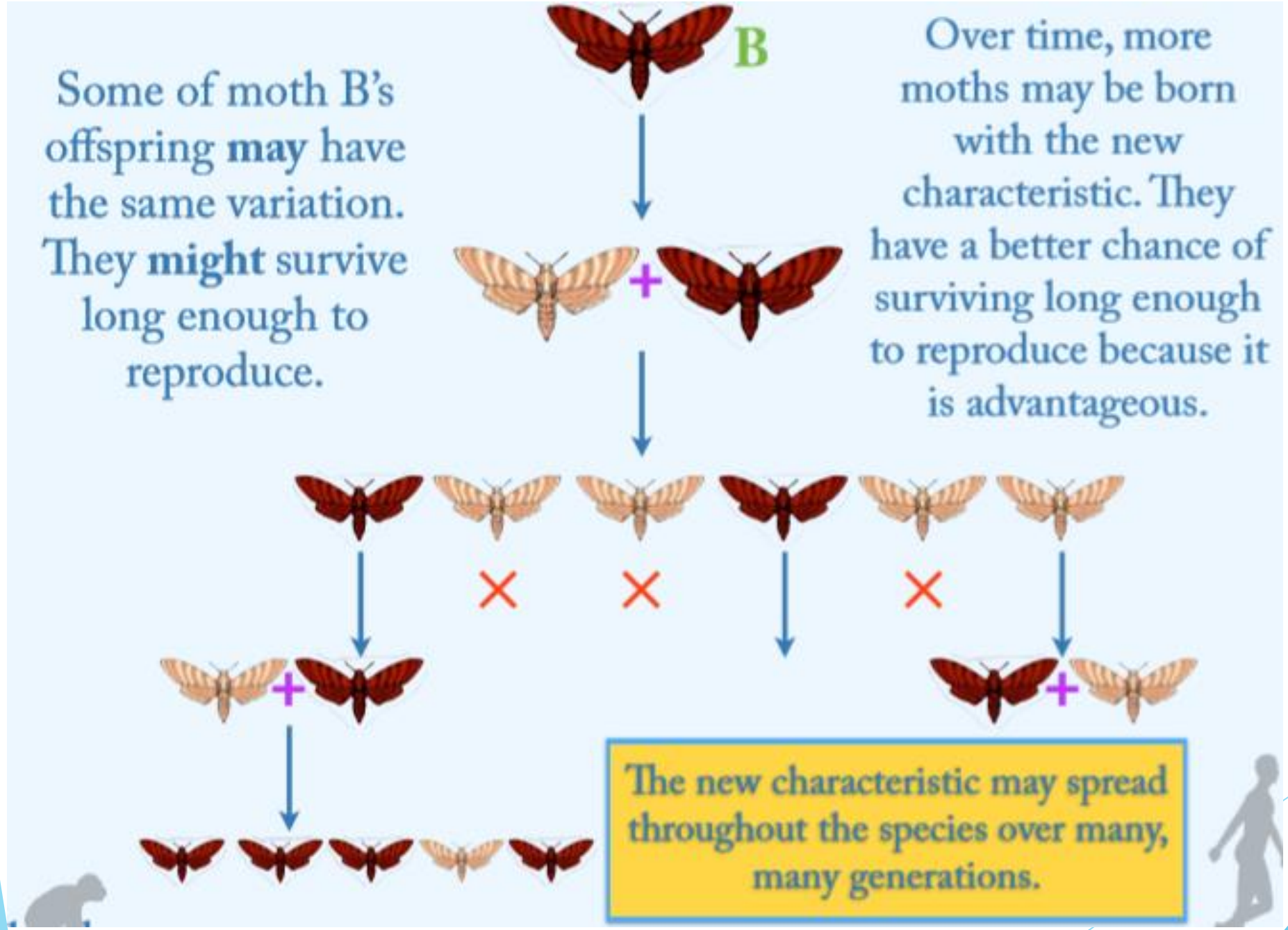
Science

This weeks' topic focus is Science. Children will be continuing with the topic 'Evolution and Inheritance'. I have included 5 days worth of lessons (not all days will have an activity, some will only require children to read information).

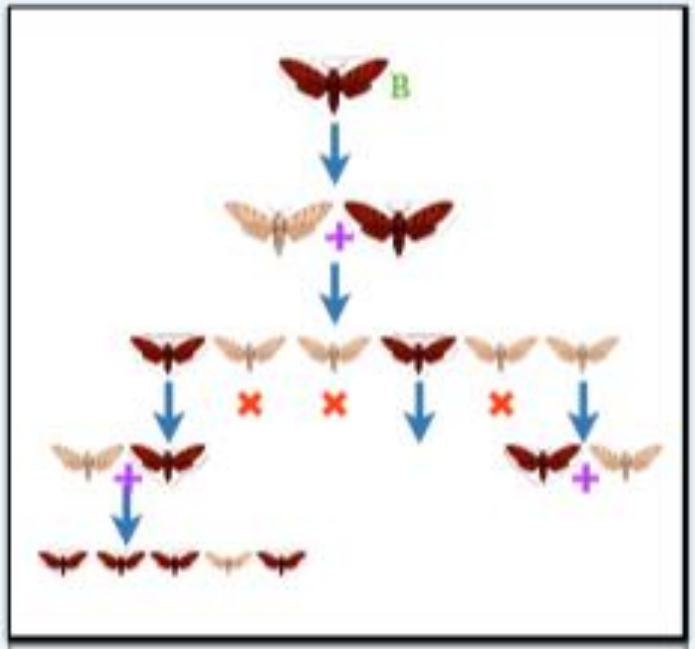
Day 1 – To understand that adaption of plants and animals to suit their environment may lead to evolution.

These two moths are different because moth B was born with an unusual characteristic. This *variation* may occur from one generation to the next. Moth B's darker colour is *advantageous* because it allows it to blend into its surroundings and hide from predators more effectively.

Because of its lighter colour, moth A is more easily seen by birds. It is eaten by a finch before it can find a mate and reproduce. Moth B survives long enough to find a mate and reproduce.


B
Some of moth B's offspring **may** have the same variation. They **might** survive long enough to reproduce.
Over time, more moths may be born with the new characteristic. They have a better chance of surviving long enough to reproduce because it is advantageous.
The new characteristic may spread throughout the species over many, many generations.

This process is part of a bigger life process called evolution. Evolution explains how all life on Earth has adapted and changed to suit its environments over time.



Let's find out more...

There is evidence to show that ancient Greek philosophers tried to understand and explain how living things have descended from one another. Over time, many scientists and other great thinkers have added to these ideas with their own theories.

Carl Linnaeus
1707-1778

In the 17th and 18th centuries, scientists such as Carl Linnaeus were developing systems for classifying living things and developing theories which explained how living things were affected and changed over time by the conditions of their environment.

During the 19th century, the work of many scientists helped define a modern understanding of evolution. Their ideas, along with the evidence they discovered through looking at fossils, have shaped our understanding of the world today.

"Charles Darwin seated crop" by Charles_Darwin_seated.jpg: Henry Maull (1829–1914) and John Fox (1833–1907) (Maull & Fox) [1]derivative work: Rtoo – Charles_Darwin_seated.jpg. Licensed under Public domain via Wikimedia Commons - http://commons.wikimedia.org/wiki/File:Charles_Darwin_seated_crop.jpg#mediaviewer/File:Charles_Darwin_seated_crop.jpg

Charles Darwin
1809-1882

Charles Darwin dedicated his life to the study of plants and animals. In 1859 he published a book called *On The Origin Of Species*. In it, he explained the evolutionary process of **natural selection**.

Let's find out more about natural selection...

Natural Selection

On The Origin Of Species explained in great detail what Darwin had observed in nature to support his explanation of natural selection, which is that:

Living things reproduce and become more numerous

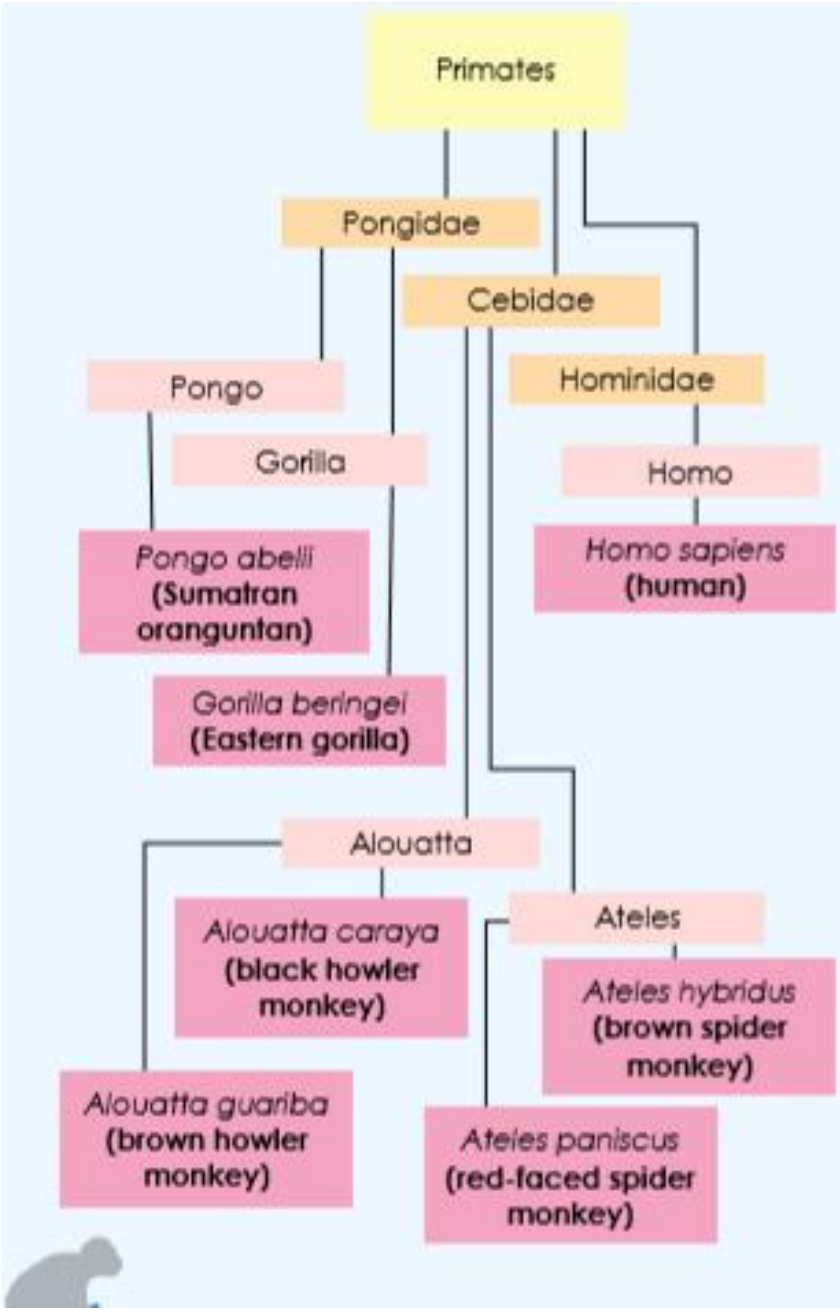
Offspring differ from their parents (variation)

Some of those differences are advantageous, giving the offspring a greater chance of surviving and reproducing

More offspring will be born with that variation

That variation may spread through a population and change it

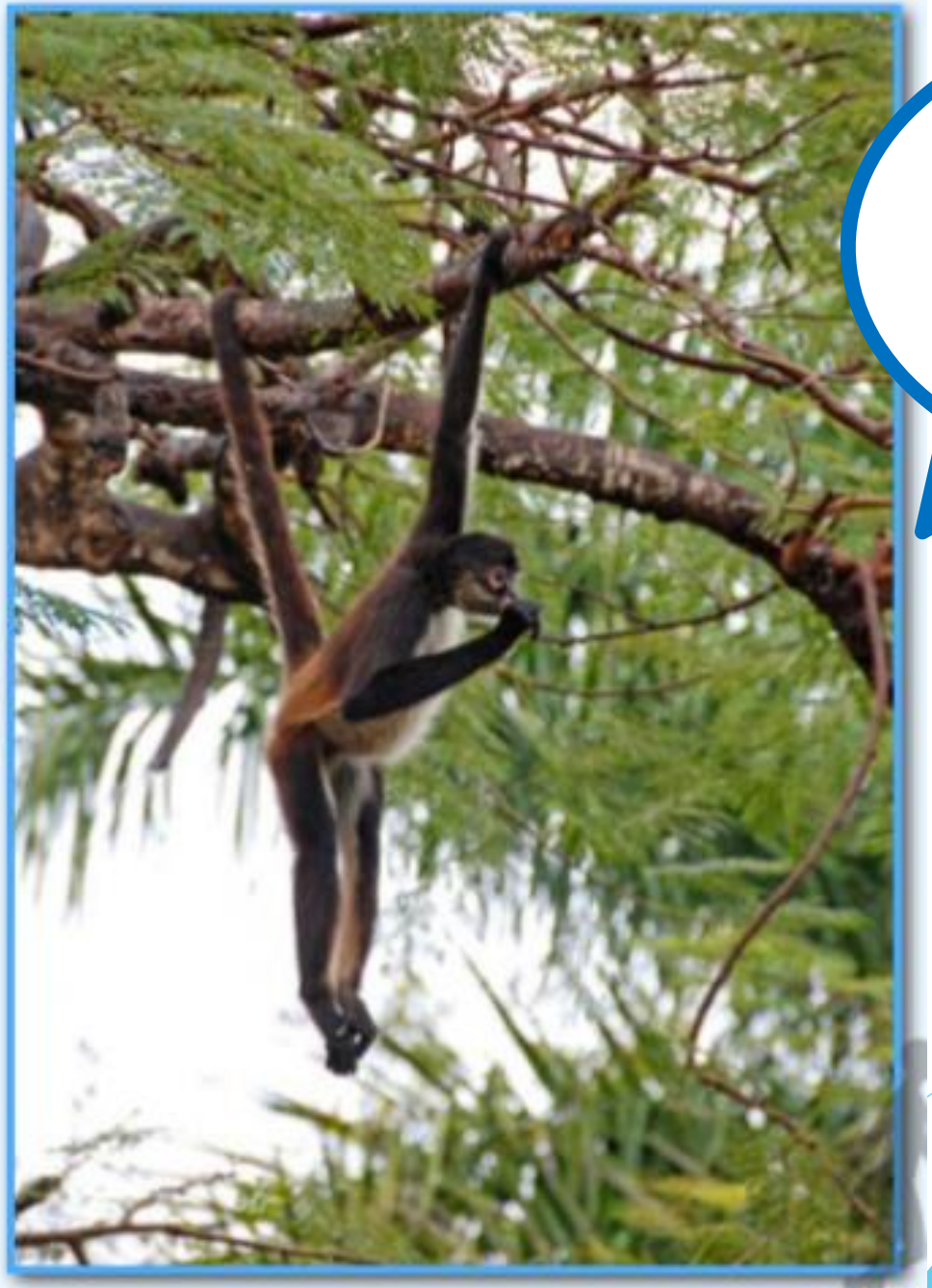
Sometimes, part of a population will develop different variations, eventually forming a new species



Scientists today continue to build on the work of earlier scientists and develop our understanding of evolution. This modern classification tree is based on the classification system developed by Carl Linnaeus. It shows just a tiny part of the order of primates. We now understand that humans and other species of monkeys and apes are parts of the same order that have evolved differently over time due to natural selection.

Spider monkeys spend most of their lives living in the tree canopies of rainforests in central America, where they forage for fruit and seeds.

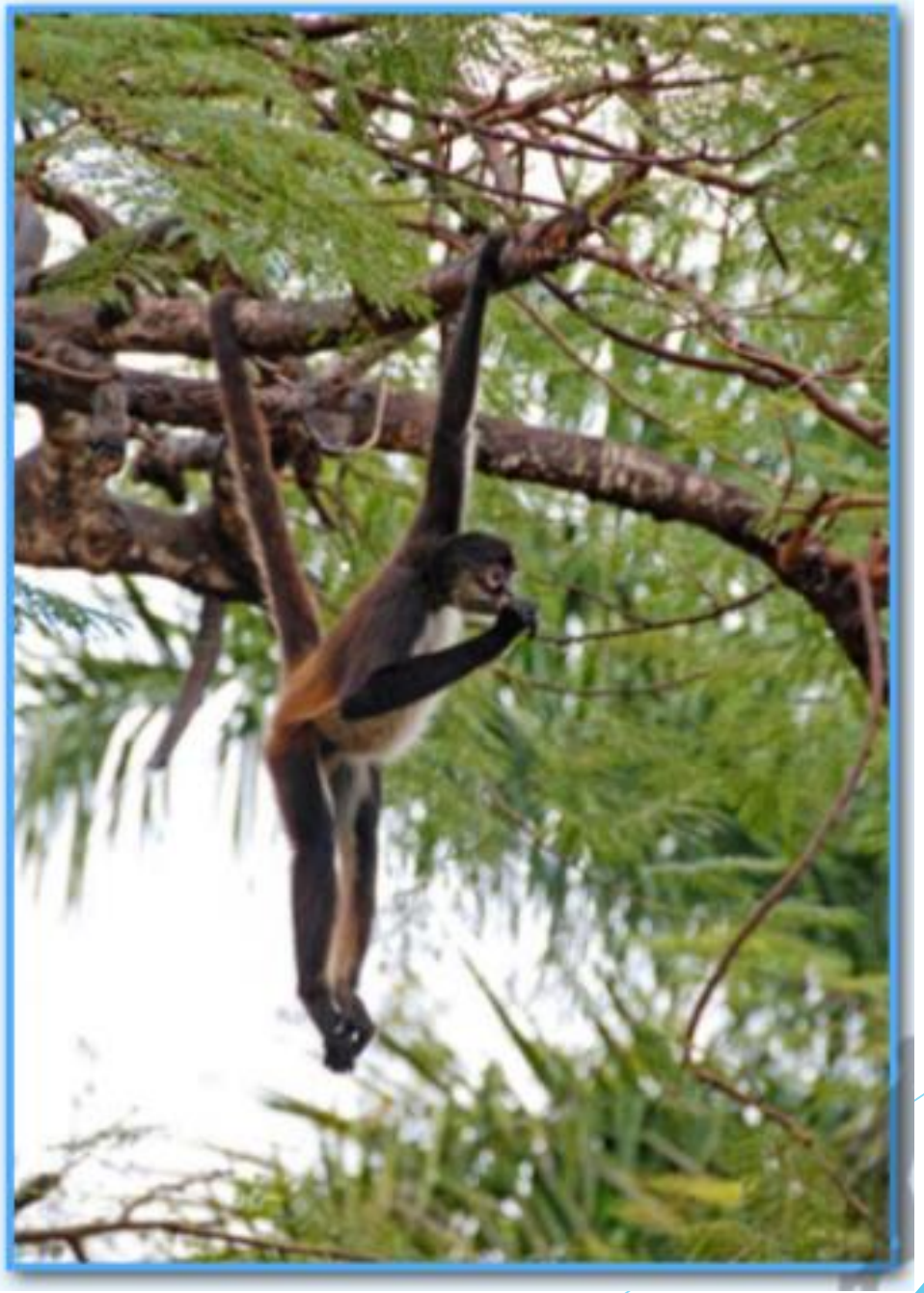
Look closely: can you see some ways in which this species of primate has adapted and evolved to suit its environment?



Let's take a closer look at some of the ways in which different species in the order of primates have evolved, developing different characteristics.

Spider monkeys have long, strong arms and legs with long toes and fingers; they can grip vines and branches with their hands or feet.

They also have a long, *prehensile* tail which they can use like an extra limb to help them climb and swing through the rainforest canopy.



Eastern lowland gorillas live in large, social groups, led by one male gorilla. They use hand gestures and facial expressions to communicate with each other. They have been seen making and using simple tools to help forage for food.

Look closely: can you see some ways in which this species of primate has adapted and evolved to suit its environment?

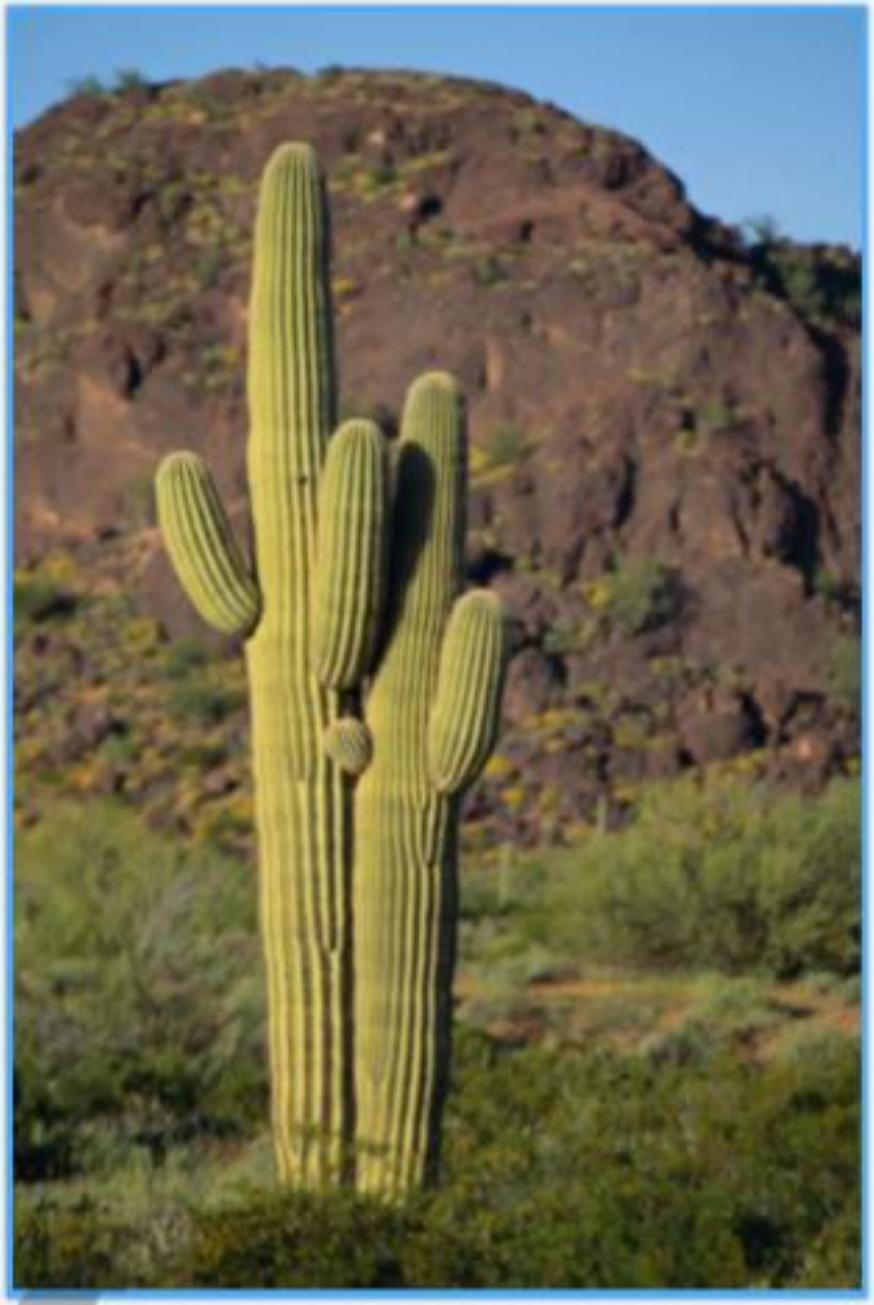
Gorillas have adapted and evolved to have very expressive faces, and hands that are very much like ours. They can express themselves and communicate within the group using these.

Their hands are adapted to do complex things, such as pick branches and strip the leaves off them to make tools to 'fish' for insects.

Their big, strong bodies help to protect themselves and others in their troop from other gorillas and, occasionally, from being attacked by leopards.

Plants have adapted and evolved to suit their environment too! Over millions of years, this saguaro cactus has adapted to the hot, dry climate of the Sonora desert in Arizona, North America.

Do you know some ways cactuses are adapted to suit hot, dry environments?



Cactuses such as this saguaro have adapted to store water inside them. They can often expand to take in lots of water when it rains. Their spines prevent many animals from getting to the stored water. Many cactuses have deep roots to take in as much water as possible. They grow very slowly; this means they can survive a long time without water and minerals.

Task

- Watch the video about Carl Linnaeus - https://www.bbc.co.uk/teach/class-clips-video/science-ks2-the-work-of-carl-linnaeus/zhnjf4j
- Watch the video about Charles Darwin - https://www.bbc.co.uk/teach/class-clips-video/science-ks2-the-work-of-charles-darwin-and-alfred-wallace/zrbxgwx

Day 2 - To find out about how the work of scientists has helped develop our understanding of the process of evolution.

These are some of the ideas that ancient Greek scientists and philosophers had about the growth, development and variation of plants and animals.

The first humans were delivered from the water on to the land in the mouths of fish.

All animals are descended from sea creatures.

All things were ranked in order of how 'high' or important they were:

humans
animals
plants
minerals

One type of animal can descend from another type of animal.

Animals are 'imperfect' and will one day evolve enough to reach their 'perfect' form.

Think about what you already know about evolution and inheritance. Can you work out which of these are now believed to be **incorrect**?

Did you get it right?

Great thinkers have always tried to explain life on Earth, but they have not always got it right!

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Scientists are constantly refining, changing and developing the ideas of other scientists. Sometimes, ideas are *refuted* when evidence is found that contradicts the idea. Sometimes, evidence is found that supports an idea.

The lifetime's work of biologist Carl Linnaeus shaped our understanding of the process of evolution.

He recognised that living things shared certain characteristics, such as having four limbs or giving birth to live offspring.

He developed a system for categorising species, which is still used today.

Carl Linnaeus
1707-1778

Let's take a closer look at Linnaeus' system...

These animals all have differences which make them unique. However, they also have some characteristics in common, such as 'dry noses', relatively large brains, the ability to communicate using lots of different facial expressions and having excellent vision. These characteristics are not shared with other primates.

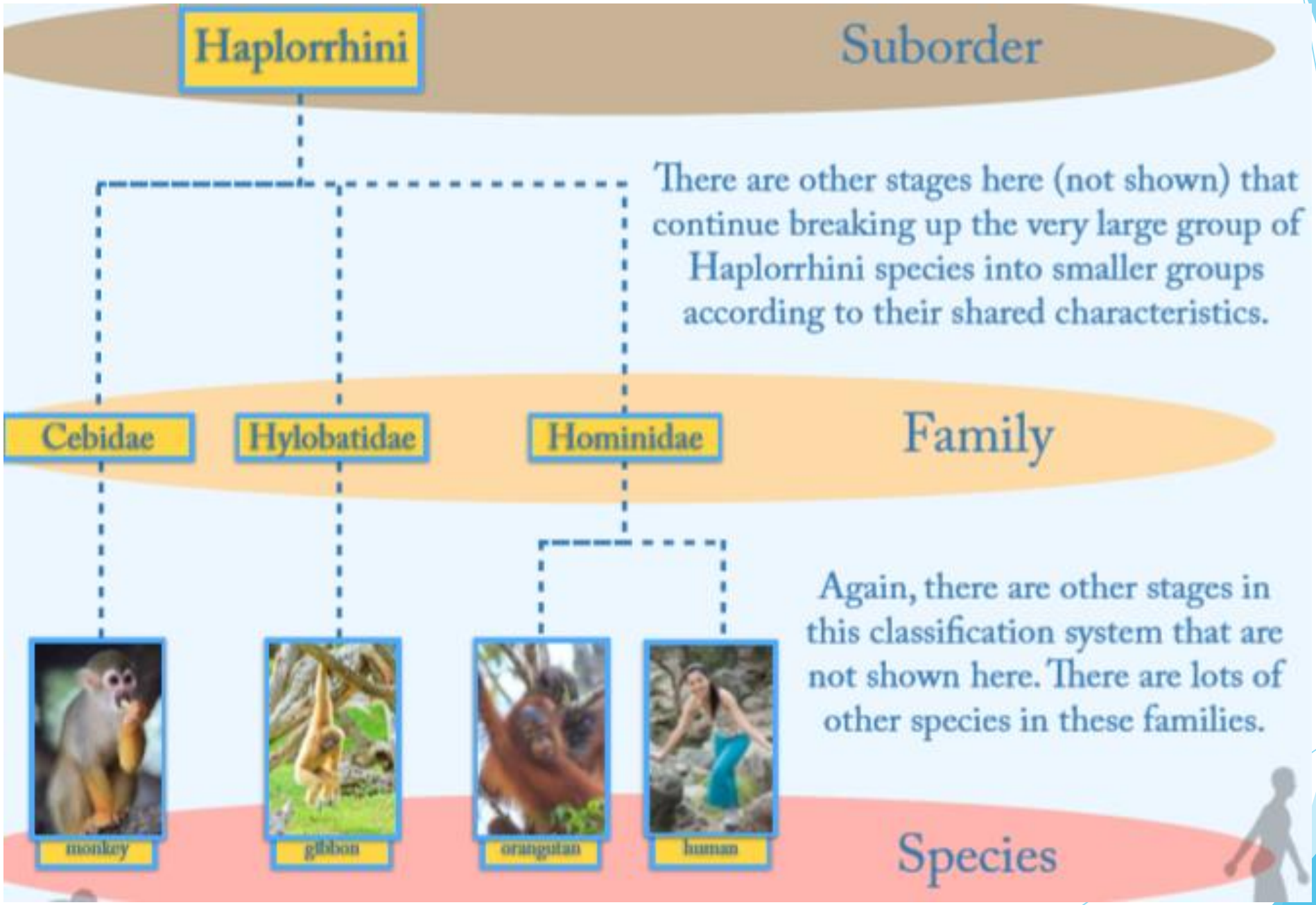
spider monkey

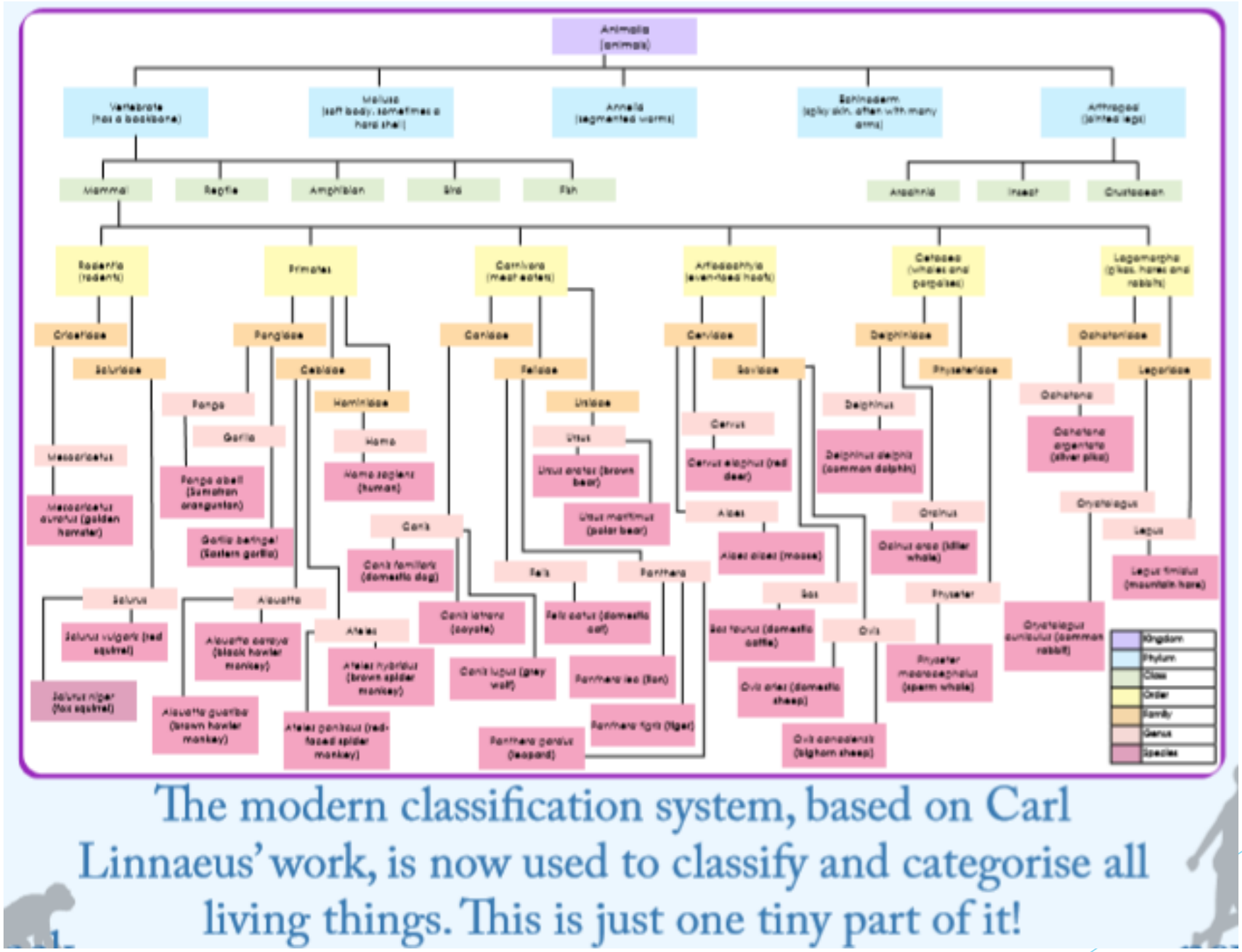
gibbon

orangutan

human

Today's scientific classification system (which is very similar to Linnaeus' system) groups these animals in the suborder of animals called 'Haplorrhini'. Let's have a look at the 'Haplorrhini' branch of the system...

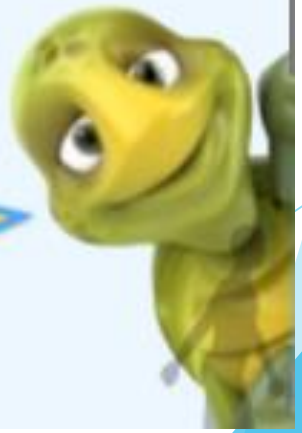

Haplorrhini
Suborder
There are other stages here (not shown) that continue breaking up the very large group of Haplorrhini species into smaller groups according to their shared characteristics.
Cebidae
Hylobatidae
Hominidae
Family
Again, there are other stages in this classification system that are not shown here. There are lots of other species in these families.
monkey
gibbon
orangutan
human
Species



The modern classification system, based on Carl Linnaeus' work, is now used to classify and categorise all living things. This is just one tiny part of it!

Charles Darwin
1809-1882

Charles Darwin's work revolutionised evolutionary thought. His life's work on the way life on Earth has evolved has shaped and influenced the work of scientists ever since its publication in the mid-nineteenth century. *On The Origin Of Species* described how his experiences studying species in the Galapagos Islands helped him to explain how **natural selection** works.



Can you
remember what Charles Darwin said
about natural selection?

Did you remember any of this?

Living things reproduce and become more numerous

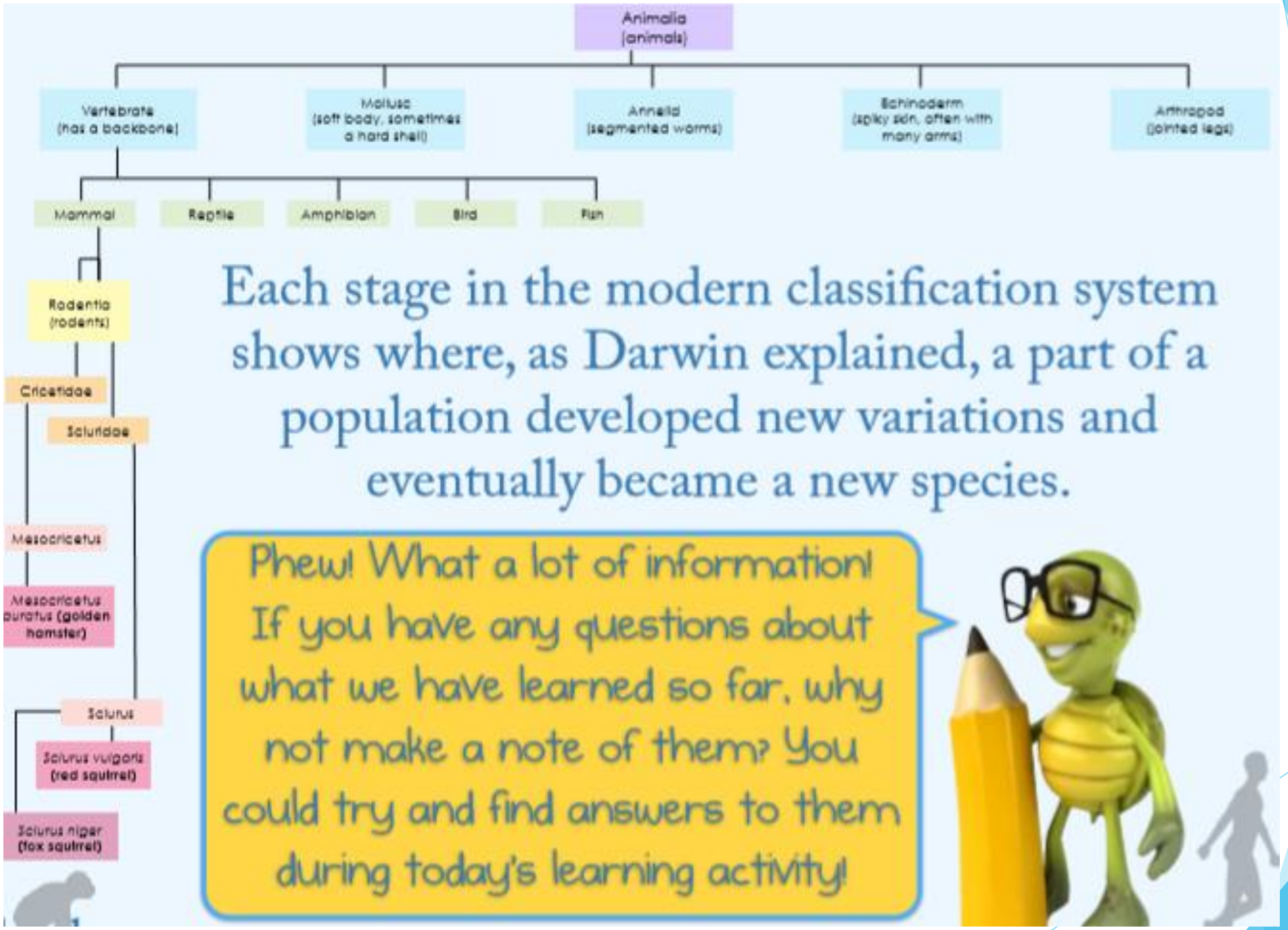
Offspring differ from their parents (variation)

Some of those differences are advantageous, giving the offspring a greater chance of surviving and reproducing

More offspring will be born with that variation

That variation may spread through a population and change it

Sometimes, part of a population will develop different variations, eventually forming a new species


Animalia (animals)
Vertebrate (has a backbone)
Mollusc (soft body, sometimes a hard shell)
Annelid (segmented worms)
Echinoderm (spiky skin, often with many arms)
Arthropod (jointed legs)
Mammal
Reptile
Amphibian
Bird
Fish
Rodentia (rodents)
Cricetidae
Sciuridae
Mesocricetus
Mesocricetus auratus (golden hamster)
Sciurus
Sciurus vulgaris (red squirrel)
Sciurus niger (fox squirrel)
Each stage in the modern classification system shows where, as Darwin explained, a part of a population developed new variations and eventually became a new species.
Phew! What a lot of information! If you have any questions about what we have learned so far, why not make a note of them? You could try and find answers to them during today's learning activity!

Task

- Using the internet, research the life and work of Charles Darwin.

Day 3 - To find out about how the work of scientists has helped develop our understanding of the process of evolution.

Task

- Continuing from yesterday's activity, I would like you to create a fact file (on paper) or a presentation (if you have a computer available) on the life and work of Charles Darwin.
- Try to answer these questions:

- When was Charles Darwin born? When did he die?
- Where was he born? Where did he grow up?
- What was Darwin's childhood like?
- What did he do before he became interested in science and naturalism?
- What did Darwin discover on his five-year voyage aboard *The Beagle*?
- Darwin wrote a book called *On The Origin of Species*. What was it about?
- What have other important people said about the work of Charles Darwin?

Day 4 - To recognise that living things have changed over time and that a number of factors can affect a species' evolution.

Why do species change over time?

1 The changes from one generation to the next are completely random.

2 When a species reproduces, its offspring have lots of variations.

3 Sometimes, some animals will get eaten by predators. The ones that survive pass on their characteristics, and the ones that die don't.

4 Things like disease or food shortages can cause changes in a species.

Which of these statements do you agree with? Which do you disagree with? Why?

The variations that occur from one generation to the next are not always random. Many characteristics are inherited from one parent or the other, and are the same from one generation to the next.

In this family, the daughter has inherited her brown eyes from her father. This is not random: if two parents have blue eyes and brown eyes, it is much more likely that their offspring will inherit brown eyes. Some *dominant* characteristics such as this are more likely to be inherited.

Do you notice any other inherited characteristics in this picture?

Although some variations are caused by *genetic information* from a parent being inherited by the offspring, many, many variations that occur from one generation to the next **are** random.

These random variations are caused by something called ***mutations***. Mutations occur naturally from one generation to the next in all living things.

Most of the time, these mutations are unnoticeable or unimportant, but sometimes they create a variation that is either advantageous or disadvantageous.

Can you roll your tongue? Tongue-rolling is caused by a harmless mutation - it is neither advantageous or disadvantageous.

1 you fold your arms the other way round to your parents

2 having a slightly different eye colour to your parent

3 tomatoes give you a stomach ache

4 you are less likely to become ill from some common cold viruses

Which of these variations caused by mutations do you think are harmless? Which are advantageous? Which are disadvantageous?

Sudden changes to a species' environment can affect how it evolves over time.

Example One:

This is an Arctic environment in Norway. This year, the winter season in this environment was much colder than usual.

Some plants in a species of grass have a variation which means they are better protected from extreme cold. Most of the grass plants in this population do not have the same variation.

What do you think will happen to this grass population?

Did you know that there are lots of factors other than inherited characteristics and mutation that can affect how a species evolves over time?

Let's find out more about some of those external factors…

Did you think of these consequences?

The grass plants that have *mutated* to resist damage caused by extreme cold are more likely to survive the winter. More of them will be able to reproduce. This variation may be inherited by new grass plants, spreading through the population until most or all new grass plants in that species have the new variation. More grass plants may grow in the environment due to their resistance to cold weather.

Sudden changes to a species' environment can affect how it evolves over time.

Example Two:

A few different species of ladybird live in this environment. They feed on aphids which, in turn, feed on the crops grown here.

The farmer changes the crop he is growing. The aphid population dies out because it cannot eat the new crop; a different species of aphid start to populate the environment. Not all of the species of ladybird can eat this new aphid.

What do you think will happen to the ladybird populations?

Did you know that there are lots of factors other than inherited characteristics and mutation that can affect how a species evolves over time?

Let's find out more about some of those external factors…

Did you think of these consequences?

The species of ladybird which can eat the new aphid will thrive; more of them will survive long enough to reproduce, and their population will grow in size. The species of ladybird which cannot eat the new aphid will shrink in size; it may even die out completely in that area.

One of the main pieces evidence that helps explain the process of evolution is the *fossil record*.

Fossils are formed over millions of years. The remains of animals have been fossilised, and layer after layer of rock built up above them as the landscape changed.

What evidence is there to show that living things have changed and evolved over time?

Palaeontologists are scientists who study fossils in rocks to learn more about how animals and plants have evolved over millions of years.

Palaeontologists use the fossil record (as well as contributing more information to it) to work out the age of fossils:

The type of rock where fossils are found is built up in layers. Scientists have worked out how old each layer of rock is.

They are then able to tell how old the fossils in these layers are too.

Palaeontologists are able to compare fossils from different rocks in different parts of the world. This is another way that fossils can be dated.

Scientists have noticed similarities between fossilised remains of animals and plants that became extinct millions of years ago and those that are alive today! Let's find out more...

Charles Darwin had an interest in fossils. While he was in South America he found *subfossilised* remains of what he though was a species similar to armadillos. He later found out that they were of *Glyptodon*, a species that went extinct over ten thousand years ago.

Can you see some similarities between the glyptodon and the armadillo? Evidence from fossils such as this help explain how species have evolved over millions of years.

Task

- Read the ‘Fossil Record’ on the next slide.
- Produce a detailed mind map (like the one below) that summarises the key information.

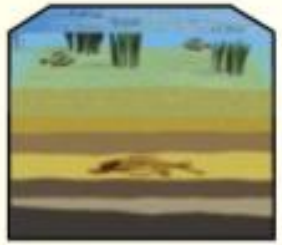
What Are Fossils?

Fossils are the petrified remains of plants and animals from more than ten thousand years ago. 'Petrified' means that the plants and animals have turned into a stony substance. Fossils can show the skeletons of animals or the imprints of plants, animals or footprints. They are found in layers of sedimentary rock, which is formed of sand and mud that has been compressed over time.

How Are Fossils Made?

The fish dies and sinks to the sea bed. The flesh rots and is eaten by other small organisms, leaving just a skeleton.

A layer of mud and sand covers the skeleton. This helps preserve it. Not much oxygen can get to the skeleton - the decaying process is slowed down.



The mud and sand become sedimentary rock. The skeleton dissolves. The space it leaves behind fills with minerals. The fossil is formed.

The movement of the Earth's crust brings the fossil closer to the surface. It is ready to be discovered!

What Does A Palaeontologist Do?

Palaeontologists are scientists who study fossils. Studying the remains of plants and animals can help them to find out what life was like a long time ago.

How Are Fossils Identified And Dated?

Scientist have measured radiation levels in the different layers of sedimentary rock found around the world. Using this information they have been able to work out the age of each layer. Fossils are roughly the same age as the layer of rock in which they are found. As fossils are discovered, information about them is recorded and shared. This fossil record helps palaeontologists identify fossils by comparing them to similar ones .

What Can We Learn From Studying Fossils?

From fossils, palaeontologists can explore how animals and plants have evolved over time, as well as how organisms interacted with each other. Fossils have been found with similar characteristics to living plants and animals.

This horseshoe crab is believed to have evolved from trilobites. Can you see some similarities?

Would you like to be a palaeontologist?

Fascinating Facts

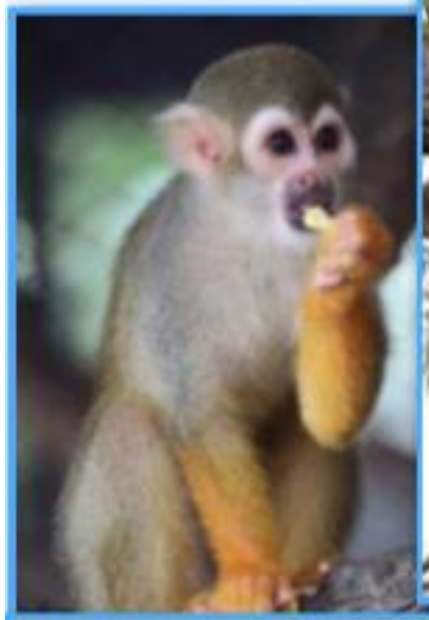
Did you know that lots of fossils are found in amber? Amber is formed from tree sap; when it seeps out of a tree, insects get trapped and preserved inside it.

Scientists estimate that less than one per cent of all living things in the history of Earth may have been, or ever will be fossilised. We will never know about most of the plants and animals that existed on Earth millions of years ago.

Day 5 - To understand how humans have evolved over time, and how human behaviour can affect change in species over time.

What do these species all have in common?

Discuss your ideas.



They are all animals.

They are all mammals.

They are all primates.

You might have thought of some of these. Species in the order of primates have a number of things in common, including:

- Ability to climb trees
- Relatively large brains
- Excellent vision

However, primates have evolved in different ways around the world...

Spider monkeys have long limbs; they can grip vines and branches with their hands, their feet and even their tail!

Baboons have adapted to environments with fewer trees and more grassland. They walk on all fours, using their knuckles.


This map shows the parts of the world inhabited by all non-human primates. Most species are only found in one region, for example, squirrel monkeys are only found in Central and South America. The conditions of their environment is one factor that has affected how different species have evolved.

Over time, humans have spread out and now inhabit environments all around the world. Can you think of some characteristics that humans have that mean they can live in different environments?

Did you think of any of these? These characteristics have allowed human population to grow and develop in environments all around the world:

Walking upright. Humans can see predators from far away, and travel long distances.

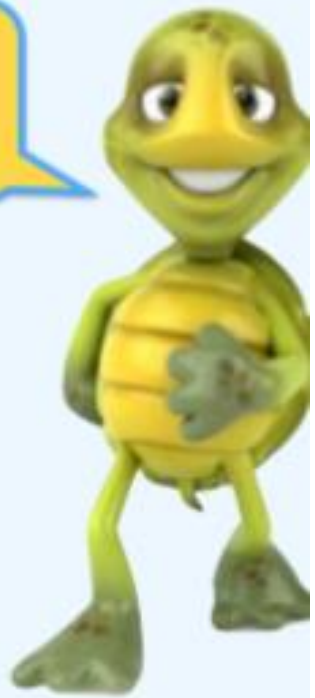
Omnivorous. Humans can eat lots of different types of food.

Large brain. Humans can solve problems and change their environment.

Opposable thumbs. Humans can grip things and use tools.

Language. Humans can express themselves in a way no other species can.

Did you know that external factors have led to some variation in humans in different parts of the world?



Humans whose ancestors have lived in Europe for generations are less likely to be *lactose intolerant*. This may be because dairy farming of cattle has been widespread in Europe for centuries. Milk has been an important and readily available food source in Europe, much more so than in other parts of the world.

The red areas of the map show where malaria is widespread. What do you notice?

Humans whose ancestors have lived in Africa for a long time are more likely to have a variation that makes them resistant to malaria - a disease transmitted by mosquitoes. Malaria is widespread in hot environments and tropical environments.

Human behaviour has had a significant effect on the evolution of other species.

Humans have cut down lots of forests to make room for farm land. Many species of animals have had their habitats destroyed.

Humans have hunted elephants for their tusks. So many have been hunted and killed that now, elephants are an endangered species.

What might have happened to these species as a consequence of human behaviour? Discuss your ideas.

Species of birds, mammals, insects, amphibians and reptiles are all threatened by *deforestation*. For example, the stone curlew is under threat in Northern Ireland due to meadows being turned into farmland.

The average tusk size of African elephants is smaller now than in previous generations. This is due to elephants with large tusks being hunted for their ivory. More elephants with small tusks survived and reproduced, spreading this variation throughout the population.

Humans are also changing the characteristics of species of plants and animals through selective breeding and cross-pollination...

Farmers have developed chickens that grow bigger and quicker by a process called *selective breeding*. Larger chickens are selected for breeding for generation after generation.

Gradually, these characteristics have spread throughout the chicken population.

Different species of flowers are cross-pollinated to create new species. Humans have created several new varieties of tulip in this way.

Task

- Look at the discussion cards on the next slide.
- With an adult, discuss whether or not you agree with the statement, giving reasons why.