Present | 100,000,000 years ago | 200,000,000 years ago | 300,000,000 years ago | 400,000,000 years ago | 500,000,000 years ago | 600,000,000 years ago | 700,000,000 years ago | 800,000,000 years ago

One Small Step . . . One Giant Leap

On July 20, 1969, Neil Armstrong was the first human to set foot on the lunar soil of our Moon. The adventure of exploring where we come from and where we are going continues . . .

Tycho Crater

Tycho Crater, about 85 kilometers across, is clearly visible on our Moon's surface. The freshness of the crater and the rays of material radiating from it suggest that this is a young crater; there has been little time to erode it.

The Rings of Saturn

The age of Saturn's thin rings is not well known. Based on the rate at which the rings are spreading, they are estimated to be less than 200 million years old. The rings are made of centimeter- to meter-sized particles of ice and dust.

Lava Flows on Venus

Unlike other terrestrial planets, the surface of Venus is not heavily cratered. Most of the surface has been covered by lava flows in the last billion years. Volcanos probably continue to erupt on Venus today.

Copernicus Crater

Copernicus Crater formed on our Moon less than a billion years ago when an impactor, several kilometers across, struck the surface. The impact produced a circular crater nearly 100 kilometers across and blew material out in prominent rays. The Apollo 12 astronauts collected samples from one of the rays. These samples provide evidence of the timing of the impact.

Giant Impact!

65 million years ago an asteroid (or comet), 10 to 16 kilometers in diameter, struck Earth on what is now the Yucatan Peninsula of Mexico, forming a crater ~180 km wide. This impact is thought to have triggered fires and tsunamis and created a cloud of dust and water vapor that enveloped the globe in a matter of days, resulting in fluctuating global climate changes. The extreme environmental shifts caused a mass extinction of 75% of Earth's species, including the dinosaurs.

First Bird

Birds began to evolve in the Jurassic Period. *Archaeopteryx* is the earliest undisputed bird, which derived from a clade of dinosaurs; however, it is not known to be a direct ancestor to any modern bird. A weak flyer, it shared characteristics with its dinosaur ancestors. Fossils show that *Archaeopteryx*, like dinosaurs, had teeth, a long bony tail, and grasping claws on its wings, but also had a bird-style hip and feathers.

The First Dinosaurs

Approximately 240 million years ago, during the Triassic Period, the dinosaurs appeared, evolved from the reptiles. *Plateosaurus* was one of the first large plant-eating dinosaurs. A relative of the much larger sauropods, it grew to about 9 meters in length. *Plateosaurus* probably walked on all four legs most of the time, occasionally rearing up to eat from the tops of trees.

Seed Plants

Because seed-bearing plants do not need water to reproduce, they were able to spread into environments not open to the earliest plants. The casing keeps the seeds from drying out and protects the nutrients, allowing seeds to lie dormant through harsh conditions. The first seed plant was the seed fern. Seed ferns were then followed relatively quickly (around 390 million years ago) by the more widely known Gymnosperms, which include the pine and giant redwood trees of today.

Barren Land

While the oceans were teeming with life, the land remained essentially barren, populated only by microbial life such as bacterial mats, algae, and lichens.

Terrestrial Plants and Insects

Primitive land plants, evolved from algae, provided food sources and niches for other organisms to exploit. The earliest plants were small, hugged the ground and required water to reproduce. Within about 60 million years, towering forests dominated the landscape. Insects originated during the Ordovician period, around 480 million years. They are thought to have developed at the same time as terrestrial plants.

Earth Goes Into A Deep Freeze

Earth experienced several ice ages that may have almost completely enveloped it in ice. These repeated deep freezes lasted for millions of years, apparently ending with abrupt warming. The fluctuations from ice age to warm period may have nearly wiped out life, but could have ultimately driven the evolution of multicellular organisms.

First Flowering Plants

Flowering plants — angiosperms — are also seed plants and are the most diverse group of land plants. The flowers attract insects and other organisms, leading to pollination and development of fruit-encased seeds. Much of our food supply — fruit, wheat, rice — comes from angiosperms.

Amphibians

Some lobe-finned fish evolved webbed, leg-like limbs. They probably lived in shallow swampy areas where their limbs allowed them to maneuver more easily than fins. Eventually (over ~50 million years), they evolved other support systems that prevented them from drying out and allowed them to move on land as the first amphibians. Although amphibians live on land, they must return to water to lay their eggs. All extant adult amphibians are carnivorous.

Reptiles

While catastrophic for some species, extinctions offer opportunities to survivors. Reptiles arose about 315-350 million years ago, and they replaced amphibians as the dominant land-dwelling animals following the Permian Extinction. Reptiles produce eggs that contain nutrients within a protective shell; unlike amphibians, they do not have to return to the water to reproduce. This difference allowed reptiles to move into new land environments. Early reptiles, like *Euparkeria*, may have been ancestors of the dinosaurs.

The Age of Mammals

The Cenozoic Era, from 65 million years ago to today, is the age of mammals and flowering plants and was marked by global cooling. The extinction of the dinosaurs allowed mammals to diversity and grow in size during the Cenozoic. Early horses, such as this Mesohippus celer, stood about half a meter high at the shoulders.

Prehistoric Turtles

Giant land turtles lived at the time of the dinosaurs and looked similar to turtles today. The largest of the land turtles was was about 2.5 meters long, weighed 4 metric tons, and had a sturdy shell to survive predators.

The First Mammals

The first mammals evolved toward the end of the Triassic period from a population of therapsids, the "mammal-like reptiles" that arose in the early Permian period. Fossils of the earliest mammals are more than 200 million years old, which means they coexisted with the dinosaurs throughout the Mesozoic Era. It is difficult to determine the first true mammal species; existing alongside dinosaurs, they were all very small. Few were larger than a mouse or rat, but some attained a probable maximal height of a large dog. It was not until the dinosaur extinction event that mammals were able to differentiate and thrive. The first classic example of a mammal was probably a marsupial.

Cambrian Explosion of Life

Approximately 543 million years ago, at the beginning of the Cambrian Period, the fossil record at locations across Earth is marked by the dramatic appearance of complex, diverse, multicellular organisms with shells. By the close of the Cambrian Period (490 million years ago), virtually every major animal group that exists today — excluding bryozoans — had appeared. Some scientists think the burst in diversity was rapid, occurring in perhaps as little as 10 million years.

Multicellular Marine Life

The first marine life was likely a plant. Dating back more 555 million years, *Chinggiskhaania bifurcata*, a fossilized seaweed discovered in Mongolia, is one of the earliest known multicellular marine algae. The simple, multicellular placozoa, or *Trichoplax adhaerens*, was most likely the first marine animal.

Reptiles Diversify

Reptiles conquered land, sea, and air during the Mesozoic Era between 250 and 65 million years ago. Plesiosaurs were marine reptiles that reached 13 meters in length.

Ocean Life Diversifies

An increasing variety and abundance of marine life populated the warm seas. While sponges, corals, and brachiopods occupied the seafloor, trilobites, cephalopods (related to squid and octopi), and jawed fishes swam in the waters above. Despite this diversity only 20% of all known species on Earth today live in water.

The first fish were jawless and belonged to the "Agnatha" superclass of fish, with characteristically defined skulls, made of either bone or cartilage. An example of this type of fish is the *Haikouichthys* which is now extinct but lived during the Cambrian Explosion.

In Devonian time, from about 416 to 355 million years ago, fishes of many different types swam and hunted in the seas. Lobe-finned fishes — ancestors to the amphibians — and the early sharks made their appearance by this time.

Permian Mass Extinction

About 250 million years ago at the end of the Permian Period, more than 90% of all species on Earth mysteriously perished during a mass extinction, perhaps within just a few thousand years. Less than 5% of sea species survived. Trilobites became extinct, coral, bryozoan, and brachiopod species diminished. Land plants and animals were also impacted, only one-third of large land animals survived. Amphibian species dwindled and fungi dominated some ecosystems. The cause of the "Great Dying" is not yet known, although many scientists attribute the catastrophe to major environmental changes, perhaps involving reorganization of ocean circulation or massive volcanism.

Human Ancestors

The first early hominids may have been bipedal — walking upright on two legs. "Lucy" is a well-known example of *Australopithecus afarensis*, which is a species that lived 3.2 million years ago and is now thought to be the species that evolved into modern humans. By about 2.5 million years ago, hominids were making tools. Humans 500,000 years ago were using fire. By 3000 years ago calendars, crop planting, and navigation were based on the stars, Moon, and Sun.

Present | 100 million years ago | 200 million years ago | 300 million years ago | 400 million years ago | 500 million years ago | 600 million years ago | 700 million years ago | 800 million years ago

Cenozoic | Mesozoic | Paleozoic | Proterozoic

PHANEROZOIC | PRECAMBRIAN