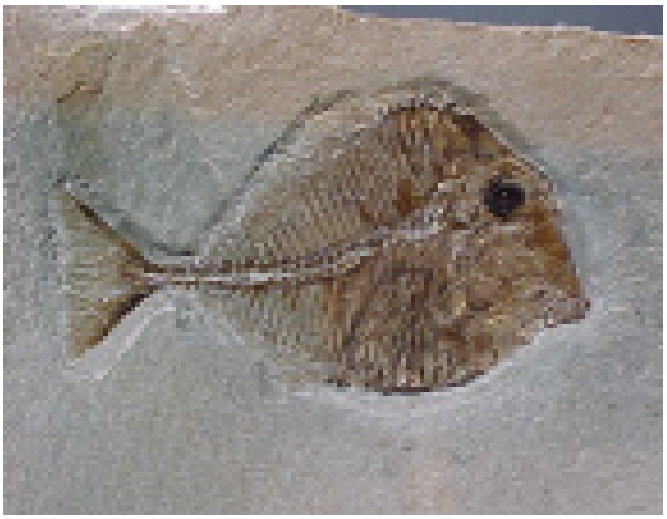
The History of Life on Earth

When did life first begin on Earth? What did it look like? When did the dinosaurs live? How long ago did the first humans live? These are questions that people have been asking for many years. Perhaps you have also wondered about some of them. Although there is still a lot that scientists do not know about the history of life, we are beginning to piece together the story of how life on Earth has changed over time.

The study of how life on Earth has changed over time is called **evolution**. Over Earth's history, life has changed from the first simple bacteria to the complex creatures that we see on Earth today. Evolution tries to explain the process by which new forms of life appear on our planet, survive for many years, and then go extinct, meaning that

Much of what we know about life in the past is based on the record of life that we see preserved as **fossils**. A fossil is some trace of a life form that lived a long time ago. Often they are bones, shells, or other parts of animals that have been slowly made rock-like by the chemicals around them. It was from fossils that people first learned about dinosaurs, and as people kept collecting and studying more and more fossils, we learned about a lot of the other plants and animals that lived on Earth long before the earliest humans. Today, after many years of collecting and studying fossils from all around the world, scientists have a pretty good idea of how life on Earth developed and changed over time, even though there are still a lot of things we don't know for sure yet. Let's look at some of the things we have learned about the history of life on our planet.



Fossils like this preserved skeleton of a fish tell us a lot about early forms of life on our planet. (Image courtesy of Pangea Fossils.com)

The Hadean (HAY-dee-an) Era

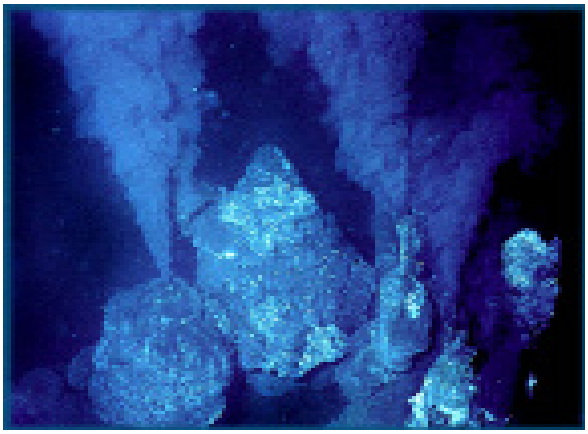
The earliest part of Earth's history is called the Hadean Era. This is the time that Earth was just being formed. Although it would be interesting to see our planet forming, the Hadean Era would have been a terrible time to live. During this time there were a lot more comets, meteoroids and asteroids in space around our planet, and these objects often crashed into our Earth. These impacts created a lot of heat, and impacts with the largest of these objects would have made our planet so hot that any oceans on the

planet would have turned completely into steam. Some impacts made our planet so hot that all the rocks on our planet's surface melted! Because of the repeated melting of the rocks on the Earth's surface, no Earth rocks from this time have survived.

The Hadean Era lasted about 700 million years, from around 4.5 billion years ago (bya) to around 3.8 bya. As you might imagine, no life could have survived the Hadean Era. Even if there were living things back then, they would all have been destroyed by the heat caused by comet and asteroid impacts. So the history of life on Earth actually begins after the Hadean Era.

The Archaean (ar-KEY-an) Era

Some time between 4.0 bya and 3.9 bya the destructive impacts into our planet became less common, and eventually conditions on Earth settled down enough so that life could survive. Still, you would not want to have lived back then. There was no oxygen in the atmosphere, and the gases that were there, like methane and ammonia, would have killed you.



Deep underwater vents like this one may have provided food for early life forms. (Michael Perfit/ University of Florida/Robert Embley/NOAA)

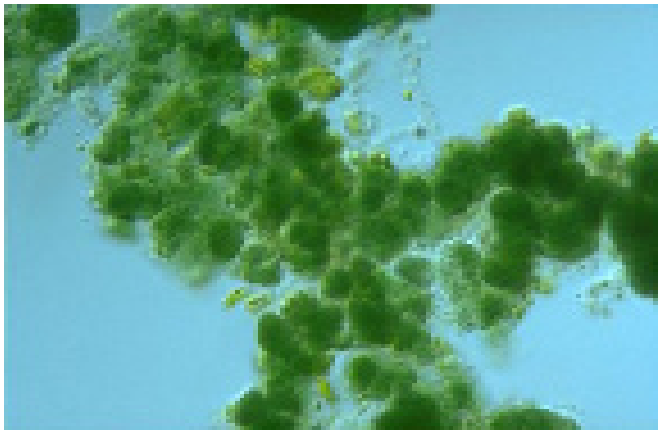
So how could life have survived? For a long time there was no life on the surface of our planet, but there was a lot of life in the oceans. What were these early living things like? They were probably like modern bacteria. They were made up of only one single cell, and they were so small that you would need a very powerful microscope to see them. These bacteria did not eat anything that you would recognize as food. Instead they ate minerals like sulfur

These earliest bacteria did not leave any fossils that we have been able to find, but we have other evidence that suggests they may have first appeared around 3.8 bya. Remember that anything living much before then would have been destroyed by comet or asteroid impacts. It is surprising that the earliest evidence of life occurs so soon after the Earth was able to support

Bacteria like these may be similar to some of the earliest life forms on our planet. These bacteria are about 10 millionths of a meter long. (Andrew Syred/Science Photo Library)

life. It seems that very shortly after the Earth stopped getting pummeled by objects from space, life appeared. To some scientists this suggests that life may be very common in our universe, and it has encouraged many scientists to look for signs of life on some of the other planets and moons of our solar system.

The earliest fossils appear to be around 3.5 billion years old. These fossils are of large colonies of bacteria called cyanobacteria (sigh-AN-o- bacteria). These may have been the first living things to get energy from sunlight. What is so amazing about cyanobacteria is that they are still common on Earth today.



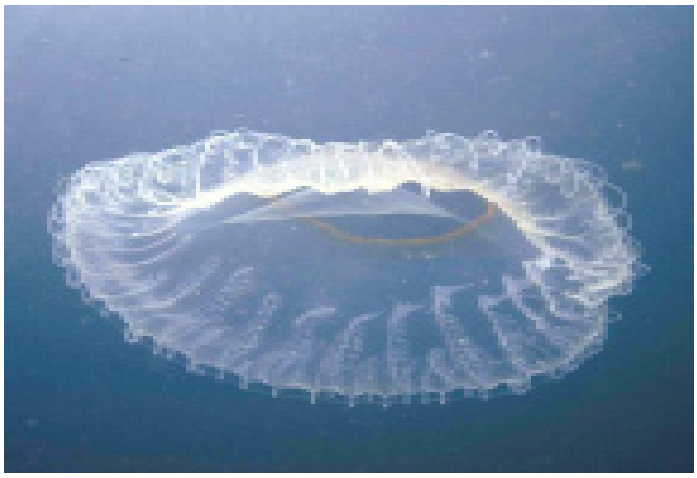
This is a photograph of cyanobacteria. Cyano bacteria have been on Earth for 3.5 billion years. (Protist Information Server)

The cells of bacteria are very different from the cells of all plants and animals. Plant and animal cells all have a nucleus (NEW-clee-us), an area in the center of the cell where all the information needed to make new cells is kept together. This cell-building information is called DNA. Although bacteria cells also contain DNA, their cells do not have a special area where this information is kept. Living things with cells that have a nucleus are called Eukaryotes (you-KAR-ee-oats). All plants and animals are eukaryotes. The first eukaryotes appeared around 1.8 bya, but these were not like the plants or animals we see today. They were made up of a single cell and, like bacteria, are so tiny that you would need a microscope to see them.

Cyanobacteria, like coral, can form underwater mounds that grow larger over time. These mounds are some of the oldest fossils known. (Discovery West Holidays)

When did life make the change from single celled individuals to individuals made of many different cells? Currently our best guess is around 1 bya, but we don't know for sure. The oldest fossils we have of individual living things large enough to see without a microscope are around 600 million years old.

A typical eukaryotic (animal) cell, showing the nucleus in the center. (Drawing by Michael Bruner.)



Animals with soft bodies, like this Medusa jellyfish, do not get preserved well as fossils. (http://www.7art-screensavers.com/sea.shtml)

One reason we don't have many fossils of these early multi-cellular life forms is that they did not have any shells or skeletons. Their bodies were very soft, like jellyfish. Because of this their bodies dissolved very quickly after they died and, in most cases, didn't leave any fossils. However, around 570 million years ago (mya) life on Earth made an important change, when animals with hard body parts first appeared.

The Paleozoic (pay-lee-o-ZO-ic) Era

The Paleozoic Era is the time when life on our planet began changing much more rapidly. The era is divided into different periods, starting with the Cambrian (CAM-bree-an) Period

By the beginning of the Cambrian Period, around 540 mya, life on Earth was changing. Animals with hard body parts were common, and because of this there are a lot more fossils from this time period. Looking at these fossils tells us that many new life forms appeared around this time. In fact, so many new forms appeared that some scientists refer to this time period as the Cambrian Explosion, meaning that life "exploded" out into many different directions. It was around this time that the first trilobites, clams, snails and corals all

Trilobites like this flourished for hundreds of millions of years after the Cambrian Explosion. Today they are extinct. (Dr. Sam Gon III, www.trilobites.info)

Corals have been living in Earth's oceans for over 500 million years. This coral fossil is around 300 million years old. (David Holloway/Museum Victoria, Australia)

By 500 mya the first animals with skeletons inside their bodies, called vertebrates (VER-ta-brets) appeared. These were fish-like animals, but they weren't true fish because they didn't have jaws. However, it appears that during this time all life was still restricted to the oceans. There was no life on land yet that we know of.

During the Silurian (si-LURE-ee-an) Period, around 420 mya, the first plants appeared on land. These early plants did not look like the trees, grasses and flowers that we see today. They were probably large mats of algae (AL-gee) that looked more like moss or mold. So even as recently as 420 mya our planet would have looked very different than it does today, and chances are you still would not be able to survive if you could go back to that time. In the oceans, the first true fish appear around this time and before long sharks are common.

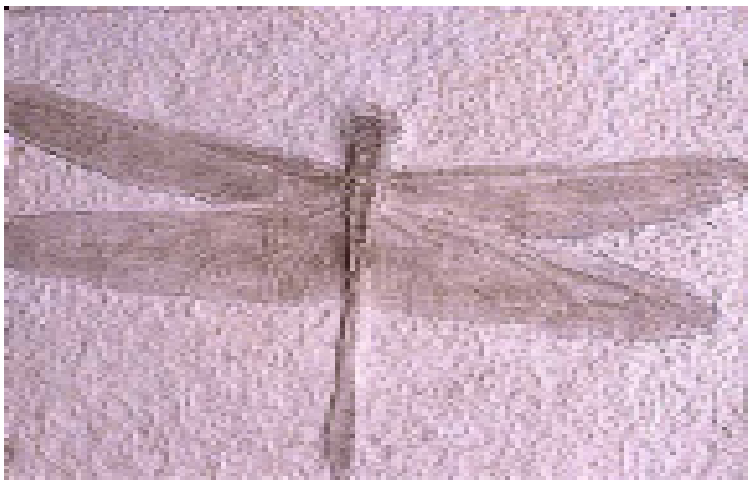
Jawless fish similar to this were the first animals to have backbones. (Matt Inlay)

The first plants on land looked very different from the trees and flowers that we see today. This plant appeared on land over 400 million years ago. (M. Alan Kazlev)

Sharks, like this blue shark, were some of the first fishes to appear on Earth. (Jim Knowlton, jimknowlton.com)

The Devonian (de-VO-nee-an) Period, beginning around 410 mya, is often called the time of the fishes because so many new types of fish first appeared during this period. Also, insects and four-legged animals first moved on to land around this time. The earliest insects were huge. Early dragonflies, for example, had wingspans over 30" across. This is longer than the earliest land animals, which rarely got over 24" long. By now the amount of oxygen in the air was close to the amount that is in our air today, and you MIGHT be able to survive on land if you could go back to the Devonian Period.

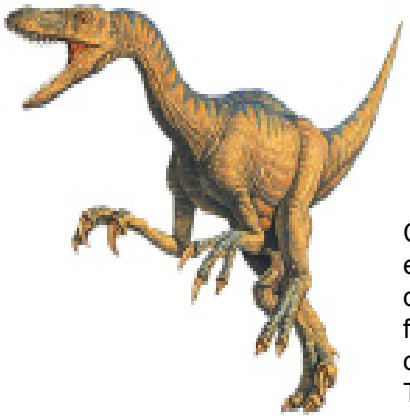
This 155 million year old dragonfly fossil is only about 6 inches across. Some of the earliest dragonflies had wingspreads 45times that length. (University of California Museum of Paleontology)



The first reptiles and amphibians appeared during the Mississippian (mis-sis-SIP-pee-an) Period, around 360 mya. These early reptiles were very small, less than 2 feet long. Later they would become much larger.

The Paleozoic Era ended around 245 mya at the end of the Permian (PER-mee-an) Period. The end of this era is marked by the single greatest mass extinction in the history of life on Earth. This is when trilobites went extinct. In fact, it is estimated that 90-95% of all the species on Earth died out at the end of the Permian Period. Nobody knows for sure what caused so many different animals to go extinct at this time, but some scientists think a comet or asteroid impact could have been the cause.

The Mesozoic (mez-o-ZO-ic) Era



Compared to the earliest life forms, dinosaurs are a fairly recent arrival on Earth. (Joe Tucciarone)

The widespread extinction at the end of the Paleozoic Era left our planet ripe for conquest by new groups of animals, and conquer they did! During the Mesozoic Era the dinosaurs took over the land and the seas. Dinosaurs lasted on Earth for 180 million years. They first appeared around 245 mya lived during the Triassic (try-AS-ic), Jurassic (jur-AS-ic) and Cretaceous (Cre-TAY-she-us) Periods. They finally went extinct around 65 mya, when a large comet crashed into the Earth near the Yucatan (yuk-a-TAN) Peninsula (pen-IN-su-la) in southern

The first mammals were about the size of a paper clip and probably weighed less than a tenth of an ounce. (Mark A. Klingler/Carnegie Museum of Natural History)

Also during this era, around 210 mya, the first mammal appeared—a tiny, shrew-like creature. The date of the first birds is not known for sure, but fossils of birds have been dated to around 160 mya. Although birds and mammals lived in the shadows of the dinosaurs during the Mesozoic Era, they became widespread after the dinosaurs went extinct. Today, they dominate our planet and can be found on every continent.

Archaeopteryx was one of the earliest birds that we know of. This fossil is around 150 million years old. (Institute for Palaeontology/ Goldfuss Museum)

Large, carnivorous terror birds roamed the Earth for 50 million years, filling the niche left open by the extinction of the dinosaurs. (Dorling Kindersley Limited)

The Cenozoic (sen-no-ZO-ic) Era

The death of the dinosaurs 65 mya left an opening for large, predatory animals, and birds were the first to assume that role. For around 50 million years many forest animals were hunted by large, flightless birds 6 to 10 feet tall. Although some of the descendants of these birds, such as emus and ostriches, are still with us today, by around 2.5 million years ago competition from mammals caused the last of these large "terror birds" to decline.

Although terror birds may have been the top predator in many places, mammals flourished throughout the Cenozoic Era. The first primates appeared around 60 mya. Primates are a large group of mammals that include lemurs, monkeys, apes and humans. The first primates did not look very much like monkeys or humans. In fact, they looked more like squirrels. But they had hands similar to monkey or human hands, with thumbs that they could use for grasping.

The earliest monkeys that we know of date from around 35 million years ago, and the first apes probably appeared around 5 to 10 million years after that. Yet none of these early primates looked anything like something we would call human. In fact, it was only around 5 mya that the first hominid (HOM-in-id), or human-like creature, appeared.

These early hominids, although human-like, were clearly not human. The earliest record we have of a creature that looks like a modern human is only about 100,000 years old, which is just an eye blink in the history of life on Earth. Although life has been on this planet for around 3.8 billion years, humans have only been here for a tiny fraction of that time.

This is a painting of australopithecus, an early human-like creature, called a hominid. (Zdenek Burian family estate)