Evolution of the Earth and Life
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Discussion on Posted Questions

Welcome to the course Evolution of the Earth and Life. Today we are going to discuss some of the questions that I posted before.

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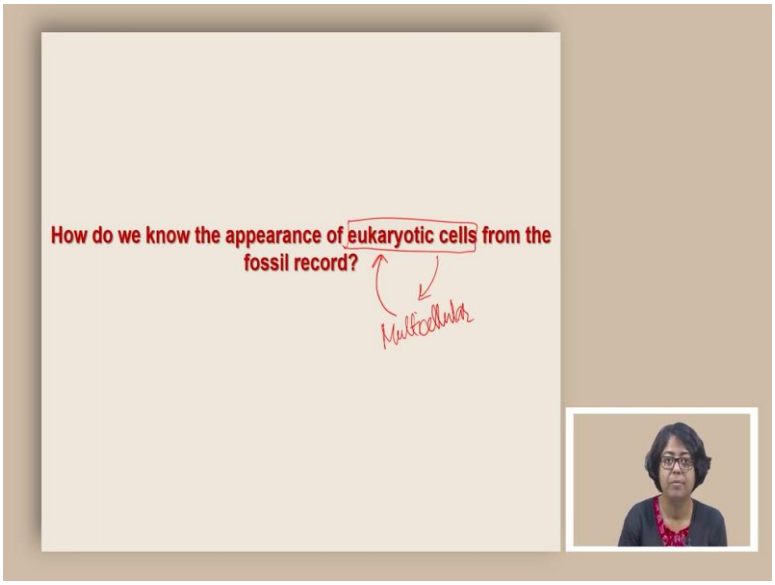

This question asks, how do we know the appearance of eukaryotic cells from the fossil record? So, the question actually, is asking that eukaryotic cells and prokaryotic cells are not possible to identify in the fossil record. So, the fossil record does not give us the internal cellular structure which is needed to identify something as an eukaryotic cell versus prokaryotic cell. Instead, what we can do is use this idea that eukaryotic cells are needed to make multicellular organisms.

So, the moment we try to find or we find multicellular organism that indicates indirectly that appearance of eukaryotic cell. And in during Proterozoic, we started to find the appearance of multicellular organisms. And therefore it indicates that that eukaryotic cells were there.

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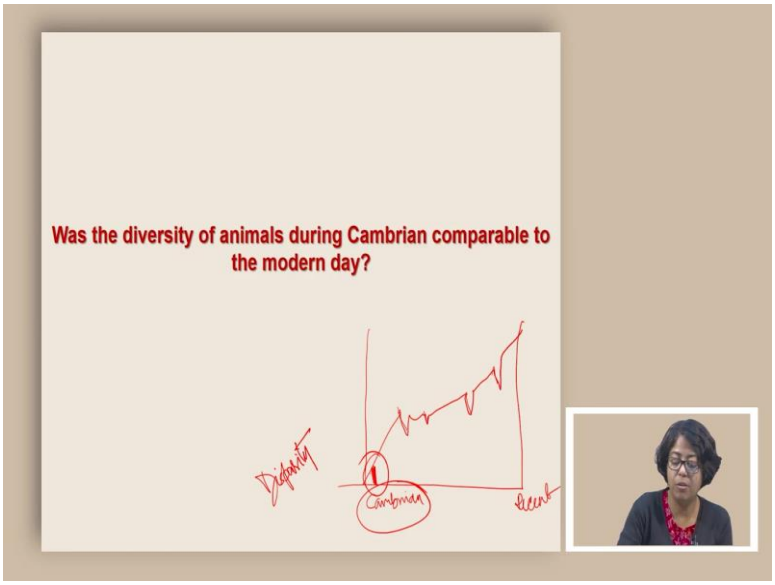

Was the diversity of animals during Cambrian comparable to the modern day? The answer is that the diversity of animals during Cambrian was much lower than the modern day. So, if we look at the diversity curve of that time, where this is the oldest this is, let us say, the Cambrian. And this is recent. So, then we know except for some of these mass extinction events, the otherwise the curve sort of looks increasing. And this is the pattern of an overall diversity curve.

Now, the important point to recognize is yes, the number of animals or the animal diversity was lower in Cambrian compared to modern day. But the important part of Cambrian is its disparity of animals. So, that disparity is very high, unlike the times afterwards. So, it is the appearance of very high disparity in Cambrian that makes the Cambrian stand out, not the diversity, the diversity of Cambrian is much lower than today's diversity.

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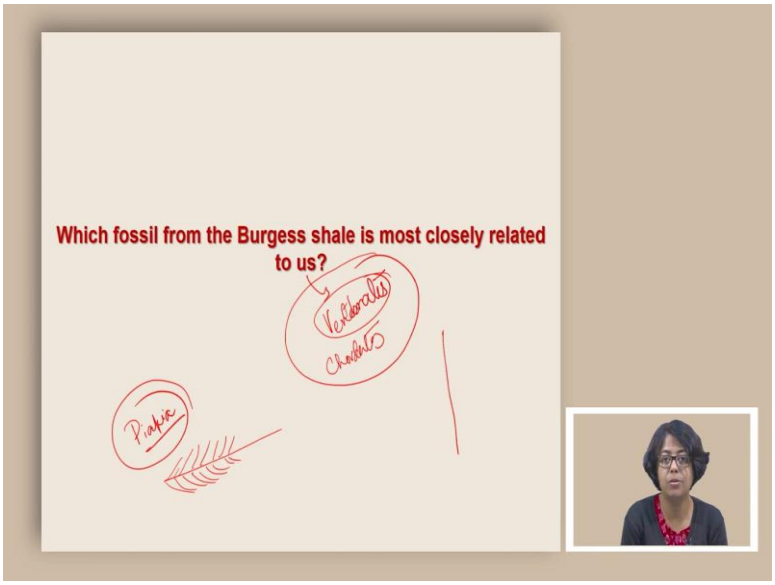

Which fossil from Burgess Shale is most closely related to us? When I say us, you can interpret it as vertebrates. So, now vertebrates have a vertebral column at their back. And if you recall, that in Cambrian there was an animal called Pikaia. This Pikaia was accorded, accorded means, it actually had a nerve cord or notochord. And then, we saw the muscular structure around it. And this is quite related to vertebrates, because vertebrates are actually part of the larger group called chordates.

So, among the budgetary and fauna, it is the Pikaia, which is closest to us in terms of the common ancestry.

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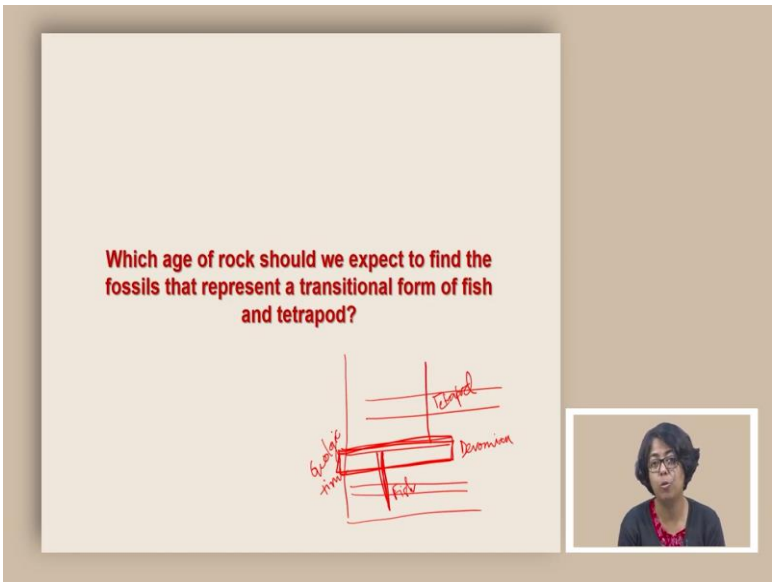

Which age of rock should we expect to find from the fossils that represent transition form of fish and tetrapod? So, we know if we look at the time, the geologic time and where we find the fish record, and where we find the tetrapod record, we know that around Devonian we started like before Devonian also, we have the fish record. And right after Devonian around carboniferous we started to find that a tetrapod record. So, if we are trying to find a transitional form, that transitional form cannot be somewhere here, because the tetrapod lineage has already started, it cannot be somewhere here because there is no tetrapod lineage close by, the fish still continues.

So, therefore, our argument is that this is the time towards the end of Devonian where we can expect to find a transitional form between fish and tetrapod.

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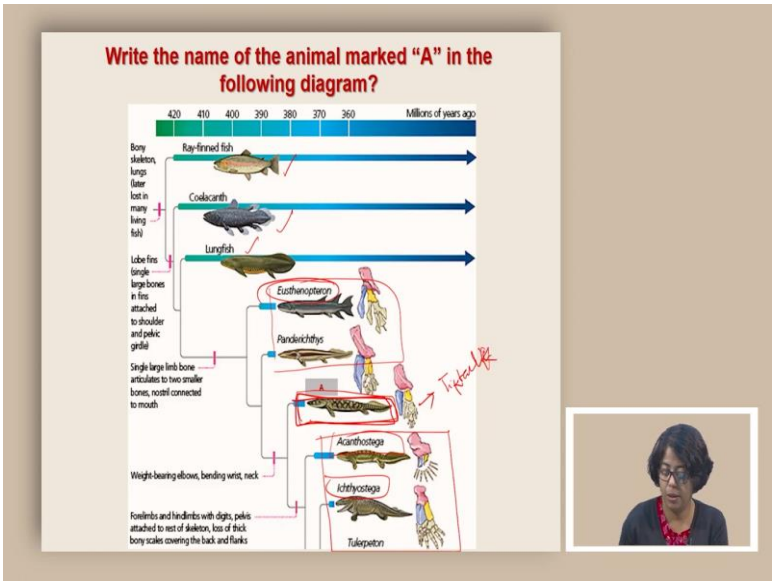

Write the name of the animal marked by A in the following diagram? So, this is the animal that we are asking about. So, let us try to look at what are the groups that are nearby. So, definitely they are fish related groups so, this is Ray-finned fish and then there is a lobed fin fish and within the lobed fin fish there is this lung fish. Now, within this group of lobed fin fish, we are finding some fossil evidences. So, this is Eusthenopteron and then we also have a Acansthotega and Ichthyostega. So, these are tetrapods and this is we definitely know these are fishes.

So, this group is the transitional form between these lobed fin fishes and the industrial tetrapod. So, this has to be the transitional form Tiktaalik.

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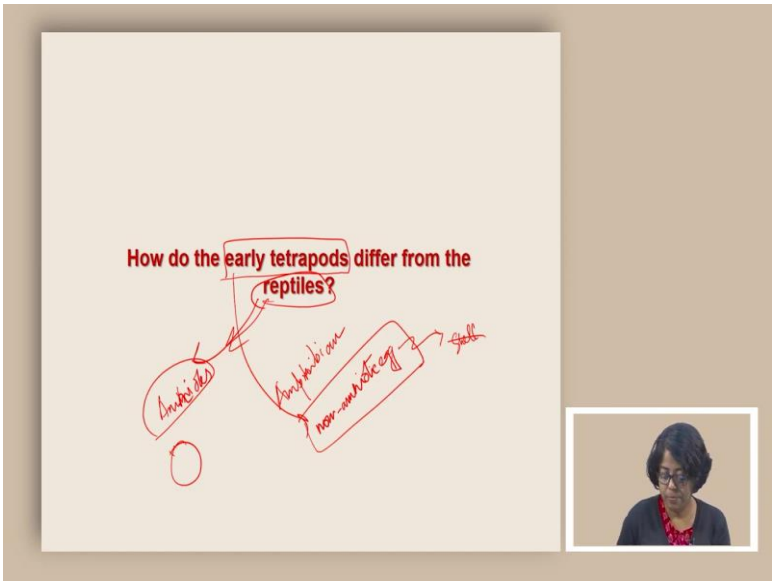

How do the early tetrapods differ from the reptiles? Now, we learned that the early tetrapods were amphibian. So, their primary character was that they could live on the terrestrial room, they can live on land, but for their reproductive cycle to be completed, they were still dependent on water because they had what it is called non amniotic egg. So, these known amniotic eggs require water and therefore, they cannot really go away from water and these known amniotic eggs also do not have a hard shell and therefore, they do not get fossilized.

Now, the early tetrapods are such animals. On the other hand, the reptiles represents the amniotes. So, these amniotes lay eggs which are hardshell and therefore it gets fossilized. So, this is the main difference that the early tetrapods are basically known amniotes and the reptiles are amniotes. So, therefore, you can distinguish an early tetrapod or amphibian by their non-amniotic egg from a reptile which has an amniotic egg with shells.

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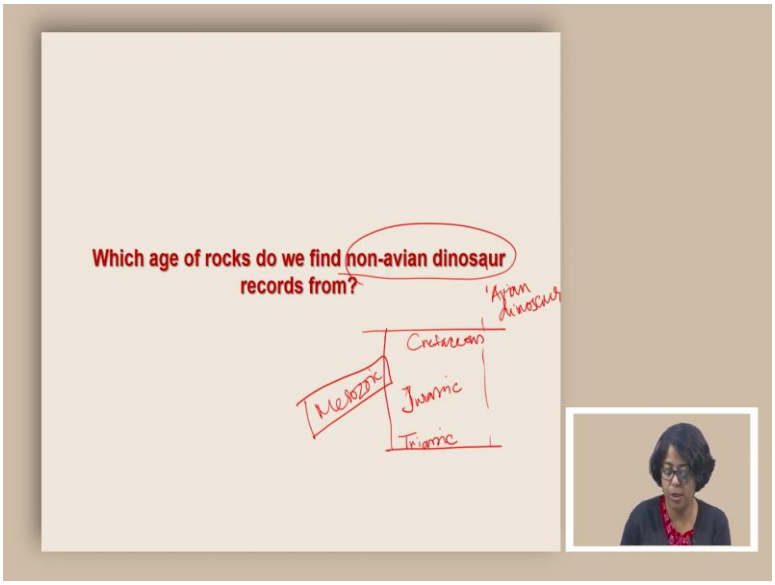

Which age of rocks do we find non avian dinosaur records from? So, non avian dinosaur record means is it is those dinosaurs, which are not related or which are not birds. And we know that the dinosaurs actually appeared in Triassic and they continued all the way to Cretaceous. In between there is Jurassic and this is called Mesozoic.

Now, the avian dinosaurs actually continued. Because we still find the birds which are technically an avian dinosaur. The non-avian dinosaurs record is only restricted within Mesozoic so, if we need to have a specific answer, in terms of what age of rocks should we go for finding the records of non-avian dinosaurs that has to be any rock from Mesozoic.

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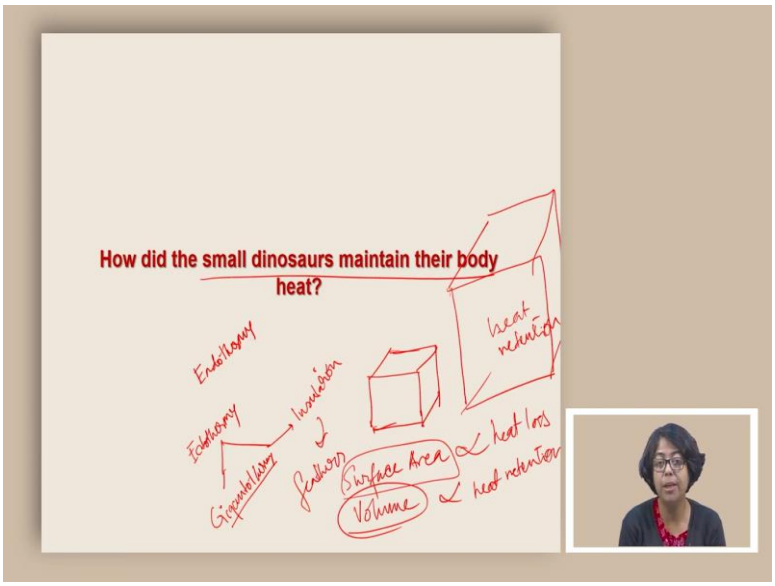

How did the small dinosaurs maintain their body heat? We know that body heat is primarily maintained by a couple of mechanisms. One is by heating the body from itself. So, that is called what is called is endothermic. There can be another way of maintaining the body heat, and that is by when they are ectothermic but using other ways of maintaining the body heat. So, between ectothermic among dinosaurs, we saw the Gigantothermy. So, this Gigantothermy shows how the dinosaurs control their body heat just by being big.

So, if we look at a cube, which is of this dimension, we know that if we make these dimensions bigger in every direction, then we are basically going to get really large cube. And these really large cubes are going to have a different volume to surface area ratio than the smaller cube. The surface area is related to heat loss, so it is proportional to heat loss. On the other hand, the volume is helps an organism to keep the heat. So, it is basically heat retention.

So, where the volume by surface area is bigger, then the heat retention is going to be high. So, for these cases, it is going to be mostly heat retention. And this is the case for larger dinosaurs, and therefore, they did not need any other thing apart from their large body volume to maintain the temperature. For smaller dinosaurs, like these cubes, it is very difficult to maintain the body heat simply because of the larger surface area. So, they needed some way of insulation. And that insulation came from feathers.

So, the small dinosaurs maintain their body heat by having feathers, which insulated the body heat.

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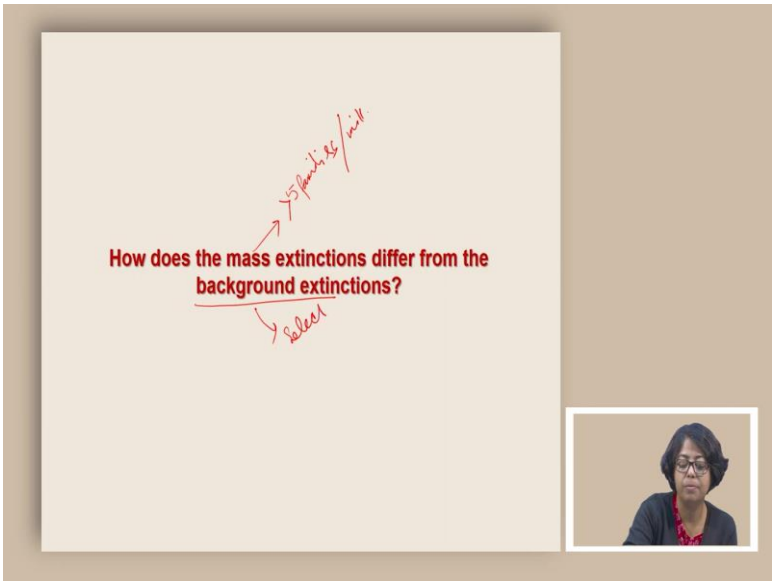

How does the mass extinction differ from the background extinction? So, by definition, mass extinction is an extinction, which is the extinction of more than 5 families every million year. And any extinction which is less than that is called a background extinction. But the way it operates is also very different mass extinctions are non-selective, whereas background extinctions are mostly selective.

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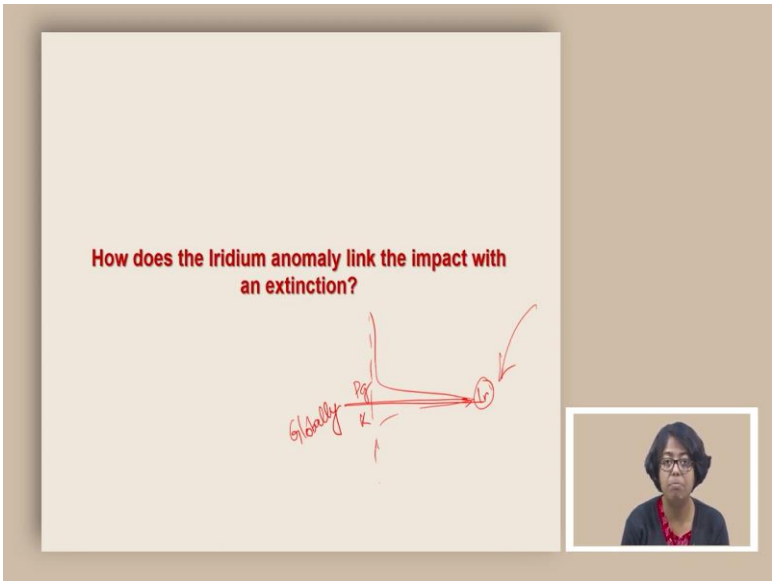

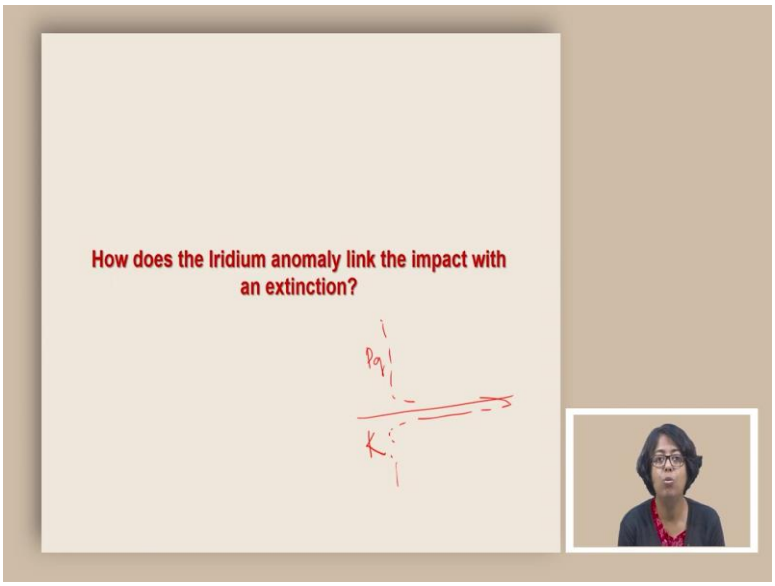

How does the Iridium anomaly link the impact with an extinction? So, we found that between Cretaceous and Paleogene rock record the boundary between these two were had a very high concentration of Iridium and this high concentration of Iridium globally shows that somehow the overall input of Iridium has increased globally during this time.

Now, Iridium is not available on Earth's crust. And the only way we can find the high concentration of Iridium throughout the world in a specific time is if Iridium is brought from outside the earth and asteroids are known to have high amount of Iridium and therefore, the high amount or concentration of Iridium in between K-Pg boundary on K-Pg boundary indicate that it is a time when the asteroids brought the iridium and that means we are talking about multiple or one big asteroid impact. And that is how the impact was connected with the extinction.

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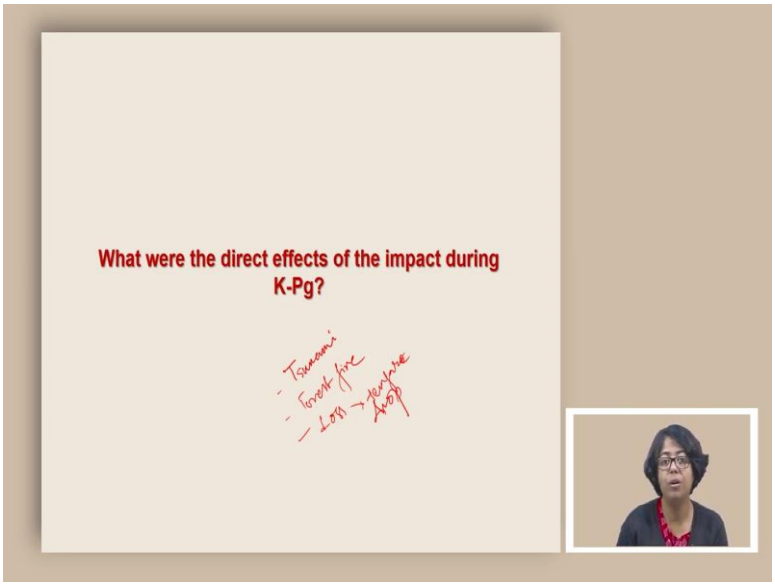

What were the direct effects of the impact during K-Pg? Now, one important aspect of these direct effect of K-Pg is what was happening right around the time after just after the impact. One was the massive tsunami because of the impact itself, then there was a forest fire and also, because of the loss of sunlight, there was a temperature drop, or nuclear winter, as it is called these were some of the immediate effects or direct effects of K-Pg impact.

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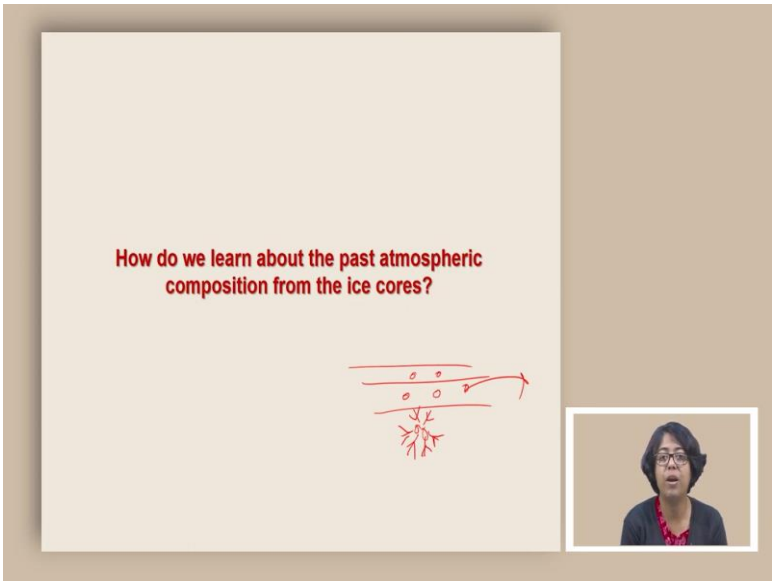

How do we learn about past atmospheric composition from the ice cores? Now ice deposits every year, especially in places like Antarctica, where it is very cold. Now, every year when the ice deposits, these ice flakes have a specific structure and it has a structure which can also trap a lot of air in it. And those airs as these things get deposited year after year and get compressed, those air bubbles basically get entrapped.

Now, these air bubbles record the atmospheric composition of specific airs, and looking at those air trapped bubble of the air of a specific time, it can be calculated that what was the atmospheric composition as well as the temperature during that time the greenhouse gas concentration from those trapped air. So, ice core basically preserves the atmospheric archive in the form of crapped air bubbles.

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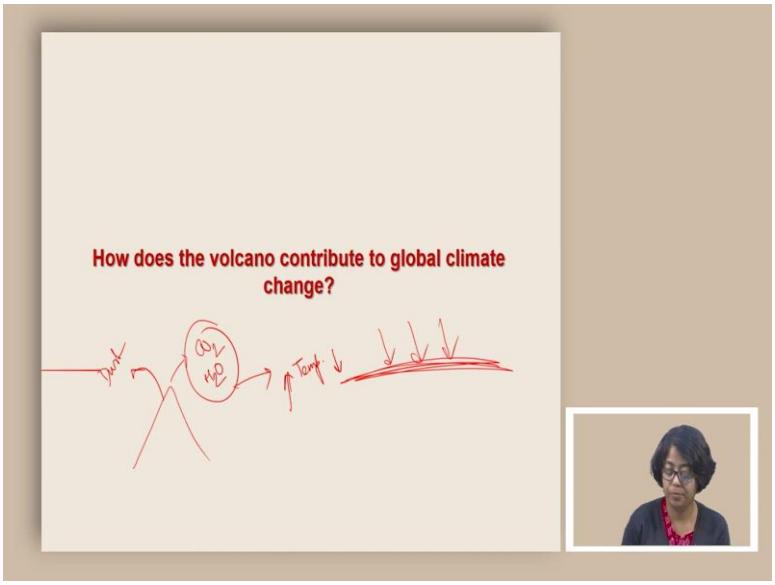

How does the volcano contribute to global climate change? Now volcanoes can contribute to global climate change in different ways. If the volcanoes emit a greenhouse gases such as carbon dioxide, H2O, Sulphur dioxide, these are greenhouse gases, so that will lead to an increase in temperature. On the other hand, if the volcanoes are emitting a lot of dust particles, sometimes these dust particles basically cover that most spherical layer and therefore the sun rays cannot really penetrate. And if that happens, then the temperature will have our temperature drop, at least for some time, and there can be a local cooling.

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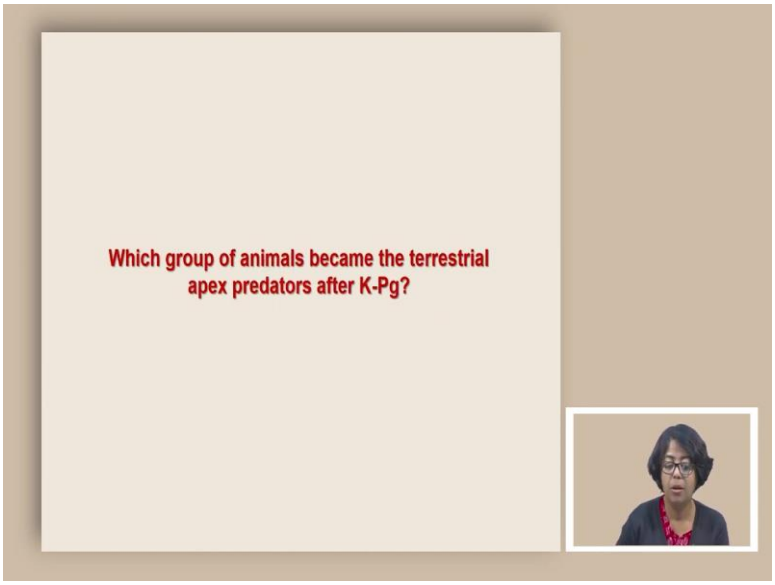

Which group of animals became the terrestrial apex predator after K-Pg? Now, after K-Pg extinction, the groups that became the terrestrial apex predator where the birds these were

large, flightless birds, which filled up the niche, which was vacated by non-avian dinosaurs, and it is only after quite some time during using where we start to find the apex predators as carnivorous mammals. So, during this entire period, the apex predators on land were primarily the birds.

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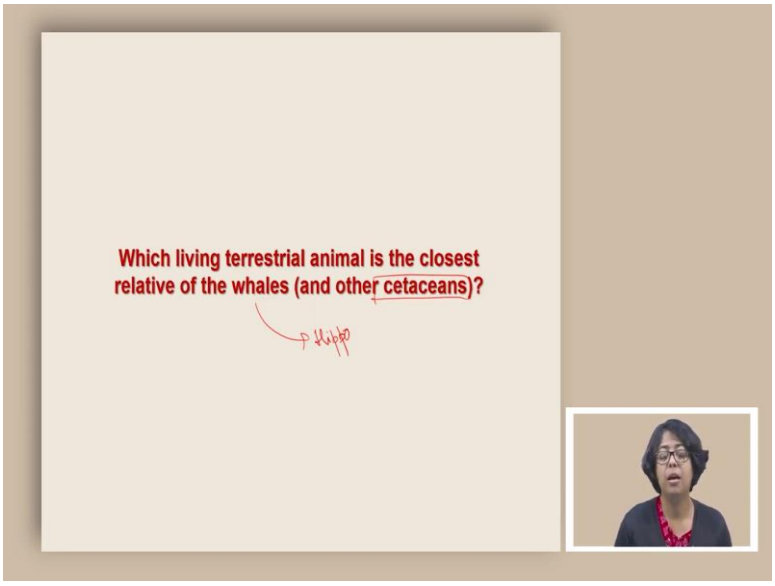

Which living terrestrial animal is the closest relative of the whales and other cetaceans. So, cetaceans means it is the group which includes whales and their relatives. And if we look at the present day, surviving animals, the closest relative of this is the hippo. So, hippos show a very similar genetic relationship with whales and other cetaceans. So, that is going to be all for today, and I will be answering other questions again in future. Thank you.