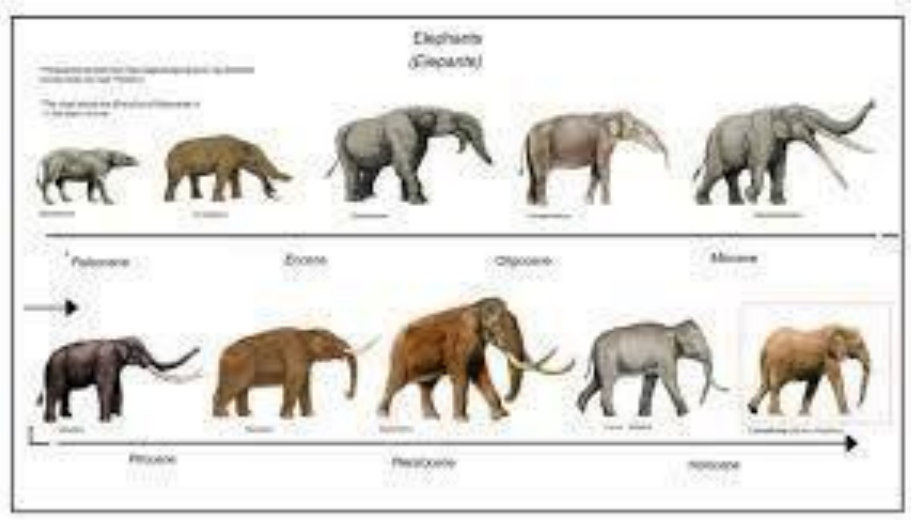
LESSON #3:
CHANGES THROUGHOUT TIME



SCIENCE

K- 5TH GRADE

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INTRODUCTION

The *Genomic Logic for Underlying Morphological Divergence (EPSCoR)* project aims to bring science-related learning experiences to schools. This lesson is the last of six, designed to facilitate learning the concepts of biodiversity (lesson 1), adaptation (lesson 2), evolution (lesson 3), plant and animal structures (lesson 4), heredity (lesson 5), and the care of butterflies (lesson 6). These lessons will serve as a tool for the trainer or professional in charge of teaching (teacher, professor, among others). For participants, they can be teachers (as part of their professional development) or students.[1]

In this third lesson, the instructors or teachers of the elementary level, and their students, will actively participate in some activities where they will understand the principles of evolution. Emphasis will also be placed on biodiversity, species, adaptation, plant and animal structures, and heredity, among others.

This lesson includes:

- ✓ Scientific background of the concepts
- ✓ Glossary
- ✓ Alignment of the content to the standards, expectations, and specificities of the Department of Education of Puerto Rico (DEPR)
- ✓ Educational Process
- ✓ Detailed activities to carry out in the classroom.

[1] Unless otherwise stated, the neutral term will be used with nouns such as teacher/s, participant/s, professor/s, instructor/s, and/or student/s.

GUÍA DEL MAESTRO

MATERIA: Ciencia **NIVEL:** Elemental (K-5to)

CONCEPTO PRINCIPAL: evolución

CONOCIMIENTO PREVIO: biodiversidad, especie, adaptación, semejanzas y diferencias, características de los seres vivos

OBJETIVOS ESPECÍFICOS DE APRENDIZAJE

Objetivos conceptuales:

- Identificar semejanzas y diferencias entre algunas especies dadas.
- Interpretar información relacionada con los conceptos especie y biodiversidad.
- Reconocer características particulares que ayudan a una especie a sobrevivir en un ambiente dado.
- Definir adaptación.
- Definir evolución.
- Mencionar mecanismos que ayudan a una especie a sobrevivir (ejemplo: camuflaje).
- Mencionar como la intervención humana puede contribuir o afectar la disponibilidad de una especie.

Objetivos procedimentales:

- Observar e identificar organismos que comparten características semejantes y diferentes, y que pertenecen a la misma especie.
- Utilizar dibujos o diagramas para explicar las similitudes estructurales entre las especies.

Objetivos actitudinales:

- Valorar y mostrar aprecio por la naturaleza y la diversidad de la vida
- Reconocer la importancia de cuidar la biodiversidad.
- Reflexionar sobre la fragilidad de una especie para crecer y cómo podemos cuidarla.
- Aceptar, respetar y reconocer los trabajos e ideas de otros.

ESTÁNDARES, EXPECTATIVAS Y ESPECIFICIDADES:

Grado: 1ro-3ro (Indicadores según los estándares de contenido)

Estándar: Estructura y niveles de organización de la materia

- Reconocer las similitudes estructurales y las diferencias entre los humanos, las plantas y los animales (puede usar dibujos, esculturas o representaciones teatrales).
- Hacer observaciones con el propósito de describir las estructuras que necesitan las plantas y los animales para sobrevivir y crecer.

Estándar: Conservación y cambio

- Interpretar información relacionada con el concepto de biodiversidad haciendo énfasis en el aprecio por la naturaleza y la diversidad de la vida.
- Reconocer que la materia (seres vivientes y no vivientes) cambian a través del tiempo.
- Describir los patrones de cambio en la materia.
- Reconocer que la reproducción es una forma de conservación de los seres vivientes.
- Deducir que los seres vivos cambian a través del tiempo.
- Identificar las características que se transmiten y se conservan de generación en generación

Estándar: Interacciones y energía

- Construir un argumento a partir de evidencia para explicar que, en un ambiente particular, algunos tipos de organismos sobreviven mejor, otros viven con más dificultad y otros no logran sobrevivir.
- Explicar cómo las variaciones en características entre individuos de la misma especie ofrecen ventajas para sobrevivir, encontrar pareja y reproducirse.
- Describir el ciclo de vida de los organismos (nacimiento, crecimiento, reproducción y muerte).
- Analizar e interpretar datos para proporcionar evidencia de que las plantas y los animales tienen características heredadas de sus progenitores, las cuales varían dentro de los organismos que pertenecen a un mismo grupo.
- Explicar cómo las variaciones en características entre individuos de la misma especie ofrecen ventajas para sobrevivir, encontrar pareja y reproducirse.
- Observar plantas y animales para comparar la diversidad de la vida en una variedad de hábitats.

Grado 4to y 5to (Indicadores según los estándares de contenido)

Estándar: Estructura y niveles de organización de la materia

- Mencionar y argumentar sobre las ventajas funcionales de las adaptaciones estructurales en los seres vivos.

Estándar: Conservación y cambio

- Definir, identificar y utilizar evidencia para elaborar argumentos sobre los mecanismos adaptativos en las plantas y animales que le permiten sobrevivir y reaccionar a cambios en el ambiente.
- Identificar formas para conservar la supervivencia de los organismos en su ambiente.
- Reconocer que la reproducción es necesaria para perpetuar la especie.
- Inferir en que la reproducción permite conservar o cambiar algunas características de las especies.
- Explicar los cambios relacionados con la forma, estructura y funciones vitales en los organismos.
- Reconocer que los organismos tienen ciclos de vida y cambian a través del tiempo.
- Reconocer que la forma, la estructura y las funciones vitales de los organismos pueden cambiar a través de sus etapas de desarrollo.

BACKGROUND

When we talk about **adaptation**, we refer to the characteristics that a species possesses that gives it the capability of survival in the environment it inhabits. A **species** is a group of organisms that share the same characteristics that can cross and produce a fertile descendance. However, individuals of one same species can show mild variations. These variations may be favorable or unfavorable. This lets the species survive in a particular environment. Depending on environmental factors, after many generations, a population can look very different. Adaptations can be **structural** or **physiological**. Butterflies are a particularly strong example of structural adaptations. These adaptations in butterflies include the way in which they use **mimicry**, **camouflage**, and even their capability to fly. Some examples of adaptations that butterflies possess are:

Camouflage = The principal structural adaptation of butterflies is in their wings and how they use them to hide. The wings of many species have evolved to imitate its surroundings, with the common green as a particularly good example. These butterflies have wings that have a color and shape that match exactly to the leaves in which they are found, which makes it more difficult for predators to find them.

Disguise and subterfuge = Many butterflies have developed “eye spots” on their wings. When their wings are open, these spots give the butterfly the appearance of a much larger creature, terrifying possible predators. In that same way, viceroy butterflies deliberately imitate the appearance of a monarch butterfly, which has evolved to be toxic upon consumption. As a result, predators avoid hunting both species. Another example that we can mention are the colors of *Heliconius*, who have red because animals associate it with a bitter taste.

Delight = Butterflies are cold-blooded creatures, which means that they need to heat their wings before taking off. That is where they are more vulnerable to predators, but it is a vital part in the progress of the butterfly. Butterflies may simply fold their wings if they overheat.

Sensibility to light = Every fourth generation of monarch butterflies migrates 2,000 miles (3,220 kilometers), traveling from as North as Canada to places to hibernate in Mexico. Monarch butterflies use their antennae to detect the basic level of light around them. This lets them know the time of the day depending on the amount of light that they can see, which also lets them stay alert.

Examples of adaptation in living beings

Species	Adaptation	How can adaptation help it survive in the environment?

Crocodiles	Digestive apparatus	Adapted to ingest a large variety of preys
Fish	Travel	It is favored by the wavelike movements of its body
Horse	Growth in size	To face prairie predators
Wolves	Development of muscles for chewing	It makes it easier to chew their prey
Anteater	Tail	It works as a coat
Mollusks	Large muscular foot	It allows them to set themselves on the sand to travel
Primates	Fingers	To collect tree branches
Butterflies	Camouflage	It allows them to imitate its surroundings with makes it harder for predators to find them

GLOSSARY

1. **Similarity** – relation among people, animals or things that have common traits.
2. **Difference** – quality that lets something distinguish itself from another thing.
3. **Species** – a group of organisms that can interbreed to produce fertile descendants.
4. **Biodiversity** – variety of organisms in our Planet.
5. **Adaptation** – traits form an animal that helps it survive in a specific environment.
6. **Structural adaptations** – adaptations that include changes in structure of some parts of the species' body.
7. **Mimicry** – structural adaptation that provides protection to an individual, letting it copy the appearance of other species.
8. **Camouflage** – structural adaptation that lets the individual blend into its surroundings. It involves the individual's change in color.
9. **Physiological adaptations** – changes in metabolic processes of an organism.

Evolution – change in inheritable traits of a population through time.

EDUCATIONAL PROCESS

BEGINNING

In this activity, prior knowledge that participants have about how species change throughout time is explored. The activity will begin by discussing the topic of the timeline of the geological eras.

1. For grades K-3, the timeline of the geological eras will be presented via socialized discussion. The teacher will form four work groups. Each group will represent a distinct Geological Era. In this step, the teacher will not identify which Geological Era corresponds to each group.

2. The teacher starts asking the students:
   Did you know that Planet Earth alongside the species that live in it have changed throughout time? The teacher will listen to the students' answers.

3. Then the teacher will comment:
   To identify changes that have occurred throughout the history of our planet, some epochs known as Geological Eras have been established.

4. The teacher will ask the students if anyone has heard about the names that have been given to each Geological Era. The teacher will wait for the students' answers.

5. If students do not mention the names of the Geological Eras, the teacher will randomly read the names of the eras out loud and will hand out and will assign one to each group.

   Group #1: *Precambrian Era* **Group #3: *Mesozoic Era***
   Group #2: *Paleozoic Era* **Group #4: *Cenozoic Era***

6. The teacher will draw on the whiteboard (or in a big paper) a timeline with the dates that correspond to each Geological Era. The teacher must keep in mind the proportion of the timeline. More than exactly measuring the time, the students should be able to observe that between each Geological Era there is a big space that represents the time that elapsed so those changes could occur. The teacher may prepare the timeline drawing beforehand.

7. The teacher will ask a member of each group to place the card with the name of their era in the date that they think that it corresponds to in the timeline.

8. Then, the teacher will hand out each group the pictures related to the organisms that existed during those Geological Eras.

9. The teacher observes and will not mention to the students if the completed task is correct. The teacher will indicate that during the following activity they will work with a story titled "The Geological Eras." The teacher will mention that it is very important that they listen to the reading of the story so that they can determine if their answers were placed in their corresponding allocation in the timeline.

10. For 4th and 5th grade, the timeline activity will be discussed like it was discussed with K-3, but 4th and 5th graders will read the story in pairs.

DEVELOPMENT

1. The activity will begin by reminding K-3 students and 4th-5th graders that they have to be very aware when the story "The Geological Eras" is read, because it will help them determine if the answers that they mentioned in the beginning activity are located in the place that they belong to in the timeline.

2. In the case of K–3 students, the teacher will read the story out loud and will be discussing the students' answers to the questions on Worksheet #1. The answers to each question will be compared with the information that students gave when they worked with the timeline during the beginning activity.

3. When the story's discussion is finalized, it is important that the teacher reviews and resumes the order of the geological eras and the characteristics and organisms present in each one. It is also important that the students understand that the changes in different geological eras occurred during extensive time periods.

4. 4th and 5th grade students will read the story in pairs and will answer the questions in Worksheet #1. Once students have answered the questions, the teacher will begin discussing them. The answers to each question will be compared to the information that the students gave when they worked with the timeline during the beginning activity. It is important that the teacher reviews and resumes the order of the geological eras and the characteristics and organisms present in each one. It is also important that the students understand that the changes in different geological eras occurred during extensive time periods.

5. When the discussion of Worksheet #1 is finalized, a *PowerPoint* presentation with an image of the timeline of the Geological Eras is shown.

6. In Worksheet #2 students (K-5) are asked to order the images that represent the changes that the elephant species have undergone throughout time. They will be ordered from the primitive elephant to the current elephant.

7. The changes that the elephant species has undergone will be discussed orally. It will be emphasized in students that these changes occurred in extensive time periods.

CLOSURE

1. In cooperative groups, 4th and 5th grade students will create an acrostic with the word **EVOLUTION**.
    - For the K-3 level, the teacher may provide the prepared acrostic (see example) and they will be placed according to the letters. Then, they should read it and review what has been learned. Visuals may be included.
2. Each group will present their acrostic to review what has been learned during this lesson.

Example of an acrostic with the word EVOLUTION:

E very species changes throughout time.

V ariations in species let them adapt to their environment.

O rganisms need to change to survive.

L iving species have primitive species that evolved throughout time.

U ndergoing changes require several environmental conditions to be met.

C harles Darwin proposed the idea that species change throughout time.

I mportant are the adaptations to guarantee the availability of the species.

O rigin and maintenance of the species

N eeded are the changes to avoid the extinction of some species.

Lesson #3: Changes throughout time **Worksheet #1**

Story: ***The Geological Eras***

It was a Friday afternoon, and the teacher left a task to Camila and Adriana. They had to investigate the organisms that existed according to *the Geological Eras.* The girls shared the Eras and went home. Camila had to investigate the Precambrian and Paleozoic Eras. Adriana would investigate Mesozoic and Cenozoic Eras. Adriana was very studious and quickly investigated her Eras. She then sent the material to her friend. Now Adriana had her free time. Instead, Camila was tired and thought:

- "Ah it's Friday, I will do my homework tomorrow."

Camila was very sleepy and decided to take a nap... and fell asleep soundly. Suddenly, Camila found herself in a place she did not know, and she began seeing creatures that reminded her of her science teacher when she talked about the Precambrian Era. The creatures Camila saw were single-celled organisms such as bacteria.

- "I'm in the *Precambrian* Age." - said Camila.
- "But this happened 4,600 million years ago - continued to speak to herself.

Then, Camila recalled that the Precambrian Era was the first and longest stage in Earth's history. And although little is known, remains of primitive seaweed and fragments of fossils such as sponges, and marine worms have been found.

Then she felt as if many years had passed and began to see plants like ferns and organisms different from those of the Precambrian Era. It was like he was in a movie of the Geological *Eras.*

- "It looks like the Paleozoic Era!" - exclaimed Camila.

Then, she continued walking and found some old papers where she could read all the information related to the Ages.

> *The Paleozoic Era was a time of change from life exclusively at sea to the conquest of the land. More invertebrate animals such as insects appeared. Vertebrates such as amphibians and reptiles began to appear. The first terrestrial vegetables, ferns and conifers also sprouted. This Age occurred 560 to 245 million years ago.*

Camila was very confident with the information while she read.

Suddenly, she met Adriana who had a notebook full of information with pictures. Camila was surprised but asked her friend what she had written in her notebook. Adriana replied:

- "I have the information I researched from the Mesozoic and Censozoic Eras." And all of a sudden, they saw a dinosaur.
- Look at Camila, a dinosaur from the Mesozoic Era! It is just what I investigated! - Exclaimed Adriana.

And Adriana showed her a dinosaur picture that she had in her notebook. Camila did not understand how Adriana was with her, but they were both in the same *movie.* The girls sat down and read the information from the notebook.

> *The Mesozoic Era is known as "The Age of Reptiles" and lasted about 180 million years. This was 245 to 65 million years ago. In this Age vertebrates were developed and diversified. The plants were formed with seeds allowing the fruits. This evolutionary leap helped in animal life, as plants are the largest source of energy in food chains.*

They continued walking and began to see horses, rhinos, whales, and primitive elephants.

- "Well, I imagine we are in the Cenozoic Era," Camila said.
- "Well, yes, that is the Age where human beings already existed," Adriana replied.
- "The Cenozoic Era began about 65 million years ago and extends to the present day. It is known as "The Age of Mammals". New groups of mammals developed, including humans. - Adriana explained to her friend.

Camila was amazed by everything she had learned from her science class research.

Suddenly, Camila got up from her bed, scared and looked at the clock. She had fallen asleep for 25 minutes.

- "I won't wait until tomorrow; I'll start my task right now" -Camila said.

Then, she called her friend and told her about her great dream of the Geological Eras. Camila and Adriana managed to finish their task that same Friday. They were ready to present their Geological *Eras* homework on Monday at their school, just as their teacher had assigned it.

Story: *The Geological Eras*

A. Using Camila's and Adriana's account of the Geological Eras, answer the following questions:

1. What was the first geological era that Camila mentioned in her dream? On what date did this era occur? What organisms and characteristics were identified in that era?

2. What was the second geological era that Camila mentioned in her dream? On what date did this era occur? What organisms and characteristics were identified in that era?

3. What was the third geological era that Adriana mentioned to Camila? On what date did this era occur? What organisms and characteristics were identified in that era?

4. What was the fourth geological era that Adriana mentioned to Camila?

5. Were the answers we mentioned at the beginning correct?

6. What is the oldest era? Which is the most recent? Which is the longest?

4th – 5th

Worksheet #1

Lesson #3: Changes throughout time

Story: *The Geological Eras*

A. Using Camila's and Adriana's account of the Geological Eras, answer the following questions:

1. What was the first geological era that Camila mentioned in her dream?
   _____

   On what date did this era occur? _____

   What organisms and characteristics were identified in that geological era?
   _____
   _____
   _____

2. What was the second geological era that Camila mentioned in her dream?
   _____

   On what date did this era occur? _____

   What organisms and characteristics were identified in that era?
   _____
   _____
   _____

3. What was the third geological era that Camila mentioned in her dream?
   _____

   On what date did this era occur? _____

   What organisms and characteristics were identified in that era?
   _____
   _____
   _____

4. What was the fourth geological era that Camila mentioned in her dream?
   _____

   On what date did this era occur? _____

   What organisms and characteristics were identified in that era?
   _____
   _____
   _____

5. Were the geological eras you indicated in the starting activity in the correct order?
   _____

6. What was the oldest geological era? _____
7. What is the most recent geological era?_____

8. What is the longest geological era? _____

4th – 5th

Worksheet #1

Lesson #3: Changes throughout time

Story: *The Geological Eras – KEY*

A. Using Camila's and Adriana's account of the Geological Eras, answer the following questions:

1. What was the first geological era that Camila mentioned in her dream?
   The first geological era is the Precambrian Era.

   On what date did this era occur? The Precambrian Era occurred 4,600 million years ago.

   What organisms and characteristics were identified in that geological era?
   There were single-celled organisms such as bacteria. There were remains of primitive seaweed and fragments of fossils such as sponges and marine worms.

2. What was the second geological era that Camila mentioned in her dream?
   The second era is the Paleozoic Era.

   On what date did this era occur?
   This Age occurred 560 to 245 million years ago.

   What organisms and characteristics were identified in that era?
   More invertebrate animals appeared such as insects, amphibians, and reptiles. The first terrestrial vegetables, ferns and conifers also sprouted.

3. What was the third geological era that Camila mentioned in her dream?
   The third Geological Era is the Mesozoic Era.

   On what date did this era occur? *This was 245 to 65 million years ago.*

   What organisms and characteristics were identified in that era?
   It is also known as the Age of Reptiles." In this Age vertebrates were developed and diversified. The plants were formed with seeds allowing the fruits. Plants are the largest source of energy in food chains.

4. What was the fourth geological era that Camila mentioned in her dream?
   The fourth geological era is the Cenozoic Era.

   On what date did this era occur?
   It started about 65 million years ago and extends to the present day.

   What organisms and characteristics were identified in that era?
   It is also known as "The Age of Mammals". New groups of mammals (horses, rhinos, whales and primitive elephants) developed, including humans.

5. Were the geological eras you indicated in the starting activity in the correct order?
   The answers may vary, but the correct order is Precambrian era, Paleozoic era, Mesozoic era and Cenozoic era.

6. What was the oldest geological era? Precambrian era
7. What is the most recent geological era? Cenozoic era.
8. What is the longest geological era? Precambrian era

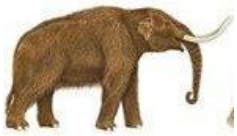
Worksheet #2

Lesson #3: Changes throughout time

Elementary level K-3

Procedure:

1. Look at the sheets.
2. Cut them out and organize them to show how the species (elephant) changed over time.
3. Follow your teacher's instructions.



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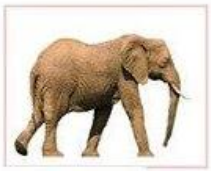

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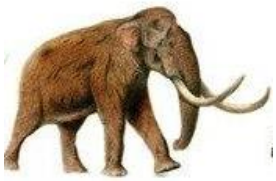

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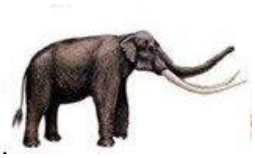


E

1 ***Primitive elephant***	**2**	**3**	**4**	**5** ***Current elephant***

Worksheet #2

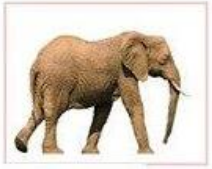
Lesson #3: Changes throughout time

Elementary level K-3

Procedure:

1. Look at the sheets.
2. Cut them out and organize them to show how the species (elephant) changed over time.
3. Follow your teacher's instructions.

A



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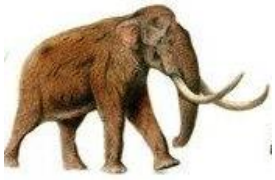

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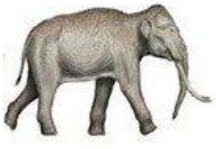
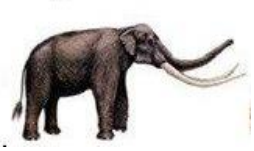


D



E

1 ***Primitive elephant***	**2**	**3**	**4**	**5** ***Current elephant***

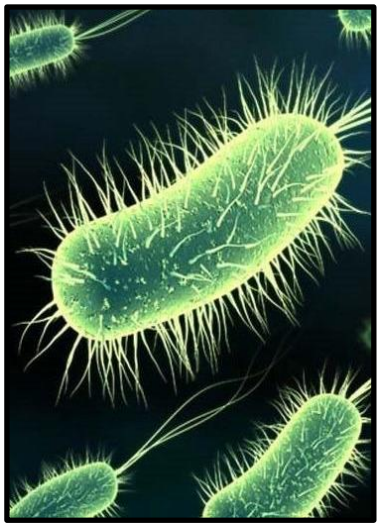
Answer: What similarities or differences can you observe between the primitive elephant and the current elephant?

_____
_____
_____
_____
_____

Pictures (examples)

Precambrian era

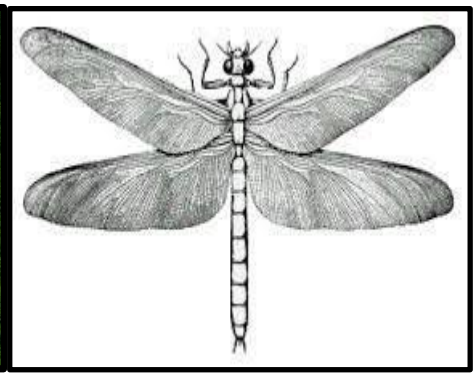
Single-celled organisms



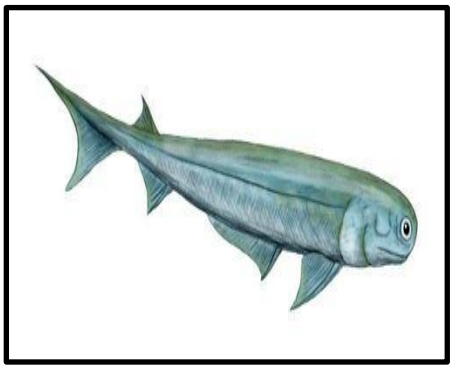
bacteria

Paleozoic

Ferns

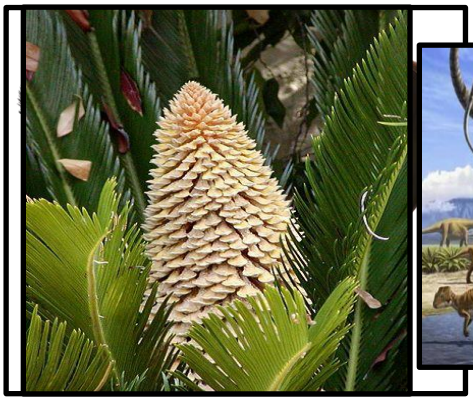


insects

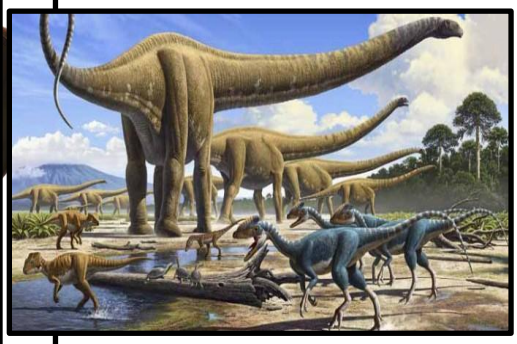


fish

Mesozoic era



Triconolestes curvicuspis



Cycas revoluta

Dinosaurs

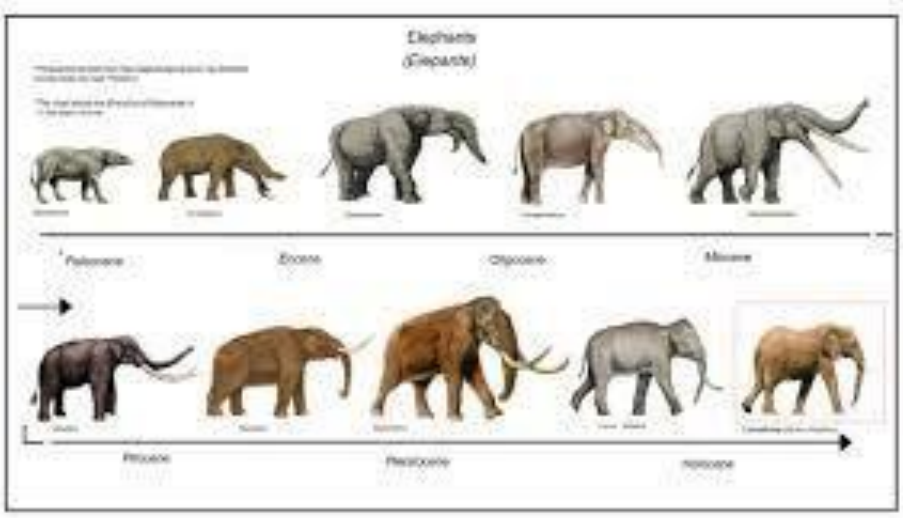
Cenozoic era

whale

horse

human being

EVOLUTION OF THE ELEPHANT KEY



Ideas:
http://eprints.ucm.es/28567/7/Erase%20una%20vez%20la%20Geologia%20I%20%282015%29.pdf

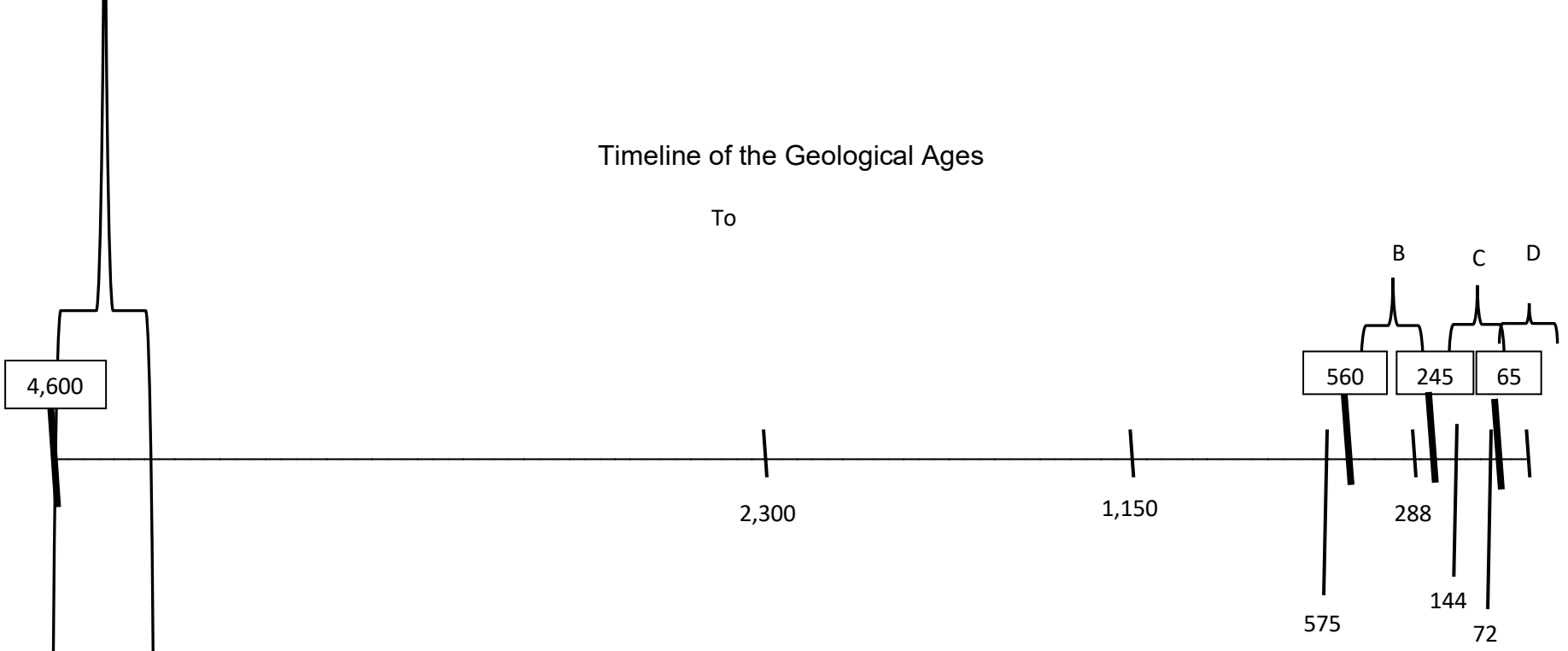
Precambrian era

Paleozoic era

Mesozoic era

Cenozoic era

Timeline of the Geological Ages



A: Precambrian era – 4,600 to 560 million years ago
B: Paleozoic era _ 560 to 245 million years ago
C: Mesozoic era – 245 to 65 million years
D: Cenozoic era – 65 million years to the present

Scale in millions of years