

9 The Evolutionary Process



Diversity of living organisms in our environment is a result of the evolutionary process. When studying about the evolution it is important to consider about the origin of the universe and the life.

In the past there were many beliefs about the origin of the universe.

9.1 Origin of the Earth

It is believed that the origin of the Earth took place about 4.5 billion years ago.

Nebular theory is the first scientific explanation of the origin of the solar system. According to this theory, small particles of materials in the universe drew together by the force of gravity, clumped up and the galaxies, the sun and other planets were formed.

Big Bang theory can be considered as the modern theory about the origin of the Earth. According to this theory universe was an energy source with a great energy. Giant explosion took place in it and large clouds of dust particles were created. These dust particles clumped up together and the galaxies were created. It is said in the big bang theory, that our solar system was created in the galaxy known as the milky way galaxy.



Figure 9.1 - Illustration of Big Bang

Initially the Earth had been a very hot object and its volcanic activities were high. The Earth got gradually cooled and less volatile metals with high density formed the core of the Earth. It is believed that later Earth's crust was created by light silicon rocks.

Various types of elements at the centre of the Earth reacted with each other and different types of gases were formed. At first the atmosphere of the Earth had gases such as Carbon dioxide (CO_2), Methane (CH_4) and Hydrogen sulphide (H_2S). The absence of Oxygen (O_2) in the early atmosphere is a significant fact.

Initially the extreme heat of the Earth has caused evaporation the water on the planet. This evaporated water got condensed and clouds were formed. Water droplets in these clouds joined together and dropped onto the Earth as rain. There had been continuous heavy rains on the Earth for many years. This rain water which was rich with minerals, collected in lower lands and oceans were formed.



Figure 9.2 - Picture of primitive Earth

9.2 Origin of life on the Earth

There are many beliefs and theories on origin of life on the Earth. It is believed that about 3.5 billion years ago life originated on the Earth.

Let us consider some theories about origin of life on the Earth.

Theory of special creation

According to this theory all living organisms on Earth were created by a supernatural power. Since there is no scientific evidence to prove this theory scientist do not pay attention to it.

Spontaneous generation theory

This theory states that life was originated from non-living things in a spontaneous manner.

e.g.

- Rats were born from pieces of clothes
- Maggots were born from rotten meat
- Weevils were born from decayed wood

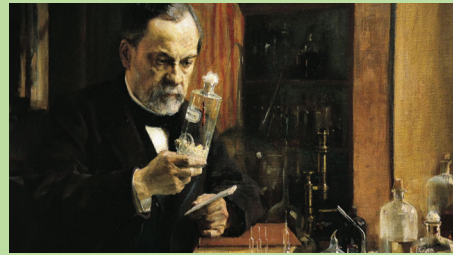
The Spontaneous generation theory has been effectively disproved by the experiments conducted by the scientist Louis Pasteur.



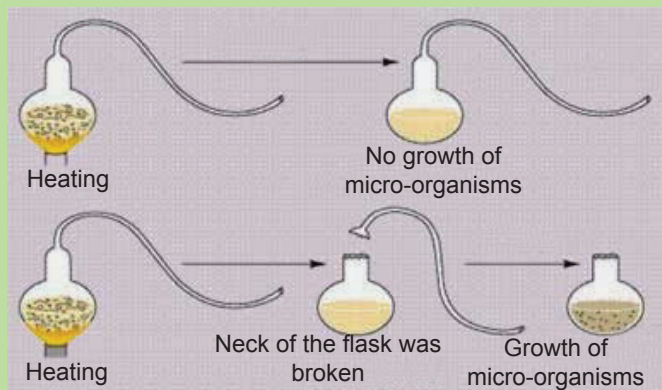
For extra knowledge

Louis Pasteur prepared an experiment to prove that spontaneous generation theory is not an acceptable theory.

- Similar amounts of sterilized nutritional media was added to two similar swan neck flasks. No growth of living organisms was observed.
- After about one year neck of the one flask was broken and taken away.
- Microbial growth was visible in the flask without the neck and no life appeared in the other flask.
- The conclusion was living organisms do not create spontaneously. This was accepted as true in 1862.



Louis Pasteur



Prove the spontaneous generation theory by doing an experiment

Cosmozoic theory

This theory suggests that, the living materials might have got established on Earth from a fallen meteor with living organisms or by spacecrafts from other planets. This theory has not been proved scientifically.

Theory of biochemical evolution

This theory confirms that at the beginning of the Earth the gases in the atmosphere reacted with each other and the ingredients that make life possible were formed. It is believed that the energy required for this was supplied by electric discharges during lightning, eruption of volcanoes and by the ultra violet radiation of the sun. These materials dissolved in rain water and collected with ocean water. This mixture is known as the **primordial soup**.

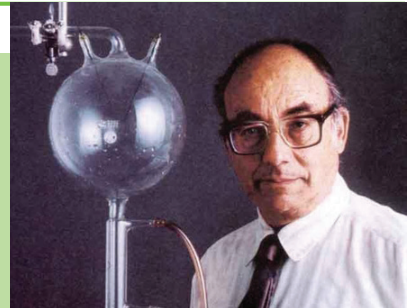
The first living cell or the **pre-cell** appeared as a result of a bio chemical reaction in primordial soup. The first organism was unicellular and was considered anaerobic and heterotrophic.

Scientists have experimentally shown that the first living cell was created by the primordial soup.



For extra knowledge

The two scientists Haldein and Oparin put forwarded the biochemical evolution theory about origin of life. This theory was scientifically proved by Stanley Miller by conducting scientific investigations in laboratory.



Stanley Miller

The first form of life on the Earth is considered to be a simple unicellular bacteria. Then, the first photosynthetic organisms, unicellular algae were formed. After that a gaseous oxygen containing atmosphere was formed.

Many changes took place for a long time period within the body of unicellular organisms and multicellular organisms were born. Gradually tissues, organs and systems were specialized within these multicellular organisms and the world of animals and plants were created.

Cnidarians, some annelids and some arthropods are considered as the first multicellular organisms.

The fish are considered as the first type of vertebrates and amphibians originated from fish. Amphibians can be regarded as the first vertebrates that entered into terrestrial environment. Reptiles evolved as a result of gradual evolutionary changes occurred in amphibians. The reptiles are completely adapted to the terrestrial life than amphibians. It is believed that birds and mammals evolved from reptiles during evolution.

The evolution of human took place about 12 million years ago. Modern human originated about 5 million (5 000 000) years ago.

Gradually flora was created by the photosynthetic algae in the oceans. First evolutionary less developed plants, then non-flowering plants, finally flowering plants originated

Accordingly, evolution of life has occurred at different times with several changes. In order to understand that process, study the figure 9.3.



Figure 9.3

9.3 Evolution

Various changes in the natural environment can have an impact on the existence of life.

Life's existence is confirmed by changes that occur gradually in living organisms in relation to continuous changes in the environment.

Early simple living organisms on the Earth have changed over time to become complex organisms.

Gradual development from simple organism to modern complex organism is called evolution.

Various evidences are considered when drawing conclusions about evolution.

- Evidences from geographical animal distribution (biogeography)
- Evidences from comparative anatomy
- Evidences from fossil study (paleontology)

Fossil records show detailed evidences about the changes in living organisms.

Fossils

Preserved plant and animal parts are found during various excavations. A fossil is the preserved remains of an organism, a part of an organism or traces or trace (foot prints, prints on shells) of a dead organism. Such types of fossils are found in rocks, ice, peat bogs, volcanic ash and in mud.



Figure 9.4 - Different types of fossils

Following are some examples for fossils.

- Harder part of an animal such as skeleton, teeth or shells
As the part of a bone gets slowly decomposed, sludge mud seeps into the pores of the bone. Then, the bone is subjected to a high pressure and turns into a bony rock. This bony rock can be considered as a fossil.
- Some of the dead animals get deposited in the mud. Later the animal get decayed and the decayed matter is removed as gas. The resulting cavity (due to the absence of the dead animal) gets filled with materials such as Silica (sand). This fossil has the same shape of the original skeleton.
- The external skeleton of some insects are preserved in tree resins and are fossilized.
- The preserved bodies of extinct animals such as mammoth are found within ice in the countries of polar region.
- The footprints of animals such as dinosaurs are preserved due to extreme environmental conditions are also considered fossils.



Figure 9.5 - Mammoth



Figure 9.6 - Dinosaur

Let us do the activity 9.1 to create a model fossil



Activity 9.1

You will need:- Kaolin/clay, plaster of Paris, binder glue, 2 yoghurt cups, a spoon, shapes of animals (an oyster shell, fern leaf) a pair of scissors

Method:-

- Fill half of a one yoghurt cup with clay. Place the shell or the leaf on it and press. When the print of the shell and the leaf are marked on clay remove the shell or the leaf.
- Put some plaster of paris into the other yoghurt cup. Add some water and prepare a plaster. Carefully pour the prepared plaster or binder glue on to the prints on the clay. Keep for about 2 hours to dry.
- Then, cut the yoghurt cup with the scissors and take out the clay lump out of the plaster or binder glue.
- Observe the model fossils on the surface of the clay lump and plaster made with plaster of paris.

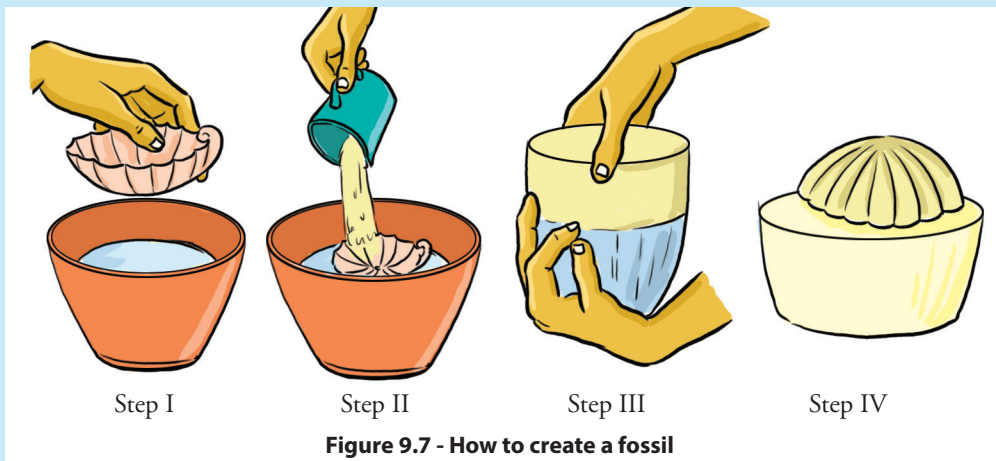


Figure 9.7 - How to create a fossil



Assignment 9.1

Prepare an article to put up in the wall paper under the following topics.

- Origin of life
- Origin of universe
- Fossils
- Bio-diversity

Living fossils

In biological evolutionary process there must be continuous changes in the bodies of the living organisms. But, some organisms survive even today retaining their physical properties unchanged though million years have passed. These non-evolved organisms are called **living fossils**.

A fish named **Coelacanth** was discovered in the sea near South Africa in 1938, which was believed to be extinct about 70 million years ago. The physical characteristics of this fish was found to be similar the fish found million years ago. So, that Coelacanth fish is considered as a living fossil.

Lingula which is found around the "Thambalagamuwa" bay in Trincomalee is also called a living fossil. Not only that the dragon fly, cockroach and lungfish are also considered as living fossils. The "Ginihota" (Tree fern) is also considered as a living plant fossil.



Coelacanth



Lingula



Dragonfly



Cockroach



Lungfish



"Ginihota" / Tree Fern

Figure 9.8 - Some living fossils

The rocks formed in different stages on the Earth were arranged in layers. These layers contain the fossils of plants and animals. The deposited rocks are at the bottom and the older fossils can be seen there.

The rocks are deposited on top of each other. The fossils in recent era can be seen on the top layer of the rocks.

The study of fossils in the rock layers reveals about the plants and animals that lived in different periods of the Earth. It gives an idea about bio evolution.



For extra knowledge

Radioactive carbon (${}^{14}_6\text{C}$), is an isotope of the carbon element which is used to determine the age of the fossils.

Evolution of horse

Coming to conclusions about evolution of organisms using proof from fossils leads to a number of problems, as all the stages of the evolution of an organisms is not preserved in fossil forms. Therefore, fossil evidences are like a story book with torn pages.

Evolutionary history of horses have been completely studied and revealed clearly as there have been enough fossil records to study the complete evolutionary history of horse.

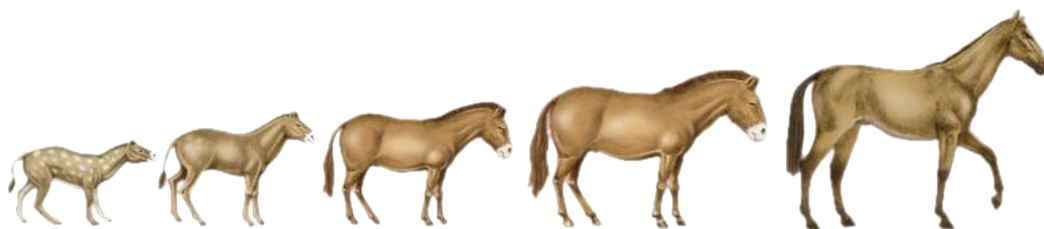


Figure 9.9 - Evolutionary process of horse

It is believed that the ancestor of modern horse had lived in North America 54 million (54×10^6) years ago. Further it has been revealed this animal was about 40 cm in height and was similar to a dog in the body shape. It could run. It had small legs with only three toes in the front legs. The significant feature about this animal is that the fingers in front legs were located on vertical position.

A lot of changes in this animal took place gradually during its evolutionary process. Some gradual changes took place in locomotion and feeding system.

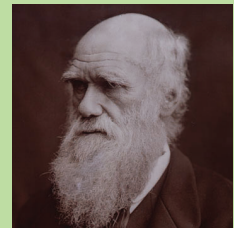
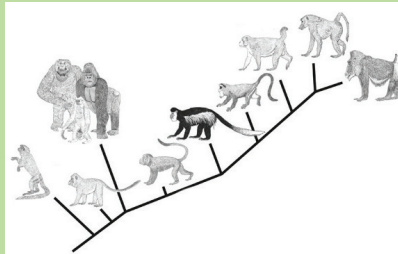
9.4 Importance of evolution in bio-diversity

There is competition among animals for the limited resources in the environment. The creatures who succeed, will be naturally selected and be established in the environment. These selected organisms become pioneers in the environment and their population increases. These creatures have created a large bio-diversity in the natural environment. In the process of evolution there may also be novel species that have evolved from former species. This is known as **speciation**. Through this the bio-diversity has been increased further.



For extra knowledge

Charles Darwin is considered as the **father of evolution**. He put forward the **Natural Selection theory** which is a scientifically accepted theory about evolution.



Charles Darwin



Assignment 9.2

Prepare a booklet by collecting information about evidence for evolution of the mankind were found in Sri Lanka.

Use the evidence found from "Batadomba" cave in "Kuruwita", "Pahiyangala" cave in "Bulathsinhala", "Ibbankatuwa", "Rawana" falls, "Pomparippu". Include the facts about the "Balangoda" human also.



Summary

- Origin of the Earth took place about 4.5 billion years ago and origin of life took place 3.5 billion years ago.
- "Origination of life is a result of a process of bio-chemical reactions" is the theory that is accepted today.
- Life originated from a unicellular organism that lived in the sea and developed into multicellular organisms.
- Gradual development of simple organism to modern complex organism is called evolution.
- Fossil records are the main detailed evidence of evolution.
- Animals that do not undergo evolution process are known as living fossils.
- Horse is an organism with complete fossil evidence about its evolution.
- Important evidences about evolution of the mankind were found in Sri Lanka.

Exercise

01) Select the correct or most suitable answer.

1. The correct sentences about the origin of the Earth is
 - a. It is considered origin of the Earth took place 4.5 billion years ago from now
 - b. The first scientific theory about origin of the universe is Nebular theory
 - c. Big Bang theory is considered as a modern theory on origin of the Earth

1. a and b 2. a and c 3. b and c 4. a, b and c
2. The false statement about the early Earth is
 1. As there was oxygen in the atmosphere there was life on the Earth.
 2. Gases such as carbon dioxide and methane were formed as a result of the reactions between elements.
 3. Heavy rain fell down on the Earth for many years.
 4. The rain water rich with minerals was collected to form oceans.
3. Today's accepted theory on origin of life on the Earth is
 1. Theory of special creation
 2. Spontaneous generation theory
 3. Cosmozoic theory
 4. Theory of bio-chemical evolution
4. The true statement on the origin of life is
 - a. First living organism on Earth was a unicellular algae
 - b. Multicellular organisms were originated from the evolution of unicellular organisms.
 - c. Origin of modern human took place 4.5 billion years ago.

1. a and b 2. a and c 3. b and c 4. a, b and c

02) State whether the following statements are true (✓) or false (x).

1. The first originated organism on primordial soup was a unicellular bacteria. ()
2. Gradual development of complex organisms from modern simple organisms is known as evolution. ()
3. To come to a conclusion on biological evolution only fossil evidence is sufficient. ()
4. Lingula is a living fossil found in Sri Lanka. ()
5. The main reason for bio-diversity is the process of evolution. ()

03) Give short answers.

1. Write two examples for living fossils.
2. Simply describe the contribution of fossils to study the evolutionary process.
3. Write five places in Sri Lanka that give evidence on evolution of the mankind.
4. Write a modification on feet of horse occurred during its' evolution.
5. Write three examples for organisms that are extinct from the Earth but their fossils were found.

Technical Terms

Big Bang theory	- මහා පිපිරුම් වාදය	- பெருவெடிப்புக் கொள்கை
Bio-diversity	- ජෛව විවිධත්වය	- உயிர்ப்பல்வகைமை
Primordial soup	- ආදි සුපය	- ஆதிக்கூழ்
Bio-chemical evolution	- ජෛව රසායනික පරිණාමය	- உயிரிரசாயனக் கூர்ப்பு
Spontaneous generation theory	- ස්වයං සිද්ධ ජනනවාදය	- தன்னிச்சைப் பிறப்பாக்கக் கொள்கை
Fossil	- පොසිල	- உயிர்ச் சுவடு
Living fossil	- ජීවමාන පොසිල	- வாழும் உயிர்ச்சுவடு
Theory of natural selection	- ස්වාභාවික වරණ වාදය	- இயற்கைத் தேர்வுக் கொள்கை
Speciation	- විශේෂ ප්‍රාචීනිය	- இனமாதல்