A STORY OF SURVIVAL

DINOSAURS

Every story of survival begins with a birth

Hi! My name is Celeste What's yours?

I'm sure glad to see you reading these pages because I need your help.

Tomorrow I have to make a presentation at school about how the dinosaurs went extinct and I have to take an origami dinosaur with me, but it's really hard to make one...

And to top it off, Moon appears and tells me that not all the dinosaurs became extinct...
Can you believe that?

So I've decided to become an EXPERT PALEONTOLOGIST and solve this big mystery. And to do that, I need to read, play and answer the questions in this guidebook.
If you'll help me out, I'm sure we can do it...

Are you up for it?

I am Moon.

A small particle of light from a star very far, far away.

I will guide you and train you to become experts in DINOSAURS.

Ah, and these are my helpers!

They will be fluttering around here in case you need their help.

Good luck!

This Diary belongs to:

Name:.....

Age:.....

School:.....

Class:.....

My best friend's name is: .....

What I like most in the world is:.....

My favorite dinosaur is:.....

Welcome!

The first thing that every paleontologist has to know is that not all the dinosaurs went extinct and that they are much closer than you may think...

What does a dinosaur have to do with a chicken?

Let's see how good your memory is.
Ready?
Here we go!

1. We begin our journey by coming out of a dinosaur E_ _.

2. Celeste confuses a Brachiosaurus with another related dinosaur called a LOHUECOTITAN

3. She realizes she made a mistake because a LOHUECOTITAN has SP_ _ES.

4. This dinosaur lived during the C_ _ T_ CEOUS period.

DID YOU KNOW THAT...? *Lohuecotitan* was an enormous sauropod that could reach a length of 20 meters. Its name refers to the dig called "Lo Hueco", where it was discovered in the year 2007, and to the giants in Greek mythology known as Titans.

What is a fossil?

Fossils are remains or signs of the activity of living beings of the past that have been preserved in rocks through chemical and geological processes.

When we talk about dinosaur fossils, we separate them into two types.

•Body fossils. These are fossils in which we recognize part of the dinosaur's body. It could be a skull, any other bone in their body, and even claws, bony scales or the animal's teeth.

•Trace fossils. These show us that an animal was there (but we don't find any parts of their body). These fossils might be dinosaur nests with their eggs, footprints that they left behind when they walked, or even dung, called coprolites.

Always remember that not all
the dinosaurs lived at the same time and that
their history on Earth began about 251 million years ago
(the Triassic period, at the start of the Mesozoic era).

But careful! At that time, the planet was very different from what it is like today.
It wasn't going through its best time and it looked very odd...

Can you recognize what the Earth was like then? (Choose the right image)

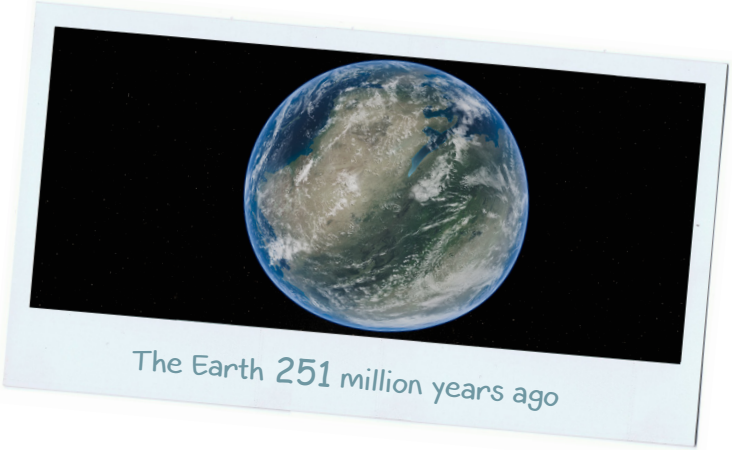
☐ ☐ ☐ ☐

IMPORTANT! You should know the words that paleontologists use.
Don't miss the dictionary at the back of this notebook to find out everything about these words.

Our journey has just begun.

This is what the Earth was like when the dinosaurs' evolutionary story began.

Do you remember the name of this moment in geological time?



The Earth 251 million years ago

And... do you remember the name of the supercontinent? And of the only ocean?

1. Supercontinente P__G_A
2. P__THALA__A.

DID YOU KNOW THAT...? Life on Earth has experienced at least five mass extinctions. The deadliest of them all happened before the first dinosaur appeared and wiped out 90% of all the species that inhabited the planet at that time.

BRAVO! You just moved up to the next level.
Each time, you know a little bit more about DINOSAURS.
You're no longer a beginner and you've achieved this all on your own.
Now pay close attention because we're going to meet... the first dinosaur!

Ancestral dinosaur

What a lizard!

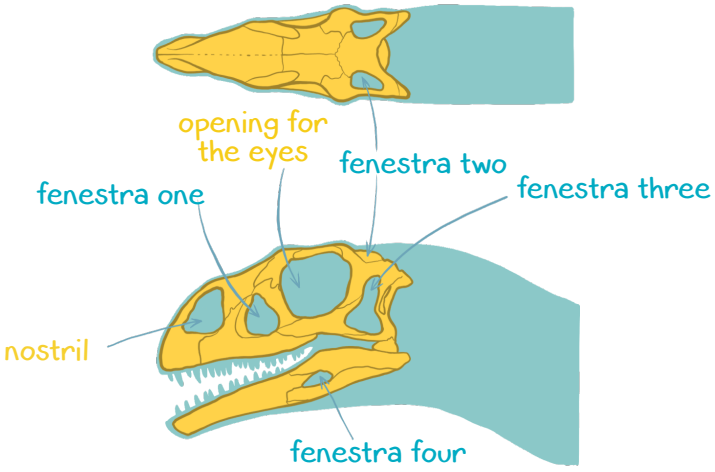
Do you remember what the main characteristics that define a dinosaur are?
(Draw a line to connect the correct options)

THE DINOSAURS ☐

- ☐ They have membranes to fly.
- ☐ They have legs placed vertically under their body and they "invented" a way of walking.
- ☐ They have at least two pairs of fenestrae (holes) in their skull and another pair in their jawbone.
- ☐ They are all huge and have very long necks.
- ☐ They can't put the soles of their front and back feet completely flat on the ground.

DINOSAUR SKULL

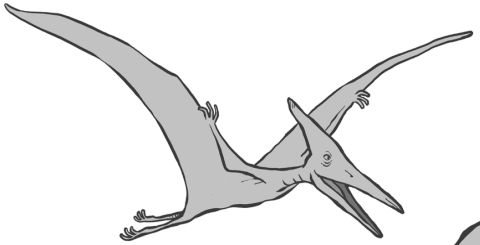
A dinosaur's skull is very characteristic because, in addition to the openings (or fenestrae, which means "windows" in Latin) for the eyes and nostrils, it has other openings that make it weigh less and allow the insertion of certain muscles.



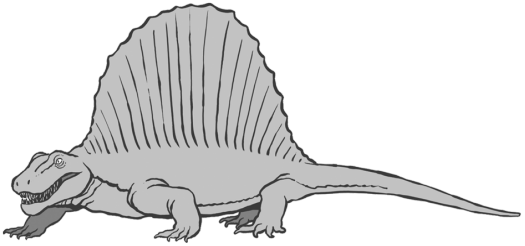
DID YOU KNOW THAT...? Mary Anning **(1799-1847)** was the first woman paleontologist. Her most important discoveries include being the first person to correctly identify correctly an ichthyosaur and to find the first plesiosaurs. Her scientific work improved our knowledge of the history of life on Earth.

ATTENTION: they are not dinosaurs!

A paleontologist must recognize which animals are not **DINOSAURS**.



Pterosaurs are flying reptiles that are not dinosaurs.



Pelycosaurs are land reptiles that are not dinosaurs.

Plesiosaurs are marine reptiles that are not dinosaurs.

Did you know that the names of dinosaurs usually refer to some special feature they have?

For example, *Concavenator corcovatus* means "humped (corcovatus) hunter (venator) from Cuenca (Conca)" because this carnivorous dinosaur with a visible hump was first found at the "Las Hoyas" dig in Cuenca province (Spain).

Can you invent a name for the dinosaurs that appear in the film?
Use your imagination!

• Name:_____

• Name:_____

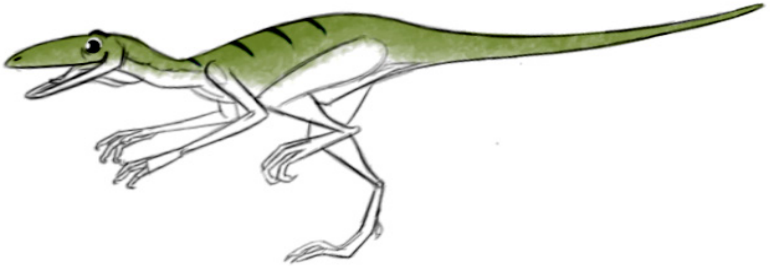
What do you say we take a break and play for a while?

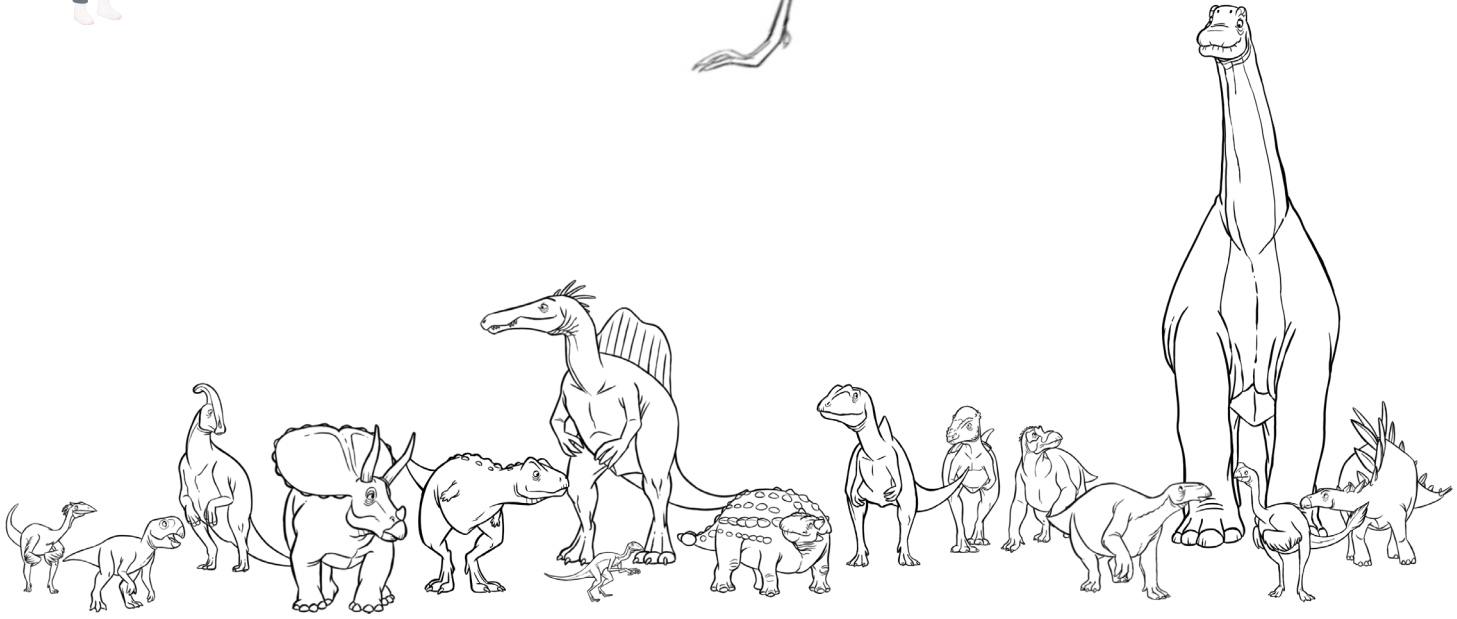
Color this spectacular *Spinosaurus!*

DID YOU KNOW THAT...? We're learning more and more about the life of the *Spinosaurus* and some paleontologists contend that it was a great diver, able to catch huge fish underwater. That would make it the first known non-avian dinosaur.

Do all dinosaurs really descend from this little animal?

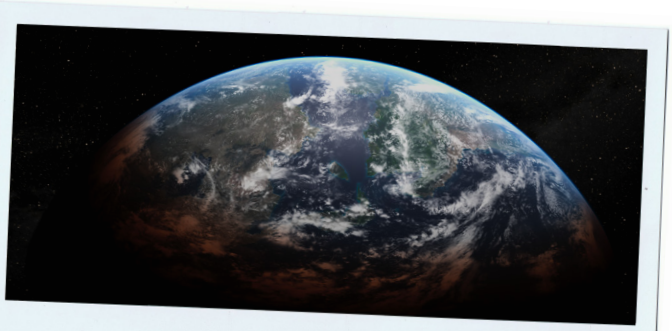
Absolutely all of them!





Pangea has broken up!

That's right, more than **100** million years have gone by and the supercontinent has split in two.



THE EARTH DURING THE JURASSIC

Do you remember the name of these two enormous continents?

LAU_ _ S_A in the north.
G_NDW_N_ in the south.

But I still don't see the continents...

No. Millions of years will have to go by for these two land masses to form the continents that you know.

CONTINENTS THAT MOVE AND OCEANS THAT CHANGE THEIR SIZE

The oceans and the large land masses, which we call continents, are constantly changing because the parts of the planet that are closest to the surface (the crust and the upper mantle) move due to the heat in the Earth's interior. These are what geologists call TECTONIC PLATES.

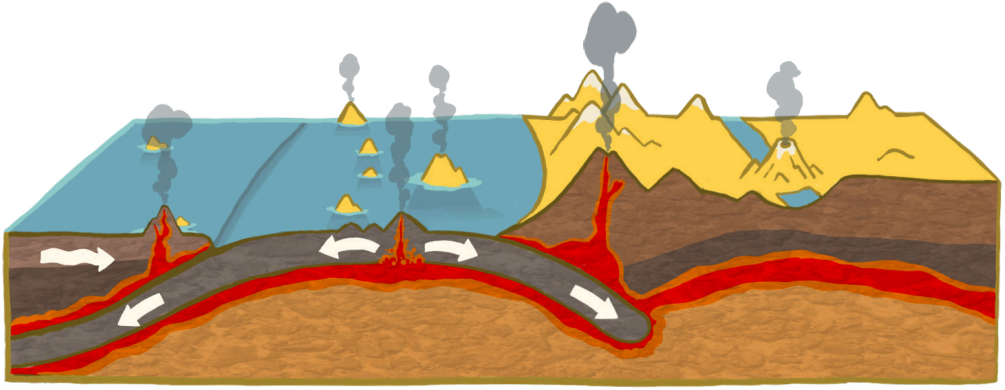
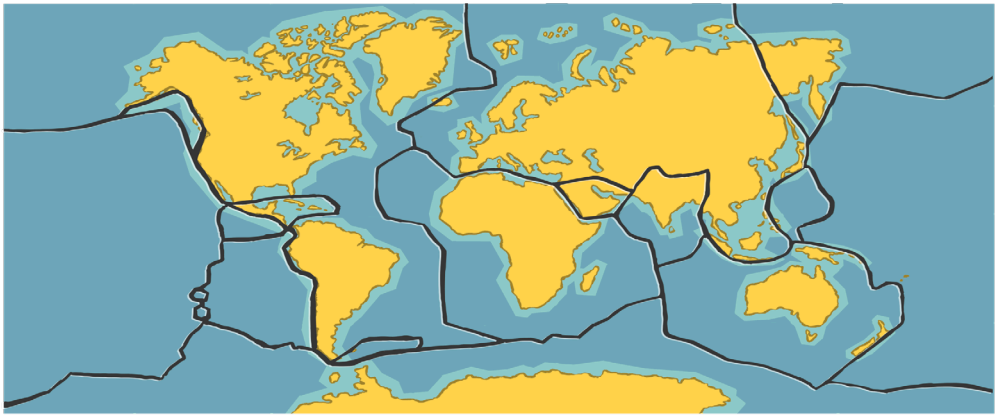


PLATE TECTONICS is a theory that tells us that the surface of the Earth is divided into **15** large pieces that move around around (like a giant puzzle).

Since the Earth has a limited surface area and the plates move, inevitably there are areas where new crust is created (at the mid-ocean ridges) and others where it is destroyed (called subduction zones).



The movements of these plates give rise to gigantic mountain ranges, oceanic trenches, chains of islands... and generate all the earthquakes that take place on Earth.

This theory is able to tell us what the Earth was like in the past (what the plane was like when the dinosaurs appeared) and what it will be like in the future, millions of years from now.

DID YOU KNOW THAT...? While the Atlantic Ocean is getting wider every year by about 4 centimeters, the Pacific Ocean is getting smaller and smaller. The movements are so slow that millions of years will have to go by for the Pacific Ocean to stop being the biggest ocean on Earth.

Now this is a *Brachiosaurus*!

They could measure up to **23** They could measure up to **80** tons.

Wow, you know a lot!

Celeste knows a lot more about this dinosaur. And you?
(Mark the correct options)

- [ ] They could eat up to **100** kilograms of plants a day.
- [ ] Their name means "reptile with gills" because they could breathe under water.
- [ ] They could eat up to **400** kilograms of plants a day.
- [ ] They are solitary dinosaurs.
- [ ] Their name means "reptile with arms" because their front legs are longer than their back legs.
- [ ] They live in herds.

DID YOU KNOW THAT...? The blue whale is the largest animal that has ever lived on our planet. It can reach a length of **29** meters and can weigh **150** tons (equal to 33 African elephants).

Name: *Torvosaurus.*
Length: 10 meters.
Weight: 4,5 tons.

Type: theropod.
Period: Jurassic.

Don't tell me they're... flirting!

That's life, Celeste! And it spreads throughout the planet!

I've decided that I'm going to tell my friends everything
I know about dinosaurs, but I want to be sure that I do it right...

Would you help me to complete the sentences?

FIVE – DINOSAURS – TRIASSIC – PANGEA – PLATE – PTEROSAURS

There have been least _____ mass extinctions on planet Earth and the deadliest one happened before the _____ appeared.

The story of the DINOSAURS began in the _____ period, **251** million years ago.

At that time, there was only one supercontinent, called _____.

The theory that explains the movement of the continents is called _____ TECTONICS.

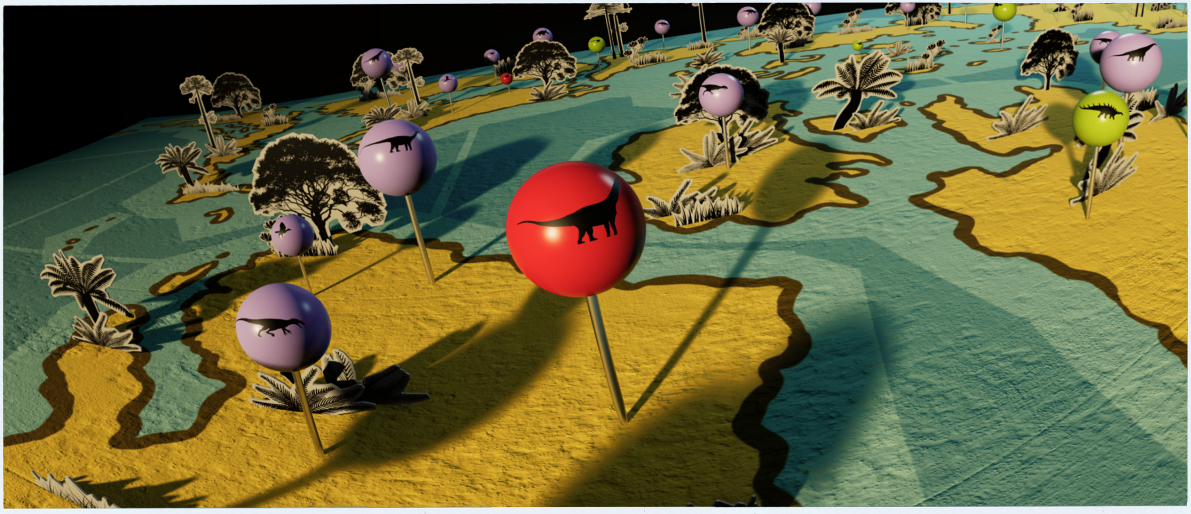
_____, plesiosaurs, and pelycosaurs ARE NOT DINOSAURS.

Okay. If you've gotten this far, you've got a very high chance of becoming a great expert.

Get ready because things are going to get more complicated...

We're going to discover a key process in the evolutionary history of the dinosaurs and all other living beings on Earth:

speciation!



Speciation is what we call the process through which new species of living beings appear out of the ones that already existed.

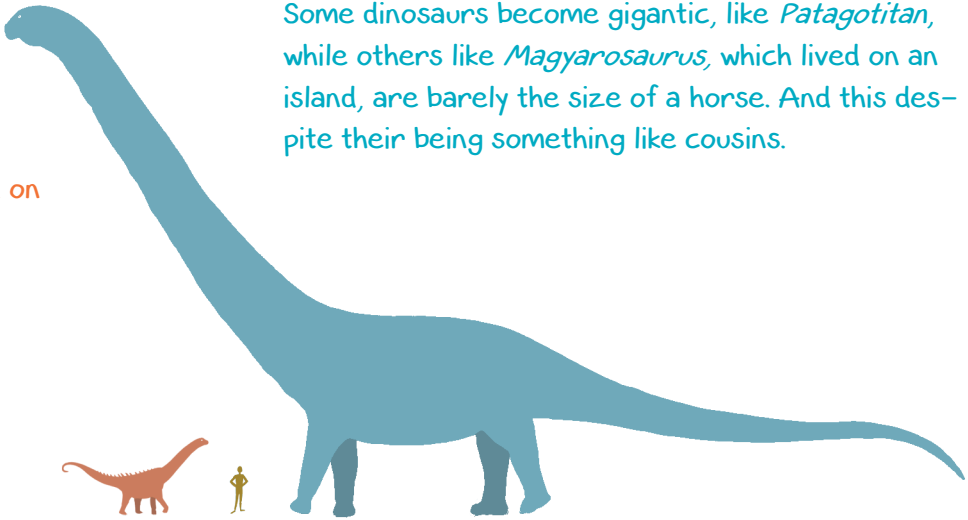
The emergence of a new species can be a process as slow as the movement of the continents and it can take millions of years to generate a new dinosaur species.

Remember: The little ancestral dinosaur gave rise to all the dinosaurs that you know in a process that lasted more than ***170*** million years.

But why do new species appear?

The land has split up. Remember? And the dinosaurs, isolated in different areas on the planet, start to have different histories and to evolve differently.

Some dinosaurs become gigantic, like *Patagotitan*, while others like *Magyarosaurus*, which lived on an island, are barely the size of a horse. And this despite their being something like cousins.



So... Does their evolution depend on the place where they live?

That's right! The changes in ecosystems select the fauna that live in them. Some species don't survive these changes and go extinct, while other new ones appear. This is precisely what speciation is.

ARMORED DINOSAURS

One of the most striking evolutionary traits of some dinosaurs is the development of features to attack others or to defend themselves: armor, spikes, and clubs. No doubt the best known of these is *Ankylosaurus*.

Name: *Ankylosaurus*.
Length: 9 meters.
Weight: up to 6 tons.

Type: Thyreophora.
Period: Cretaceous.

Now that's a good defense mechanism! Nobody's coming near him!

Well, that was awkward!

DID YOU KNOW THAT...? Fossilized dung is called COPROLITES (Copro = dung and Lite = rock) and the ones from dinosaurs provide very valuable information about their diet. When they study them, paleontologists are able to discover what dinosaurs ate.

If I could have my pick, I'd turn into a humongous dinosaur, with lots of teeth and tough armor that nobody could pierce.

Are you sure?...
It's not always a good thing to go through life covered with armor.

PROTECTOR DINOSAURS

Although most dinosaurs did not care for their young,
paleontologists have discovered that some species did, like the *Psittacosaurus*.

Name: *Psittacosaurus*.
Length: 2 meters.
Weight: 90 kilograms.

Type: Ornithischian.
Period: Cretaceous.

I don't think it's willing to go.

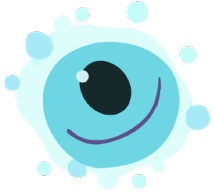
It's got to get out of here!
The volcano is erupting!

It's its baby!

Yes. It's very important for your parents to take care of you when you're little in order to survive, don't you think?

I don't understand, Moon.

I know that we've learned lots of things about
dinosaurs through fossils, but...
also how they behaved or the color of their skin?



In some cases, that´s possible.
At exceptional digs that offer loads of information.

Fossil of *Concavenator corcovatus.*

This is a fossil of a *Concavenator corcovatus.*

Do you remember what we could see in it? (Mark the option that is incorrect)

- ☐ Teeth with serrated edges.
- ☐ Claws on its hands.
- ☐ A strange hump.
- ☐ Scales on its skin.
- ☐ Eyelids and eyelashes on its eyes.
- ☐ The mark of the pads of the soles of its feet.

DID YOU KNOW THAT...? At the "Las Hoyas" dig, besides exceptionally well-preserved dinosaurs and fossilized footprints, scientists have also found a large number of land plants, algae, crustaceans, fishes, aquatic insects, amphibians, turtles, and crocodiles.

Remember! You should never, ever collect fossils in the field without authorization.
Neither adults, nor your teacher, nor your parents should do that.

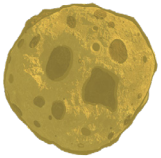
Except in very specific cases, only paleontologists can get permission to do that.

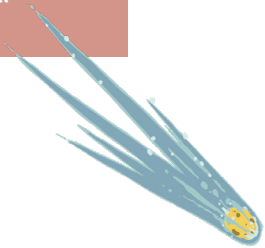
If you take a fossil home without anyone giving you permission to,
you can do irreparable damage to our knowledge of what happened in the past,
because you might destroy information that paleontologists will never be able to recover.

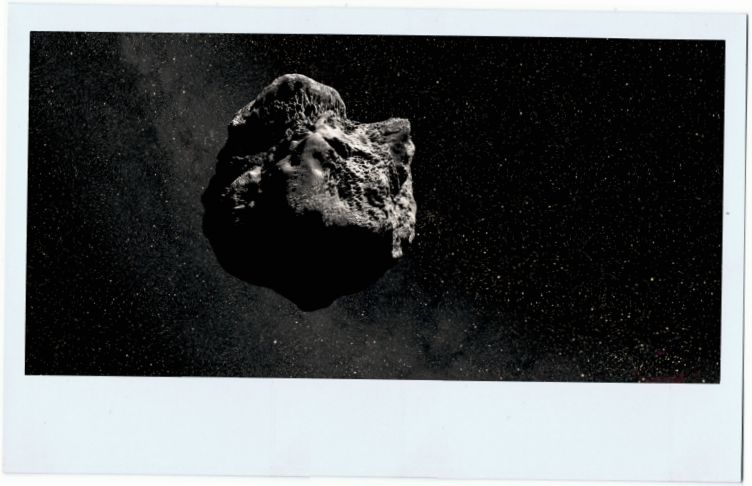
ASTEROID OR COMET?

The most widely accepted theory maintains that it was an asteroid that impacted the Earth **66** million years ago, although new research proposes that it might have been a comet from the Oort cloud.

Oh! The asteroid!
I almost forgot!







Asteroids are neither planets nor moons. They are smaller rocky bodies that orbit the Sun. Nonetheless, some can be bigger than a mountain and move faster than the speed of a bullet..

Comets are huge balls of rock and ice that also orbit the Sun. Unlike asteroids, comets form long tails when the ice on their surface vaporizes as they draw close to the Sun. That is when they look the most striking.

It's a comet!
I can see its tail!

DID YOU KNOW THAT...? The Oort cloud may be formed by **1,000,000,000,000** comets and is considered the outermost limit of the Solar System.

We're in the late Cretaceous period and an asteroid – or a comet – is going to crash into the Earth, causing a mass extinction.

Do you remember the size and speed of the asteroid... or comet?

- ☐ Yes, it was bigger than Mount Everest and hit the Earth at a speed ***100*** times faster than a bullet.
- ☐ Yes, it was bigger than Mount Kilimanjaro and hit the Earth at a speed ***100*** times faster than an airplane.
- ☐ Yes, it was bigger than Mount Fuji and hit the Earth at a speed ***100*** times faster than a high-speed train.

The poor dinosaurs!
So much growing, arming themselves,
and adapting, just to get wiped out in the end.

I didn't say they all disappeared...

DID YOU KNOW THAT...? The mass extinction that marked the end of the Mesozoic era killed off **75%** of all the plant and animal species that inhabited the continents and oceans on Earth. This was the fifth mass extinction that had taken place on the planet.

FEATHERS.

Allow me to introduce you to *Citipati*.

Wait a minute...
A dinosaur with feathers?

Citipati lived in the Upper Cretaceous, more than **70** million years ago. The fossils found belonging to this animal are one of the many pieces of evidence to confirm that many dinosaurs had feathers.

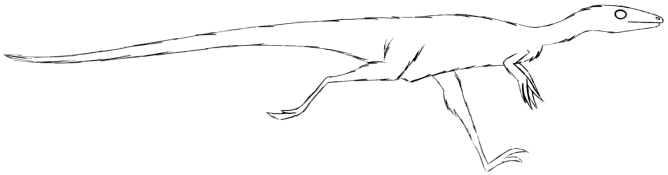
Besides flying... what other purposes did feathers serve for a dinosaur?
(Mark the correct options)

- ☐ To camouflage itself and go unnoticed.
- ☐ To regulate its body temperature.
- ☐ To attract the attention of a mate.
- ☐ To brush off dust and keep its den clean.

DID YOU KNOW THAT...? Feathers are modified reptile scales. In the beginning they looked like simple spikes, but over time more complex designs appeared, until they eventually became feathers for flight.

THE ORIGIN OF FLIGHT... in dinosaurs.

Some small dinosaurs probably began to use their feathered arms to run faster and to jump forward.



In some cases, the dinosaurs' arms and feathers gradually grew longer, and this may have helped them to gain speed.

Eventually those feathered arms became wings that could keep them up in the air and those dinosaurs were able to start to fly.

DID YOU KNOW THAT...? Thanks to the fossil of the *Archaeopteryx,* we know that the first dinosaurs able to fly managed to take flight at least **150** million years ago.

Birds are dinosaurs!

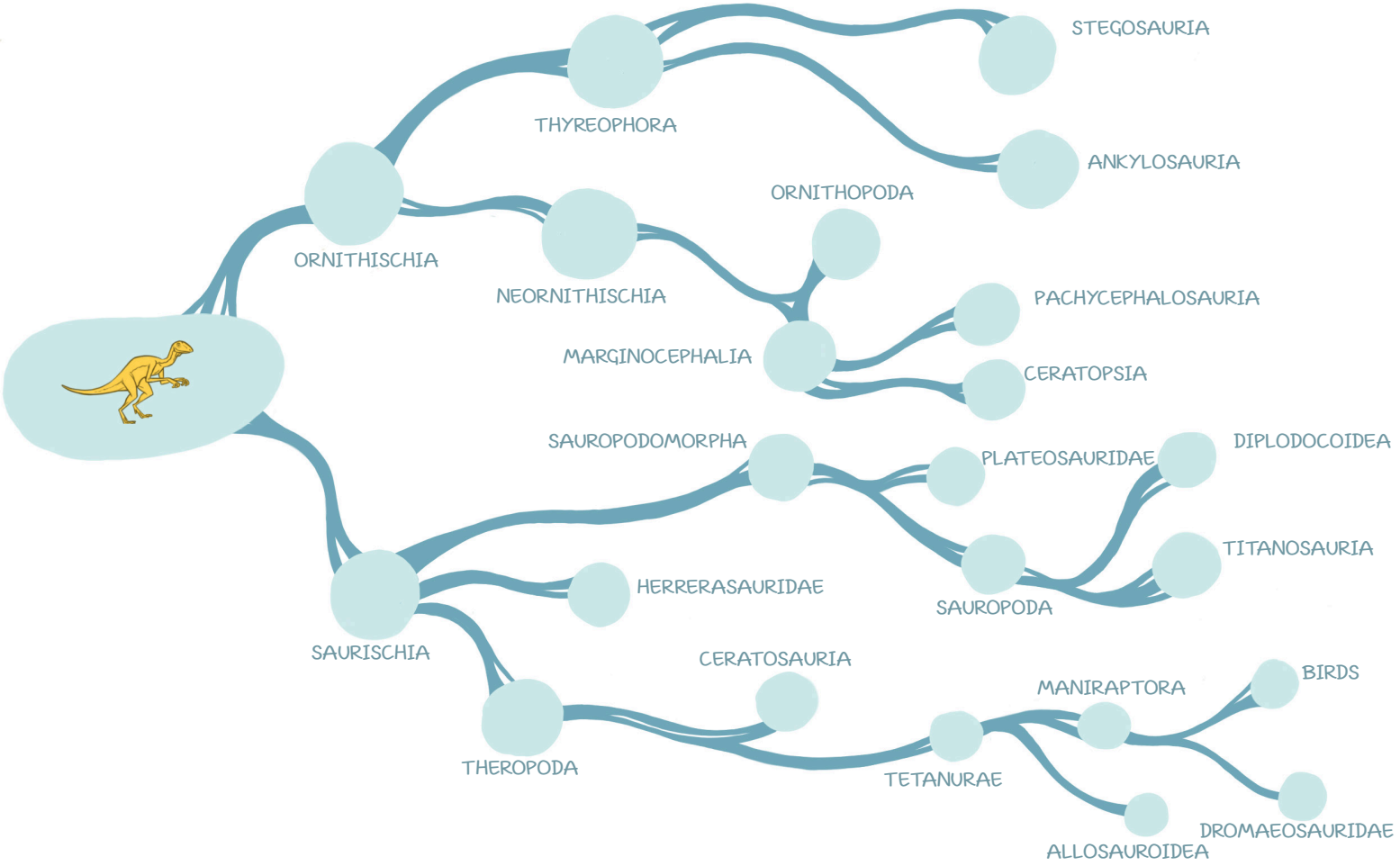
That's right. A few feathered dinosaurs that were able to fly survived the mass extinction and gave rise to all of today's birds.

DID YOU KNOW THAT...? Today there are more than twice as many bird species as there are mammal species (some **10.000** bird species, compared to **4.500** mammals) and they have adapted to all the ecosystems on Earth: jungles, deserts, oceans... and even to places as hostile as the Antarctic, where temperatures can drop to minus **50** degrees Celsius.

A chicken? What does a dinosaur have to do with a chicken?

Explain it in your own words.

THE DINOSAURS' FAMILY TREE



You've done an excellent job. And don't forget... many more digs with fossilized dinosaurs are still out there waiting to be discovered. If you really want to, keep learning about these fascinating beings from the past (and the present).

If you keep your passion for these creatures burning and continue studying, the day will come when you'll find a new dinosaur species and maybe... you'll name it and remember our adventure.

DICTIONARY OF PALEONTOLOGY

Let's see, every aspiring paleontologist needs to know certain prior concepts so as not to get lost. Here are some of the ones that we've seen in DINOSAURS. Oh! And don't forget to write down the ones that you learn on your own.

-**Asteroid:** A rocky body that orbits the Sun.
-**Comet:** A celestial body made up of rock, ice, and dust that orbits the Sun.
-**Coprolite:** Fossilized dung.
-**Cretaceous:** A division of the geological time scale that belongs to the Mesozoic era. It began **145** million years ago and ended **66** million years ago.
-**Mid-ocean ridge:** A large underwater mountain range where new oceanic crust is created.
-**Geological era:** A unit of time that comprises a series of periods (shorter units of time) of the planet's history.
-**Speciation:** The process by which new species emerge.
-**Mass extinction:** A catastrophic phenomenon that causes the abrupt disappearance of a large number of species in a short period of time.
-**Fossil:** Remains of an organism or of its biological activity that have been preserved in rock.
-**Jurassic:** A division of the geological time scale that belongs to the Mesozoic era. It began **200** million years ago and ended **145** million years ago.
-**Mesozoic:** The era that extends from **251** million years ago to **66** million years ago. It is divided into three periods: the Triassic, the Jurassic, and the Cretaceous.
-**Oort cloud:** An area where comets have accumulated at the outermost edge of the Solar System.
-**Paleontology:** The branch of science that studies fossils.
-**Paleontologist:** A person who studies fossils to discover what life and Earth's environment were like in the past.

-**Pangea:** The single supercontinent that existed on Earth **300** million years ago.
-**Panthalasa:** The enormous ocean that surrounded the supercontinent Pangea.
-**Geological period:** A unit of time that covers a series of millions of years in the Earth's past.
-**Plate tectonics:** The theory that explains how the Earth's surface is transformed in a continuous process of creation and destruction.
-**Earthquake:** A shaking of the ground caused by readjustments of the tectonic plates.
-**Geological time:** The calendar of the different events on Earth. It extends from the planet's birth, **4,5** billion years ago, to the present day.
-**Triassic:** A division of the geological time scale that belongs to the Mesozoic era. It began **251** million years ago and ended **201** million years ago.
-**Dig: A** place that is excavated in search of fossils, in the case of a paleontological dig, or of human artifacts and remains, if it is an archeological dig.
-**Subduction zone:** The border zone between two tectonic plates that are approaching each other, which forces one of the plates (the densest one) to slide under the other.
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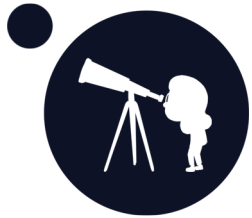

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