DEPARTMENT OF EDUCATION
SCHOOLS DIVISION OF NEGROS ORIENTAL
REGION VII
Kagawasan Ave., Daro, Dumaguete City, Negros Oriental

GEOLOGIC TIME SCALE OF THE HISTORY OF LIFE ON EARTH

for General Biology 2 Grade 11

Quarter 3 / Week 2

SELF-LEARNING KIT

FOREWORD

Dear students of Senior High School, welcome back to this week's self-learning kit where you will journey to the new lesson. This learning kit will serve as a guide in understanding deeply the concepts on the history of life on Earth.

Geologic time is the extensive interval of time occupied by the geologic history of Earth. It is the "calendar" for events in Earth history. It subdivides all time into named units of abstract time called—in descending order of duration—eons, eras, periods, epochs, and ages.

We shall embark on this module the sequence of events that took place and feature the characteristics of each major event.

OBJECTIVES

At the end of the lesson, learners shall be able to:

K: describe the general features of the different subdivisions that characterized the earliest animals and when they appeared on Earth;

S: identify the subdivisions of the geologic time scale; and

A: appreciate the beginnings of life and its existence in the present time.

LEARNING COMPETENCY

Describe general features of the history of life on Earth, including generally accepted dates and sequence of the geologic time scale and characteristics of major groups of organisms present during these time periods. **(STEM_BIO11/12-IIIc-g-8)**

I. WHAT HAPPENED

Let's Have Fun: Four Pics, One Word

Directions. Analyze carefully the pictures below. Guess the word being described from the pictures. Clues are given using the jumbled letters provided. Write your answer in your notebook.

Sources:
https://pixels.com/featured/triassic-landscape-publiphoto.html
https://study.com/academy/lesson/holocene-epoch-lesson-for-kids.html
https://www.emedicinehealth.com/how_many_days_after_your_period_do_you_ovulate/article_em.htm
https://www.pngfind.com/mpng/iiJixwJ_tcr77220-punctuation-marks-magnetic-accents-image-punctuation-marks/

R I C H D E P O

Answer: _____ _____ _____ _____ _____ _____

II. WHAT I NEED TO KNOW

DISCUSSION

The earth is around 4.5 billion years old. The planet we all call our home has undergone a series of geological and biological challenges that have changed not only its landscape but also its inhabitants. By studying the Earth's geological timeline, we will be able to trace the processes by which fossils and living organisms have evolved since the time that life started until the present day.

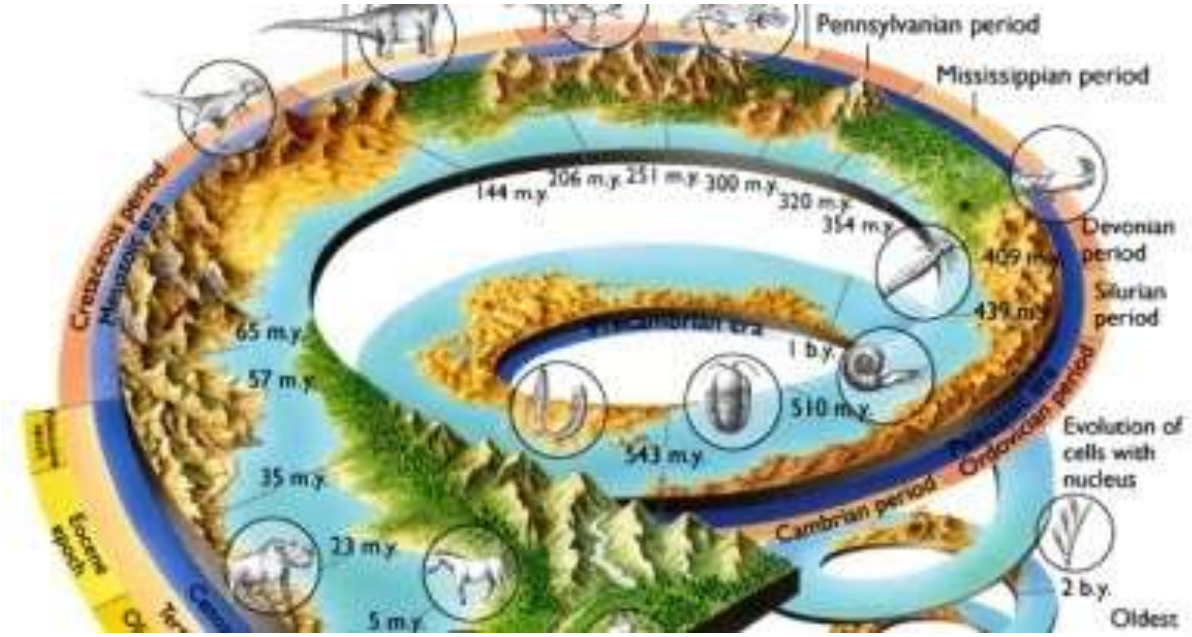


Figure 1. Geologic Time Scale. Source: https://www.mcqbiology.com/2012/10/mcq-on-evolution-geological-time-scale.html#.YBESOOgzbos

Both the likeness and the differences between all present-day organisms indicate the presence of a common ancestor from which all known species have originated and diverged from through the process of evolution. (General Biology 2 Textbook for Senior High School. Quezon City: Vibal Group, Inc.)

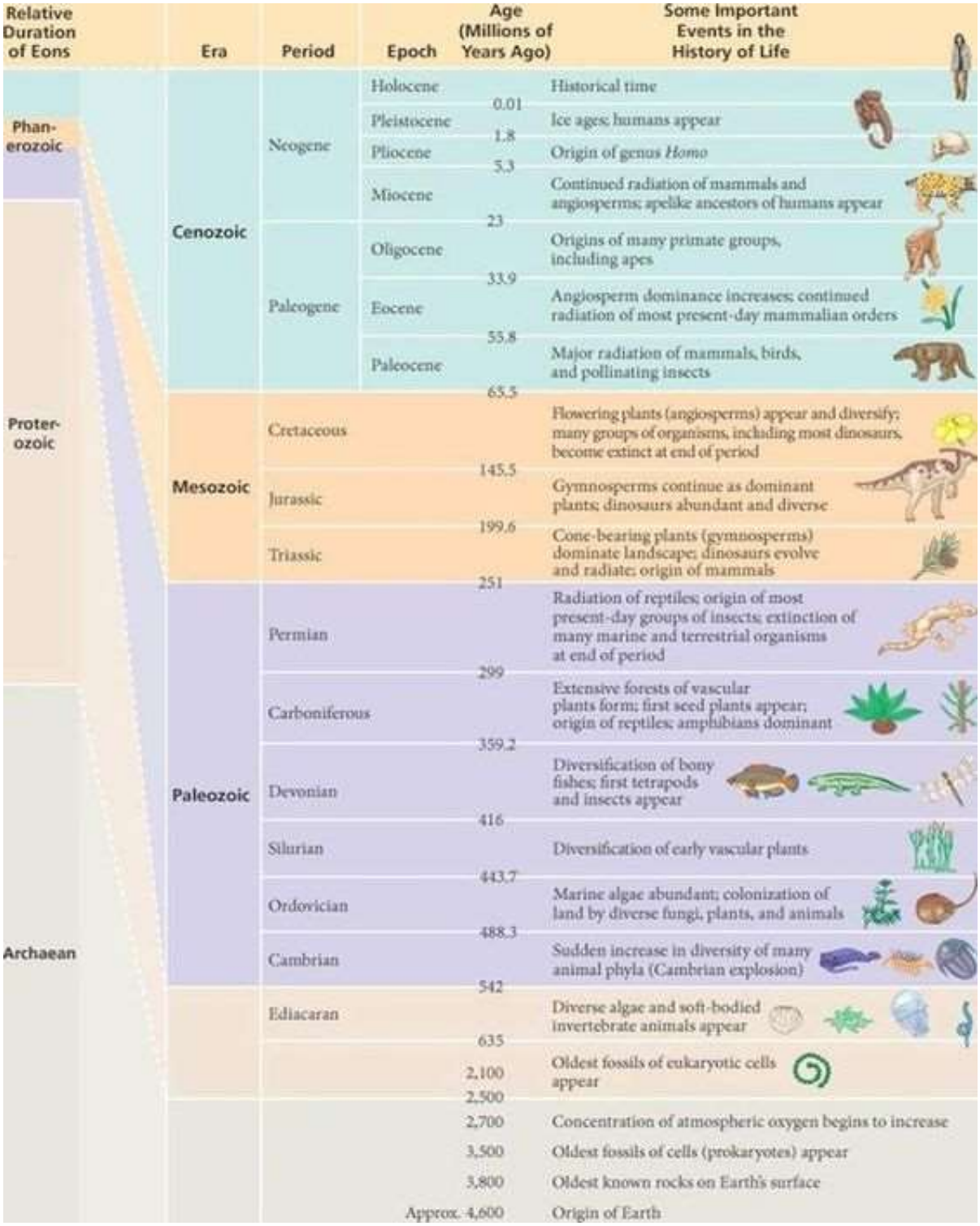


Figure 2. Geologic Time Scale where the history of earth is divided into eons, eras and periods. Source: https://www.pinterest.ph/pin/175499716715361317/

Geologic time may be divided into epochs which last for less than ten million years, periods lasting for tens of millions of years, eras which last for hundreds of millions of years, and in eons which last for billions of years. Many scientists have studied the Earth and

how changes in the Earth's land and water forms and its atmosphere have brought about the subsequent evolution of the species. The Earth's geological life may be divided in the following:

1. Precambrian

This is a period of time extending from about 4.6 billion years ago (the point at which Earth began to form) to the beginning of the Cambrian Period, 541 million years ago. The Precambrian encompasses the Archean and Proterozoic eons, which are formal geologic intervals that lasted from 4 billion to about 541 million years ago, and the Hadean Eon, which is an informal interval spanning from 4.6 billion to 4 billion years ago. The Precambrian represents more than 80% of the total geologic record. All life forms were long assumed to have originated in the Cambrian, and therefore, all earlier rocks were grouped together into the Precambrian. Although many varied forms of life evolved and were preserved extensively as fossil remains in Cambrian sedimentary rocks, detailed mapping and examination of Precambrian rocks on most continents have revealed that additional primitive life forms existed approximately 3.5 billion years ago. Nevertheless, the original terminology to distinguish Precambrian rocks from all younger rocks is still used for subdividing geologic time.
(https://www.britannica.com/science/Precambrian)

The earliest evidence for the advent of life includes Precambrian microfossils that resemble algae, cysts of flagellates, tubes interpreted to be the remains of filamentous organisms, and stromatolites (sheetlike mats precipitated by communities of microorganisms). In the late Precambrian, the first multicellular organisms evolved, and sexual division developed. By the end of the Precambrian, conditions were set for the explosion of life that took place at the start of the Cambrian, the first period of the Phanerozoic Eon (541 million years ago to the present).
(https://www.britannica.com/science/Precambrian)

The Earth was already more than 600 million years old when life began. The planet had cooled down from its original molten state, developing a solid crust and oceans created from water vapor in the atmosphere. Many scientists think these primordial seas gave rise to life, with hot, mineral-rich volcanic vents acting as catalysts for chemical reactions across the surface of tiny water bubbles, which led to the first cell membranes. Other bubbles are thought to have formed self-replicating substances by attracting chemicals from around them. Over time the two combined to produce energy-using, living cells.

The earliest living organisms were microscopic bacteria, which show up in the fossil record as early as 3.4 billion years ago. As their numbers multiplied and supplies of their chemical fuel were eaten up, bacteria sought out an alternative energy source. New varieties began to harness the power of the sun through a biochemical process known as photosynthesis—a move that would ultimately lead to simple plants and which opened the planet up to animal life.

Some three billion years ago, the Earth's atmosphere was virtually devoid of oxygen. At about 2.4 billion years ago, oxygen was released from the seas as a byproduct of photosynthesis by cyanobacteria. Levels of the gas gradually climbed, reaching about 1% around two billion years ago. About 800 million years ago, oxygen levels reached about 21% and began to breathe life into more complex organisms. The oxygen-rich ozone layer was also established, shielding the Earth's surface from harmful solar radiation.

Figure 3. Dickinsonia fossil. Source: google.com/search?q=dickinsonia+fossil&rlz=1C1BNSD_enPH940PH940&tbm=isch&source=iu&ictx=1&fir=jF7_g313B5IIOM%252CeplEpJjRD9OoPM%252C_&vet=1&usg=AI4_kSSR5o5A8NPkhSZOrvSX1a7_u3OLQ&sa=X&ved=2ahUKEwiout2EuebuAhVM05QKHadzC80Q_h0wAHoECBcQAw&biw=1536&bih=754#imgrc=jF7_g313B5IIOM

The first multicelled animals appeared in the fossil record almost 600 million years ago. Known as the Ediacarans, these

bizarre creatures bore little resemblance to modern life forms. They grew on the seabed and lacked any obvious heads, mouths, or digestive organs. Fossils of the largest known among them, *Dickinsonia*, resemble a ribbed doormat. What happened to the mysterious Ediacarans is not clear. They could be the ancestors of later animals, or they may have been completely erased by extinction.

The earliest multicelled animals that survived the Precambrian fall into three main categories. The simplest of these soft-bodied creatures were sponges. Lacking organs or a nervous system, they lived by drawing water through their bodies and filtering out food particles. The cnidarians, which included sea anemones, corals, and jellyfish, had sac-like bodies and a simple digestive system with a mouth but no anus. They caught food using tentacles armed with microscopic stinging cells. The third group, the annelids, or segmented flatworms, had fluid-filled body cavities and breathed through their skins.
(David Doubilet and Jennifer Hayes.
https://www.nationalgeographic.com/science/prehistoric-world/precambrian-time/)

2. The Cenozoic Era

The Cenozoic Era is the most recent of the three major subdivisions of animal history.

The Cenozoic spans only about 65 million years, from the end of the Cretaceous Period and the extinction of non-avian dinosaurs to the present. The Cenozoic is sometimes called the Age of Mammals, because the largest land animals have been mammals during that time. This is a misnomer for several reasons. First, the history of mammals began long before the Cenozoic began. Second, the diversity of life during the Cenozoic is far wider than mammals. The Cenozoic could have been called the "Age of Flowering Plants" or the "Age of Insects" or the "Age of Teleost Fish" or the "Age of Birds" just as accurately.
(https://ucmp.berkeley.edu/cenozoic/cenozoic.php)

The Cenozoic (65.5 million years ago to present) is divided into three periods: the Paleogene (65.5 to 23.03 million years ago), Neogene (23.03 to 2.6 million years ago), and the Quaternary (2.6 million years ago to present). Paleogene and Neogene are relatively new terms that now replace the deprecated term, Tertiary. The Paleogene is subdivided into three epochs: the Paleocene (65.5 to 55.8 million years ago), the Eocene (55.8 to 33.9 million years ago), and the Oligocene (33.9 to 23.03 million years ago). The Neogene is subdivided into two epochs: the Miocene (23.03 to 5.332 million years ago) and Pliocene (5.332 to 2.588 million years ago)
(https://ucmp.berkeley.edu/cenozoic/cenozoic.php)

Figure 4. Cenozoic Period.
Source: https://www.google.com/search?rlz=1C1BNSD_enPH940PH940&ei=z54nYOjrNIm2mAW1pq_ACQ&q=cenozoic&oq=cenozoic&gs_lcp=Cgdnd3Mtd2l6EAMyBwgAELEDEEMyBwgAELEDEEMyBAgAEEMyBAgAEEMyAggAMgIIADICCAAyCAgAELEDEIMBMgIIADICCAA6BwgAELADEEM6BwgAEEcQsAM6CggAELEDEIMBEEM6BQgAELEDOg4ILhCxAxCDARDHARCvAToHCC4QsQMQQzoKCC4QxwEQowIQCjoICC4QxwEQrwE6BAguEAo6BwguELEDEAo6DQguELEDEMcBEKMCEEM6BQguELEDOgIILjoICC4QsQMQgwFQ4hBY_mpg4HpoBnACeASAAcgBiAGXFJIBBjAuMTcuMZgBAKABAaoBB2d3cy13aXqwAQDIAQrAAQE&sclient=gws-wiz&ved=0ahUKEwioj534yObuAhUJG6YKHTXTC5gQ4dUDCA0&uact=5

Neogene

The **Neogene** (informally **Upper Tertiary** or **Late Tertiary**) is a geologic period and system that spans 20.45 million years from the end of the Paleogene Period 23.03 million years ago (Mya) to the beginning of the present Quaternary Period 2.58 Mya.

The term "Neogene" was coined in 1853 by the Austrian palaeontologist Moritz Hörnes (1815–1868). During this period, mammals and birds continued to evolve into modern forms, while

other groups of life remained relatively unchanged. Early hominids, the ancestors of humans, appeared in Africa near the end of the period. Some continental movement took place, the most significant event being the connection of North and South America at the Isthmus of Panama, late in the Pliocene. This cut off the warm ocean currents from the Pacific to the Atlantic Ocean, leaving only the Gulf Stream to transfer heat to the Arctic Ocean. The global climate cooled considerably over the course of the Neogene, culminating in a series of continental glaciations in the Quaternary Period that follows. (https://en.wikipedia.org/wiki/Neogene)

The continents in the Neogene were very close to their current positions. The Isthmus of Panama formed, connecting North and South America. The Indian subcontinent continued to collide with Asia, forming the Himalayas. Sea levels fell, creating land bridges between Africa and Eurasia and between Eurasia and North America. (https://en.wikipedia.org/wiki/Neogene)

The global climate became seasonal and continued an overall drying and cooling trend which began at the start of the Paleogene. The ice caps on both poles began to grow and thicken, and by the end of the period the first of a series of glaciations of the current Ice Age began. Marine and continental flora and fauna have a modern appearance. The reptile group Choristodera became extinct in the early part of the period, while the amphibians known as Allocaudata disappeared at the end. Mammals and birds continued to be the dominant terrestrial vertebrates and took many forms as they adapted to various habitats. The first hominins, the ancestors of humans, may have appeared in southern Europe and migrated into Africa. (https://en.wikipedia.org/wiki/Neogene)

In response to the cooler, seasonal climate, tropical plant species gave way to deciduous ones and grasslands replaced many forests. Grasses therefore greatly diversified, and herbivorous mammals evolved alongside it, creating the many grazing animals of today such as horses, antelope, and bison. Eucalyptus fossil leaves occur in the Miocene of New Zealand, where the genus is not native today, but have been introduced from Australia. (https://en.wikipedia.org/wiki/Neogene)

Paleogene

The **Paleogene** (informally **Lower Tertiary** or **Early Tertiary**) is a geologic period and system that spans 43 million years from the end of the Cretaceous Period 66 Mya to the beginning of the Neogene Period 23.03 Mya.

The global climate during the Paleogene departed from the hot and humid conditions of the late Mesozoic Era and began a cooling and drying trend which, despite having been periodically disrupted by warm periods such as the Paleocene–Eocene Thermal Maximum, persisted until the temperature began to rise again due to the end of the most recent glacial period of the current ice age. The trend was partly caused by the formation of the Antarctic Circumpolar Current, which significantly lowered oceanic water temperatures. (https://en.wikipedia.org/wiki/Paleogene)

During the Paleogene, the continents continued to drift closer to their current positions. India was in the process of colliding with Asia, forming the Himalayas. The Atlantic Ocean continued to widen by a few centimeters each year. Africa was moving north to meet with Europe and form the Mediterranean Sea, while South America was moving closer to North America (they would later connect via the Isthmus of Panama). Inland seas retreated from North America early in the period. Australia had also separated from Antarctica and was drifting toward Southeast Asia. (https://en.wikipedia.org/wiki/Paleogene)

Mammals began a rapid diversification during this period. After the Cretaceous–Paleogene extinction event, which saw the demise of the non-avian dinosaurs, mammals transformed from a few small and generalized forms that began to evolve into most of the modern varieties we see today. Some of these mammals would evolve into large forms that would dominate the land, while others would become capable of living in marine, specialized terrestrial, and airborne environments. Those that took to the oceans became modern cetaceans, while those that took to the

trees became primates, the group to which humans belong. Birds, which were already well established by the end of the Cretaceous, also experienced adaptive radiation as they took over the skies left empty by the now extinct pterosaurs. (https://en.wikipedia.org/wiki/Paleogene)

Pronounced cooling in the Oligocene led to a massive floral shift and many extant modern plants arose during this time. Grasses and herbs such as *Artemisia* began to appear at the expense of tropical plants, which began to decline. Conifer forests developed in mountainous areas. (https://en.wikipedia.org/wiki/Paleogene)

3. The Mesozoic Era

The Mesozoic Era is the age of the dinosaurs and lasted almost 180 million years from approximately 250 to 65 million years ago. This era includes three well known periods called the Triassic, Jurassic, and Cretaceous periods. It is also called the **Age of Reptiles** and the **Age of Conifers**.
(https://en.wikipedia.org/wiki/Mesozoic)

A mass extinction marked the beginning and end of the Mesozoic Era. The event that caused the transition from the Paleozoic Era to the Mesozoic Era was the greatest extinction this earth has seen. This extinction wiped out about 95% of all marine life and 70% of land life. This allowed the dinosaurs to step in and settle into their role as the lords of the earth. The era ended with "The Great Extinction" which marked the end of the dinosaurs as the Cenozoic Era began.

At the beginning of the Mesozoic Era, the continents as we know them were joined together as the massive mother continent, Pangaea. It was during the age of the dinosaurs that Pangaea was transformed to the modern continents. Pangaea became two great continents known as Laurasia and Gondwana and the Atlantic Ocean began to grow. Laurasia eventually split into the continents of North America and Eurasia. Gondwana became the modern continents of South America, Africa, Australia, Antarctica, and the India subcontinent,

which, after the Mesozoic Era, collided with Eurasia forming the Himalayas. (Dinosaurs and other fossils. Jason Hamilton. https://scienceviews.com/dinosaurs/mesozoic.html)

The environment was unusually warm and polar ice caps did not yet exist. This played a large part in evolution and is a key factor behind the flourishing of the dinosaurs. During the Triassic period, the climate was generally dry, which changed near the Jurassic Period as oceans began to rise due to mounting layers of magma covering the seafloor. As a result, flooding overtook many parts of the exposed land. This allowed the climate to change with increased humidity and it continued that way even into the Cretaceous Period. However, the climate began to cool during the Cretaceous although temperatures may have risen again near the end of the Mesozoic. (Dinosaurs and other fossils. Jason Hamilton. https://scienceviews.com/dinosaurs/mesozoic.html)

The dominant land plant species of the time were gymnosperms, which are vascular, cone-bearing, non-flowering plants such as conifers that produce seeds without a coating. This is opposed to the earth's current flora, in which the dominant land plants in terms of number of species are angiosperms. One particular plant genus, *Ginkgo*, is thought to have evolved at this time and is represented today by a single species, *Ginkgo biloba*. As well, the extant genus *Sequoia* is believed to have evolved in the Mesozoic.

Flowering plants radiated during the early Cretaceous, first in the tropics, but the even temperature gradient allowed them to spread toward the poles throughout the period.

(https://en.wikipedia.org/wiki/Mesozoic)

Triassic Period

The **Triassic Period**, in geologic time, the first period of the Mesozoic Era. It began 252 million years ago, at the close of the Permian Period, and ended 201 million years ago, when it was succeeded by the Jurassic Period.

Figure 5. Triassic Period animals.
google.com/search?q=triassic+period&tbm=isch&ved=2ahUKEwi62YOMuebuAhWLHaYKHVgND0QQ2cCegQIABAA&oq=triassic&gs_lcp=CgNpbWcQARgAMgcIABCxAxBDMgQIABBDMgQIABBDMgIIADICCAAyAggAMgIIADICCAAyAggAMgIIADoFCAAQsQNQ_P1AWPadQWDWskFoAHAAeAOAAbkEiAHOIpIBDDAuMTIuMi4wLjEuNJgBAKABAaoBC2d3cy13aXotaW1nsAEAwAEB&sclient=img&ei=Mo4nYLr4GYu7mAXYmrygBA&bih=754&biw=1536&rlz=1C1BNSD_enPH940PH940#imgrc=g5L4it14uGofCM

The Triassic Period marked the beginning of major changes that were to take place throughout the Mesozoic Era, particularly in the distribution of continents, the evolution of life, and the geographic distribution of living things. At the beginning of the Triassic, virtually all the major landmasses of the world were collected into the supercontinent of Pangea. Terrestrial climates were predominately warm and dry (though seasonal monsoons occurred over large areas), and the Earth's crust was relatively

quiescent. At the end of the Triassic, however, plate tectonic activity picked up, and a period of continental rifting began. On the margins of the continents, shallow seas, which had dwindled in area at the end of the Permian, became more extensive; as sea levels gradually rose, the waters of continental shelves were colonized for the first time by large marine reptiles and reef-building corals of modern aspect.

The Triassic followed on the heels of the largest mass extinction in the history of the Earth. This event occurred at the end of the Permian, when 85% to 95% of marine invertebrate species and 70% of terrestrial vertebrate genera died out. During the recovery of life in the Triassic Period, the relative importance of land animals grew. Reptiles increased in diversity and number, and the first dinosaurs appeared, heralding the great radiation that would characterize this group during the Jurassic and Cretaceous periods. Finally, the end of the Triassic saw the appearance of the first mammals—tiny, fur-bearing, shrewlike animals derived from reptiles.
(https://www.britannica.com/science/Triassic-Period)

Another episode of mass extinction occurred at the end of the Triassic. Though this event was less devastating than its counterpart at the end of the Permian, it did result in drastic reductions of some living populations—particularly of the ammonoids, primitive mollusks that have served as important index fossils for assigning relative ages to various strata in the Triassic System of rocks.
(https://www.britannica.com/science/Triassic-Period)

Jurassic Period

The **Jurassic Period** ranges from 200 million years to 145 million years ago and features three major epochs: The Early Jurassic, the Middle Jurassic, and the Late Jurassic.

The Early Jurassic spans from 200 to 175 million years ago. The climate was tropical, much more humid than the Triassic. In the oceans, plesiosaurs, ichthyosaurs, and ammonites were abundant. On land, dinosaurs and other archosaurs staked their claim as the dominant race, with theropods such as Dilophosaurus at the top

of the food chain. The first true crocodiles evolved, pushing the large amphibians to near extinction. All in all, archosaurs rose to rule the world.

Figure 6. Jurassic Period dinosaurs.
Source: https://www.google.com/search?q=jurassic+period&tbm=isch&ved=2ahUKEwist_CLvebuAhVQAKYKHWJwBnMQ2-cCegQIABAA&oq=jurassic+period&gs_lcp=CgNpbWcQAzIFCAAQsQMyAggAMgIIADICCAAyAggAMgIIADICCAAyAggAMgIIADICCAA6BggAEAcQHjoECAAQQzoHCAAQsQMQQ1CGkgdYqrEHYIqzB2gAcAB4AoAB2AOIAZIXkgEKMC4xMC4zLjIuMZgBAKABAaoBC2d3cy13aXotaW1nwAEB&sclient=img&ei=Y5InYOz5M9CAmAXi4JmYBw&bih=754&biw=1536&rlz=1C1BNSD_enPH940PH940#imgrc=XerZAeljnzLzuM&imgdii=w4By3Fz3m4B3KM

Meanwhile, the first true mammals evolved, remaining relatively small but spreading widely; the Jurassic Castorocauda, for example, had adaptations for swimming, digging and catching fish. Fruitafossor, from the late Jurassic Period about 150 million years ago, was about the size of a chipmunk, and its teeth, forelimbs, and back suggest that it dug open the nests of social insects (probably termites, as ants had not yet appeared). The first multituberculates like Rugosodon evolved, while volaticotherians took to the skies.

The Middle Jurassic spans from 175 to 163 million years ago. During this epoch, dinosaurs flourished as huge herds of sauropods, such as Brachiosaurus and Diplodocus, filled the fern prairies, chased by many new predators such as Allosaurus. Conifer forests made up a large portion of the forests. In the

oceans, plesiosaurs were quite common, and ichthyosaurs flourished. This epoch was the peak of the reptiles.

The Late Jurassic spans from 163 to 145 million years ago. During this epoch, the first avialans, like Archaeopteryx, evolved from small coelurosaurian dinosaurs. The increase in sea levels opened up the Atlantic seaway, which has grown continually larger until today. The divided landmasses gave opportunity for the diversification of new dinosaurs.
(https://en.wikipedia.org/wiki/Mesozoic)

Cretaceous Period

The Cretaceous Period was the last and longest segment of the Mesozoic Era. It lasted approximately 79 million years, from the minor extinction event that closed the Jurassic Period about 145.5 million years ago to the Cretaceous-Paleogene (K-Pg) extinction event dated at 65.5 million years ago.
(Mary Bagley, Cretaceous Period: Animals, Plants & Extinction Event. LiveScience.com Jan 8, 2016.https://www.livescience.com/29231-cretaceous-period.html)

One of the hallmarks of the Cretaceous Period was the development and radiation of the flowering plants. The oldest angiosperm fossil that has been found to date is *Archaefructus liaoningensis*, found by Ge Sun and David Dilcher in China. It seems to have been most similar to the modern black pepper plant and is thought to be at least 122 million years old. It used to be thought that the pollinating insects, such as bees and wasps, evolved at about the same time as the angiosperms. It was frequently cited as an example of co-evolution.
(https://www.livescience.com/29231-cretaceous-period.html)

The Cretaceous is usually noted for being the last portion of the "Age of Dinosaurs", but that does not mean that new kinds of dinosaurs did not appear then. It is during the Cretaceous that the first ceratopsian and pachycepalosaurid dinosaurs appeared. Also during this time, we find the first fossils of many insect groups, modern mammal and bird groups, and the first flowering plants.

The breakup of the world continent Pangea, which began to disperse during the Jurassic, continued. This led to increased regional differences in floras and faunas between the northern and southern continents.

The end of the Cretaceous brought the end of many previously successful and diverse groups of organisms, such as non-avian dinosaurs and ammonites. This laid open the stage for those groups which had previously taken secondary roles to come to the forefront. The Cretaceous was thus the time in which life as it now exists on Earth came together.
(https://ucmp.berkeley.edu/mesozoic/cretaceous/cretaceous.php)

No great extinction or burst of diversity separated the Cretaceous from the Jurassic Period that had preceded it. In some ways, things went on as they had. Dinosaurs both great and small moved through forests of ferns, cycads, and conifers. Ammonites, belemnites, other molluscs, and fish were hunted by great "marine reptiles," and pterosaurs and birds flapped and soared in the air above. Yet the Cretaceous saw the first appearance of many life forms that would go on to play key roles in the coming Cenozoic world.

Perhaps the most important of these events, at least for terrestrial life, was the first appearance of the flowering plants, also called the angiosperms or Anthophyta. First appearing in the Lower Cretaceous around 125 million years ago, the flowering plants first radiated in the middle Cretaceous, about 100 million years ago. Early angiosperms did not develop shrub- or tree-like morphologies, but by the close of the Cretaceous, a number of forms had evolved that any modern botanist would recognize. The angiosperms thrived in a variety of environments such as areas with damper climates, habitats favored by cycads and cycadeoids, and riparian zones. High southern latitudes were not invaded by angiosperms until the end of the Cretaceous. Ferns dominated open, dry and/or low-nutrient lands. Typical Jurassic vegetation, including conifers, cycads, and other gymnosperms, continued on into the Lower Cretaceous without significant changes. At the beginning of this period, conifer diversity was fairly

low in the higher latitudes of the Northern Hemisphere, but by the middle of the period, species diversification was increasing exponentially. Swamps were dominated by conifers and angiosperm dicots.

At about the same time, many modern groups of insects were beginning to diversify, and we find the oldest known ants and butterflies. Aphids, grasshoppers, and gall wasps appear in the Cretaceous, as well as termites and ants in the later part of this period. Another important insect to evolve was the eusocial bee, which was integral to the ecology and evolution of flowering plants.
(https://ucmp.berkeley.edu/mesozoic/cretaceous/cretaceous.php)

4. Paleozoic Life

The story of the earliest Paleozoic animals is one of life in the sea. Presumably simple fungi and related forms existed in freshwater environments, but the fossil record provides no evidence of these modes of life. The terrestrial environment of the early Paleozoic was barren of the simplest of life forms.

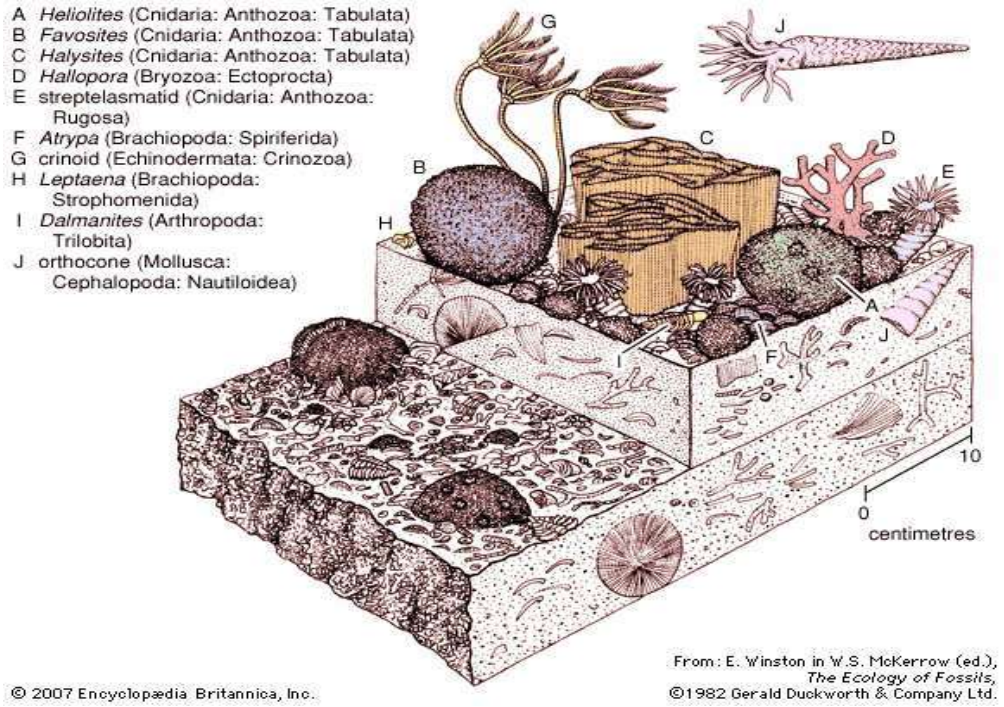


Figure 7. An early Silurian coral-stromatoporoid community.
From E. Winson in W.S. McKerrow (ed.), The Ecology of Fossils, Gerald Duckworth & Company Ltd

The Cambrian explosion was a sharp and sudden increase in the rate of evolution. About 541 million years ago, at the onset of the Cambrian Period, intense diversification resulted in more than 35 new animal phyla; however, new discoveries show that the "explosion" started roughly 575 million years ago, near the end of the Proterozoic Eon (2.5 billion to 541 million years ago), with the Ediacara fauna. The biota rapidly diversified throughout the Cambrian and Ordovician periods as life forms adapted to virtually all marine environments. In numbers of described marine species, fossils of trilobites dominate Cambrian rocks, whereas brachiopods (lamp shells) predominate in strata from the Ordovician through the Permian Period.

Several different kinds of organisms adapted independently to life on land, primarily during the middle Paleozoic. Leafless vascular plants (psilophytes) and invertebrate animals (centipede-like arthropods) were both established on land at least by Silurian time. Vertebrate animals made the transition to land via the evolution of amphibians from air-breathing crossopterygian fish during Devonian times. Further conquest of the land became possible during the Carboniferous Period, when plants and animals evolved solutions to overcome their dependence on moist environments for reproduction: waterborne spores were replaced by seeds in plants of seed fern origin, and shell-less eggs were replaced by amniote eggs with protective shells in animals of reptilian origin. Flight was first achieved also during the Carboniferous Period as insects evolved wings.

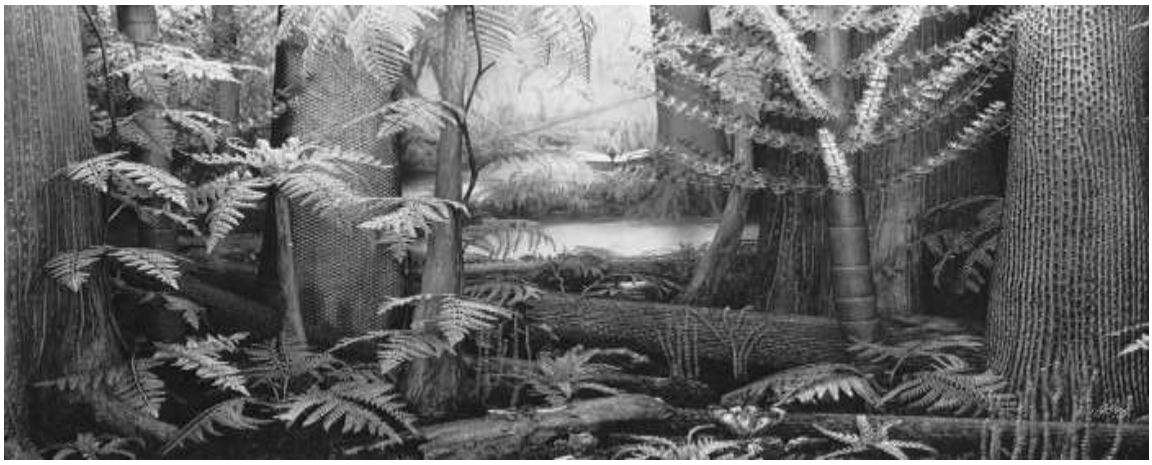


Figure 8. Pennsylvanian coal forest diorama. The lone tree with horizontal grooves in the right foreground is a jointed sphenopsid (*Calamites*); the large trees with scar patterns are lycopsids. Courtesy of the Department Library Services, American Museum of Natural History, neg. #333983

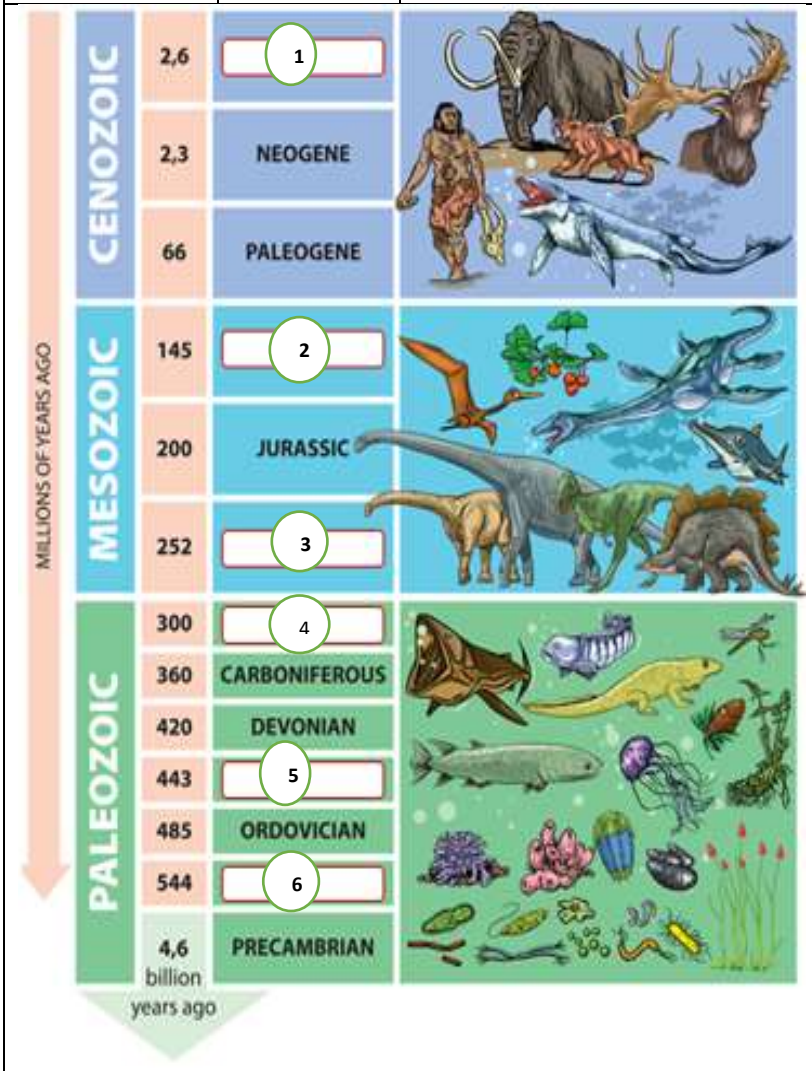
The Permian extinction, at the end of the Paleozoic Era, eliminated such major invertebrate groups as the blastoids (an extinct group of echinoderms related to the modern starfish and sea lilies), fusulinids, and trilobites. Other major groups, which included the ammonoids, brachiopods, bryozoans (moss animals), corals, and crinoids (cuplike echinoderms with five or more feathery arms), were severely decimated but managed to survive. It has been estimated that as many as 95% of the marine invertebrate species perished during the late Permian Period. Extinction rates were much lower among vertebrates, both aquatic and terrestrial, and among plants. Causes of this extinction event remain unclear, but they may be related to the changing climate and exceptionally low sea levels of the time. Although of lesser magnitude, other important Paleozoic mass extinctions occurred at the end of the Ordovician Period and during the late Devonian Period. (Crick, Rex. Paleozoic era. https://www.britannica.com/science/Paleozoic-Era. Updated January 19, 2021)

PERFORMANCE TASK

Directions: Fill out the table according to what is required. Choose from the choices below the periods being described and discuss the major events. Write your answers in your notebook.

Periods: **Triassic** **Silurian** **Permian**

Cambrian **Cretaceous** **Quarternary**

ERA	PERIOD	LIFE FORMS	MAJOR EVENTS (Answer only the numbered boxes)
			

III. WHAT I HAVE LEARNED

POST-TEST

Directions: Read each item carefully and choose the letter that best corresponds to your answer. Write your answers in your notebook.

1. During which geologic period did the earth become oxygen rich?
   a. Orosirian Period
   b. Ediacaran Period
   c. Devonian Period
   d. Ordovician Period

2. Which period did the first green plants and fungi appeared on land?
   a. Ediacaran Period
   b. Devonian Period
   c. Orosirian Period
   d. Ordovician Period

3. During which period did the flowering plants first appeared?
   a. Jurassic Period
   b. Carboniferous Period
   c. Cretaceous Period
   d. Silurian

4. What is the present epoch in the Earth's age?
   a. Holocene
   b. Miocene
   c. Pleistocene
   d. Pilocene

5. Which of the following is mainly characterized by the rise of human civilization?
   a. Holocene
   b. Pleistocene
   c. Pliocene
   d. Miocene

6. Which geologic period in the age of earth is also known as the Age of Fish?
   a. Orosirian Period
   b. Devonian Period
   c. Ediacaran Period
   d. Ordovician Period

7. As per the latest radiometric dating, what is the age of the earth?
   a. 4 billion years
   b. 4.54 billion years
   c. 4.45 billion years
   d. 4.64 billion years

8. During which period in the age of earth did terrestrial life was well established?
   a. Pleistocene Period
   b. Jurassic Period
   c. Carboniferous Period
   d. Cretaceous

9. During which geologic period did the first birds and lizards appeared on earth?
   a. Jurassic Period
   b. Carboniferous Period
   c. Pleistocene Period
   d. Cretaceous

10. Which period did angiosperm originated?
   a. Upper cretaceous
   b. Lower Jurassic
   c. Mid cretaceous
   d. Carboniferous

11. During evolution, when did the first multicellular organisms appear?
   a. 1 billion years ago
   b. 2 bullion years ago
   c. 600 million
   d. 200 million

12. Which geologic period did the maximum diversity of reptiles occur?
    a. Jurassic
    b. Ordovician
    c. Triassic
    d. Cretaceous

REFERENCES

Cenozoic era. Retrieved February 2, 2021 from https://ucmp.berkeley.edu/cenozoic/cenozoic.php

Cenozoic period. Retrieved February 2, 2021 from https://ucmp.berkeley.edu/cenozoic/cenozoic.php

Cretaceous period. Retrieved February 2, 2021 from https://www.livescience.com/29231-cretaceous-period.html

Cretaceous Period. Retrieved Februaury 3, 2021 from https://ucmp.berkeley.edu/mesozoic/cretaceous/cretaceous.php

Cretaceous Period: Animals, Plants & Extinction Event. Mary Bagley. Retrieved February 4, 2021 from https://www.livescience.com/29231-cretaceous-period.html

Crick, Rex. Paleozoic era. Retrieved February 1, 2021 from https://www.britannica.com/science/Paleozoic-Era. Updated January 19, 2021

David Doubilet and Jennifer Hayes. https://www.nationalgeographic.com/science/prehistoric-world/precambrian-time/

Dinosaurs and other fossils. Jason Hamilton. Retrieved February 4, 2021 from https://scienceviews.com/dinosaurs/mesozoic.html

General Biology 2 Textbook for Senior High School. 1253 G. Araneta Avenue, Quezon City: Vibal Group, Inc.

Mesozoic period. Retrieved February 4, 2021 from https://en.wikipedia.org/wiki/Mesozoic

Neogene period. Retrieved February 3, 2021 from https://en.wikipedia.org/wiki/Neogene

Paleogene period. Retrieved February 3, 2021 from https://en.wikipedia.org/wiki/Paleogene

Precambrian Period. Retrieved January 28, 2021 from https://www.britannica.com/science/Precambrian

Triassic period. Retrieved February 1, 2021 from https://www.britannica.com/science/Triassic-Period

DEPARTMENT OF EDUCATION
SCHOOLS DIVISION OF NEGROS ORIENTAL

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PSDS – Division Science Coordinator

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Librarian II (LRMDS)

ELMAR L. CABRERA
PDO II (LRMDS)

NOVEM I. SARDON
Writer

IVANNE RAY A. GIDOR
Layout Artist

ALPHA QA TEAM

LIEZEL A. AGOR
MA. OFELIA I. BUSCATO
ANDRE ARIEL B. CADIVIDA
THOMAS JOGIE U. TOLEDO

BETA QA TEAM

LIEZEL A. BESAS
JOAN B. VALENCIA
LIELIN A. DE LA ZERNA
PETER PAUL A. PATRON
THOMAS JOGIE U. TOLEDO

SYNOPSIS

This module talks about the geologic time, the extensive interval of time occupied by the geologic history of Earth. Formal geologic time begins at the start of the Archean Eon (4.0 to 2.5 billion years ago) and continues to the present day. Modern geologic time scales additionally often include the Hadean Eon, which is an informal interval that extends from about 4.6 billion years ago (corresponding to Earth's initial formation) to 4.0 billion years ago. Geologic time is, in effect, that segment of Earth history that is represented by and recorded in the planet's rock strata. It subdivides all time into named units of abstract time called—in descending order of duration—eons, eras, periods, epochs, and ages. The relative geologic time scale developed from the fossil record has been numerically quantified by means of absolute dates obtained with radiometric dating methods.

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ANSWER KEY

PRE-TEST

PERIOD

PERFORMANCETASK

Period:
1. Quarternary
2. Cretaceous
3. Triassic
4. Permian
5. Silurian
6. Cambrian

Major Events: Possible answers
7. Ice ages, human appear
8. Origin of primates
9. Formation of Rocky Mountains
10. Dinosaurs abundant and diverse
11. First seed plants appear
12. Mountain building in Europe
13. Diverse vascular plants
14. Beginning of mountain building in North America
15. Oceans covered most of North America

POST-TEST

1. A
2. D
3. C
4. A
5. A
6. B
7. B
8. C
9. A
10. C
11. A
12. D

ABOUT THE AUTHOR

BERNADETTE NOVEM I. SARDON is a licensed Professional Teacher. She is a graduate of University of San Carlos with the degree of Bachelor of Science in Biology. She is currently teaching at San Miguel National High School as a Senior High teacher and at the same time the Teacher-in-Charge of the same school. She has earned units in Masters in Biology and Master of Education major in Guidance and Psychology.