a thin gaseous layer called the atmosphere, which is the air we breathe and through which birds and airplanes fly. The atmosphere protects us from harmful radiation, keeps all the water of the oceans from evaporating into space, and also keeps the Earth from cooling and freezing. The oceans cover about three-fourths of the Earth. It is in the oceans where most life is found, because the necessary ingredients of water, energy, oxygen and nutrients are all present in the oceans.

There is a tremendous variety of life on Earth!



Credit: Vista Palenque

There are animals that fly...

... that walk on solid ground ...



Credit: Ato Z animals

... and that swim in the sea.



Credit: New England Aquarium

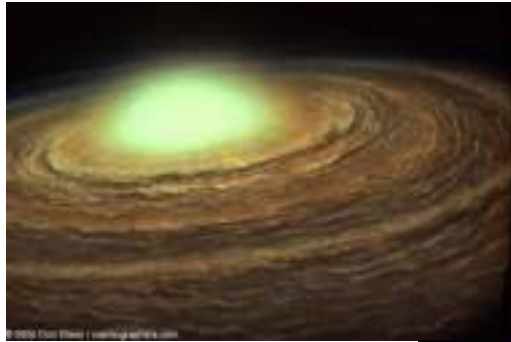
The Earth has a spherical shape and is enveloped by a thin gaseous layer: the atmosphere. The atmosphere is crucial for life.



Credit: University of Toronto



The Earth formed along with the entire Solar System from a cloud of interstellar gas and dust similar to this one (Hubble Space Telescope).



The Solar System before the formation of the planets.  
(Artistic interpretation by Don Dixon)

Clumps of material colliding to form the Earth.  
(Artistic interpretation by Don Dixon, cosmographica.com)



To imagine the structure of the Earth, think of a melon. The seed zone would be the core, the flesh would be the molten interior, and the rind would be the crust, where the oceans and continents are located.

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## As the Earth was born

The Solar System formed 4.6 billion years ago from a huge cloud of gas and dust. The dense center of the cloud became the Sun. The rest of the cloud, rotating around the Sun, formed clumps that collided with each other, generating a lot of heat and forming larger clumps. One of these giant clumps became the Earth.

In the beginning, the Earth was molten, like lava. Over time, it began to cool and its mineral elements began to separate. The lighter ones floated to the surface and formed a thin crust. The heavier ones sank towards the center of the Earth. Thus several layers were formed: the core, which is made of iron and nickel, the mantle, which is made of molten rocks such as lava, and the crust, which is the outer layer that forms the continents. Water and air are in the outer layer.

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## From the interior to the surface

The crust is fragmented. It is like pieces of a jigsaw puzzle, called "plates". They move continuously over the viscous mantle, the "magma". **Earthquakes** occur when one plate collides with another.

When magma finds a way to escape through a crack to reach the Earth's surface, it creates a **volcano**.

In some places the crust contains deep caverns with water. Near the bottom, magma heats the water. When the water boils, steam rises to the surface and is expelled as a column of hot water: a **geyser**.

The Earth's metallic core is spinning and creates a **magnetic field**, which acts like a huge magnet. Several species of animals, such as migratory birds and dolphins, use the magnetic field to navigate.

**Earthquakes** occur frequently on Earth. The strongest ones cause a lot of damage, like this one in Haiti (Scientific American).



Geysir, the Icelandic **geyser** that gave its name to all the others (Viator)



Photo: Thrainn Kolbeinsson

On March 19, 2021, after several thousand small earthquakes, a new **volcano** appeared in Iceland, named Geldingadalir.

The Earth is a huge **magnet** that makes compasses point to the north or south pole. (Tech Explorist)



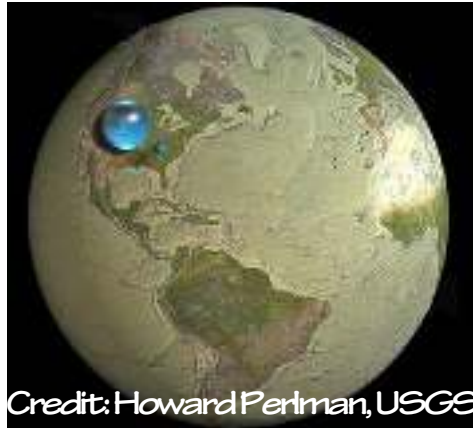
## Water on Earth

The Earth's surface has elevations and depressions, and water flows from the former to the latter. This is where life is found. All living things are composed of 60 to 90 % water. Water maintains the structure of cells and serves as a vehicle for transporting nutrients from one place to another and for eliminating waste.

Where did the water come from? When the Earth formed, it was so hot that almost all the water on the surface evaporated. As the Earth cooled, volcanoes and geysers spewed water vapor into the atmosphere. A large number of comets made of water ice also fell to Earth, so much of Earth's water probably came from space.

Although the oceans cover 70% of the Earth's surface, water represents only 0.16% of its volume, since the seas on average are only about 5 km deep (compared to the 6400 km of the Earth's radius).

The volume of salt water relative to the volume of the Earth is like that of a pea relative to a melon. The volume of fresh water is even smaller.



Credit: Howard Perlman, USGS



Extinct volcanoes in France (Parc du Massif Central).



Artist's view of a meteoroid shower falling on Earth 3.8 billion years ago (credit NASA)





Artistic vision of the formation of the first cells in the underwater depths of the Earth (Richard Bizley).

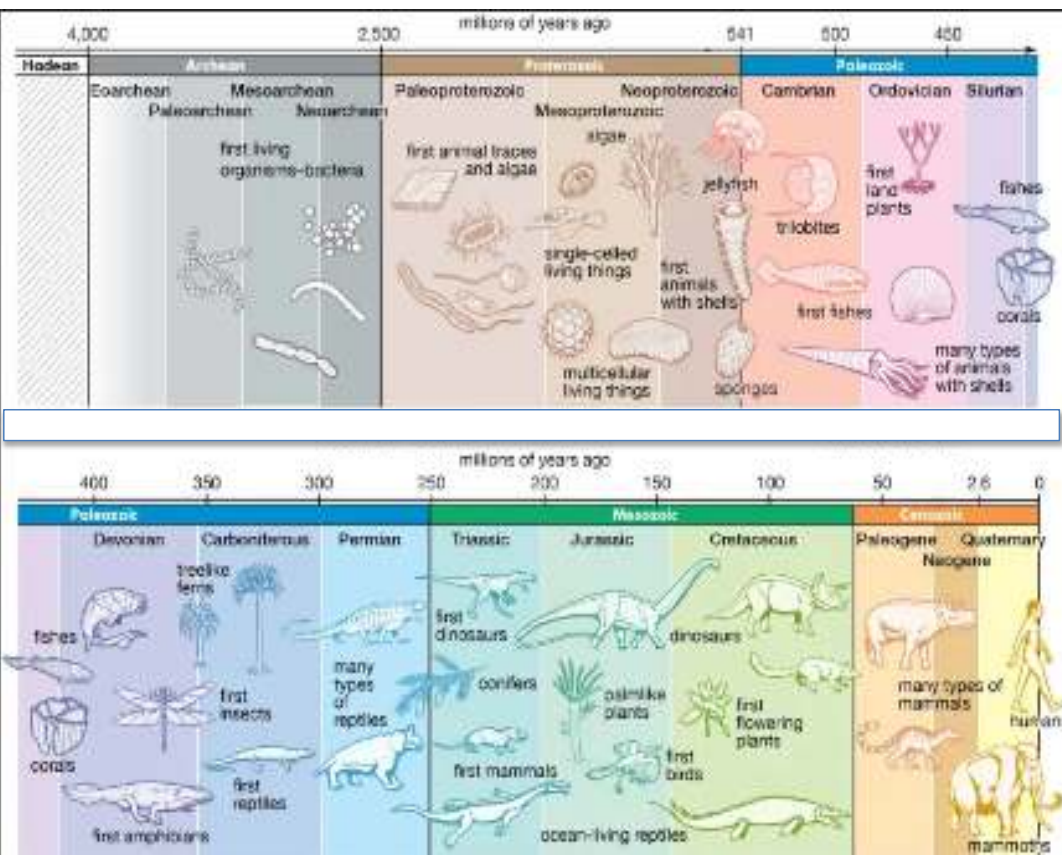
## How life on Earth began

Based on the age of the oldest rocks and fossils, scientists believe that life on Earth began about 3.5 billion years ago.

In the beginning, primitive organisms were formed from the most abundant chemical elements that easily bond together to form molecules, such as hydrogen, oxygen, nitrogen and carbon.

As the millennia passed, little by little more complicated organisms were formed, such as plants and animals. First primitive animals appeared, such as mollusks, then fish and birds, and finally mammals.

Modern man emerged in Africa about 300,000 years ago. All humans are descendants of Africans.



Simplified representation of the evolution of life on Earth. (Encyclopedia Britannica).

## Earth: the pale blue dot

Referring to the image of the Earth taken by Voyager 1, Carl Sagan wrote: 'Look at that dot. That's here. That's home. That's us. On it everyone you love, everyone you know, everyone you ever heard of, every human being who ever was, lived out their lives.

[...] Every hero and coward, [...], every king and peasant, every young couple in love [...] lived there [...].

It has been said that astronomy is a humbling and character-building experience. There is perhaps no better demonstration of the folly of human conceits than this distant image of our tiny world. To me, it underscores our responsibility to deal more kindly with one another, and to preserve and cherish the pale blue dot, the only home we've ever known.'

Enlargement of the image of the pale blue dot



NASA/JPL-Caltech

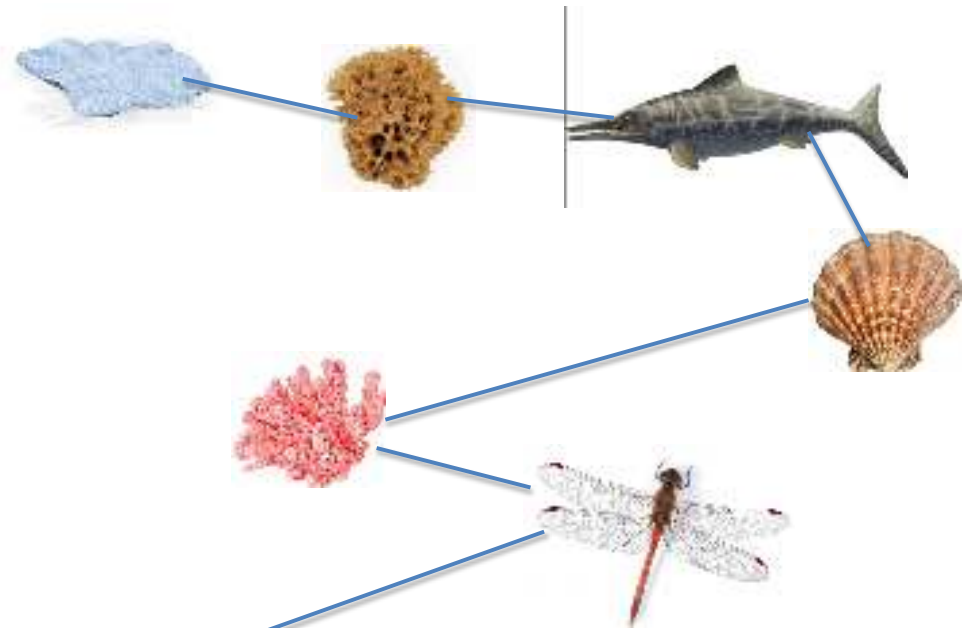
Image taken by the Voyager 1 probe in 1990 at a distance of 6.06 billion kilometers from Earth, where the Earth is seen as a pale blue dot.

This image is part of a series of photos taken at the suggestion of Carl Sagan when the Voyager 1 primary mission had already come to an end, after having taken pictures of Jupiter, Saturn and their satellites. This series showed the Earth and the other planets of the Solar system from an unprecedented perspective.

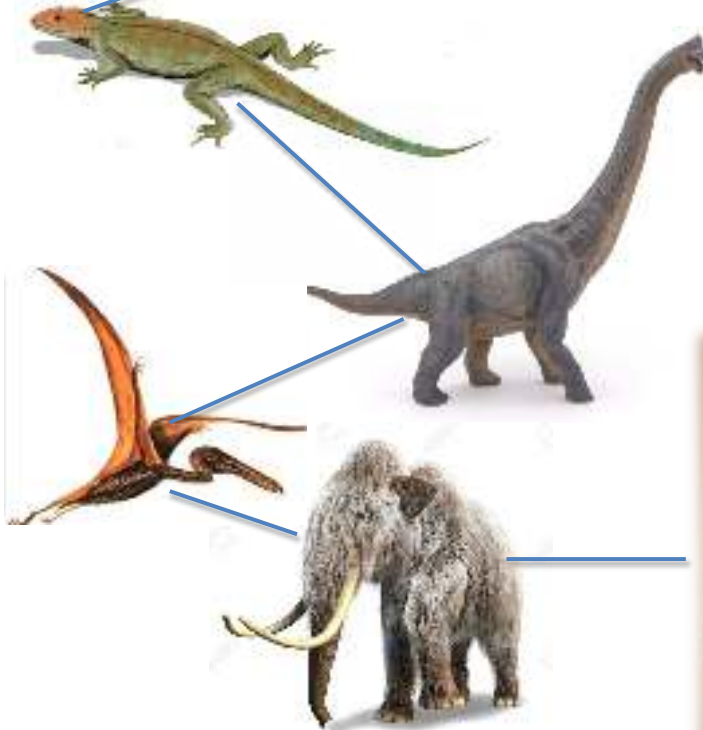


# Challenge

Can you organize the images of these animals in the order of their appearance on Earth?



# Answer to the Challenge



Answers on the back



# The Universe in my pocket No. 25

This booklet was written in 2022 by Julieta Fierro of the Instituto de Astronomía, UNAM, Mexico and Grażyna Stasińska of Paris Observatory

Cover image: The first photograph of the Earth as a whole, taken on December 7, 1972 by Harrison Schmitt, a member of the Apollo 17 crew en route to complete NASA's final mission to land on the Moon. The Earth looks rather like a beautiful blue marble.



To learn more about this collection and the topics presented in this booklet, please visit <http://www.tuimp.org>.

Translation: Stan Kurtz  
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