# Transcript Episode 1

Speaker 1

In the distance, a giraffe wanders across a hazy yellow savannah dotted with trees, quick pack and stares out of the window of a vehicle as it travels across the far reaching plain. BBC Studios presents across our natural world.

Speaker 2

Life was taken on countless forms. Strange and endlessly diverged.

Speaker 1

A brightly coloured bird takes flight.

Speaker 2

It's easy to imagine that all of this is like somehow pre. It's been made a world of balance and purpose, but the truth, the truth is much wider. This is a world full of survivors. From Earth's earliest moments, even pollution has quietly, relentlessly shaped the story of life. I can hear it and in. This series is quite from honest with you. We'll trace the astonishing evolution journeys 5 iconic modern animals. Look at this truly spectacular. will meet their old ancestors from the distant past and discover how generation by generation. Absolutely amazing. They changed to become the creatures we know today. From the smallest beginnings come the most extraordinary stories. Stories of survival of bizarre transformations shaping life in the strangest. the way and behind it all the unstoppable force of evolution.

Speaker 1

A flash of bright white light emanating from two single cells and travelling through a tunnel of leaves and feathers even The leathery grey legs of an elephant reflected in rippling water. It flicks its trunk, splashing water back into the lake. Then a hairy grey trunk lifts up briefly. The elephant forest in Kenya. Chris steps up to the edge of the leg, on the other side across the muddy water, a bird of elephants is splashing about. Chris watches them with a smile in slow motion, an elephant It rears its head and sinks down into the water.

Speaker 2

Look at that. I used to say that animals couldn't experience joy. That looks like muddy. Get joy to me.

Speaker 1

Baby elephants cavort in the water alongside the adults who gather together, splashing and blowing in the mud.

Speaker 2

The African Savannah Elephant Has to be one of evolution's most in chantingly strange creatures. When you look at the trunk, that measures 2 metres in length and it contains perhaps 90,000 muscles and the tusks. Those teeth that now stop growing. The ears. Look at the ears on this one. The size of a table. Their one most obvious defining feature of course is their size. Look at that. can regularly reach five, six, seven times the very biggest 10 times. So, here's a question for you: How did he evolution come up with something as complex, as beautiful, and as enormous as this. How did the elephant come to be?

Speaker 1

A large gray ear flaps.

Speaker 2

To understand the elephant, just land and animal alive today, you have to understand evolution itself. There was no blueprint, no Evolution is a process shaped by powerful invisible drivers like hunger.

Speaker 1

Conflict and even a meteor you're hitting the Earth.

Speaker 2

Catastrophe. So where does our story begin? Your answer lies in what these giants are made of. They may be the world's largest land mouse. They may be beautiful, but brutally biologically speaking, This is just a giant mass of cells. Now, in the case of the elephant, that's a lot of cells. It's a quadrillion. That's A1 with 15 zeros after it.

Speaker 1

From an elephant wandering. through trees to a close-up of microscopic cells.

Speaker 2

Skulls are the fundamental building blocks. Not just of elephants, but of all life today. Be it animal, Plant or bacteria? So where did those cells come from? Well, each one. of this animal cells has come from other cells which have either divided or reproduced. Okay, where do those cells come from? Well, they came from other cells that divided and reproduced. In fact, we can trace This chain of cells back over unimaginable periods of time through many long lost extinct species until remarkably it converges at a single point. A single cell. child organism that's connected to every living thing, every

branch on the tree of life, a common ancestor that lived billions of years ago, a cell that's Start with everything. Now, when it comes to evolution, you need to take the long view. I'm in, though really long view. The elephant is in crop gorgeous. Any begins before mammals before dinosaurs about before anything even had legs to stop. It's a story that starts with a simple truth. If you want to evolve, you have to survive first.

Speaker 1

A time line travels swiftly back to 4.2 billion years ago, light treats a dark planet.

Speaker 2

Frankly, overdramatic. The young Earth is no paradise. But beneath the waves, life has already taken hold.

Speaker 1

Spherical blobs embedded in rock.

Speaker 2

Trillions of tiny primitive cells back all the elements. Almost all will perish.

Speaker 1

A reconstruction of the cell was disintegrating.

Speaker 2

But one cell is different within this tiny speck lies the future. of all living things. It's a speck with the name. Meet Luca, the ultimate survivor, the great, great great times a billion grandparent of view the elephant and every other living thing on earth.

Speaker 1

A bird's eye view of Chris walking across an expanse of Dry mud, his lengthy shadow trailing behind him. The still waters of Lake Mogad, set in a far reaching plain. A white bird land amongst a flock settled on the lake.

Speaker 2

Lucas. and the last universal common ancestor. So let's just think about this for a moment because it was this single-celled organism floating around in a world entirely alien to our own. which gave rise to every living thing on our planet. That's me, that's you, that's all the animals, all the plants, all the fungi, all the bacteria, everything. So Luca isn't just a clever acronyms something out of a biology class. Luke defines the point where the story of life as we know it truly began.

Speaker 1

A flock of white birds with long bells.

Speaker 2

There are no of Luca, but because all living things have DNA and use the same genetic code, we know there must be a shared origin.

Speaker 1

Mud bubbling in shadow water.

Speaker 2

But why did Luke and his descendants survive? Or when trillions of others vanish, she started to burn my hand. Clues can be found in the Earth's most extreme places. Set my hand out there. That's how hot it is.

Speaker 1

He's crashing by air bubbling spring.

Speaker 2

Alkaline water up to 86 degrees centigrade. These are the sort of hostile conditions may have endured, but nevertheless. Look, life is tolerating it all around here.

Speaker 1

Micro real community domains are here, bacteria, and eucaria.

Speaker 2

I know what you're thinking. This doesn't look like much, and certainly be compared. to ask this is pretty simple stuff, but I've got to tell you it's not the cells in here are amongst the most complex things in the universe. Each one of these cells is generating energy. distributing that energy, dealing with waste. It's sensitive to its environment. It's reproducing. Every one of these cells is more complex than any machine ever made by any human. Just like these cells, Luca was complex, robust, resilient, which may have helped cling on against the odds. Can we know that Luca wasn't the first cell and that it lived amongst other cells. But what made it special is that it didn't just live, it survived. It survived that little bubble of chemicals. Called in chaos billions of years ago.

Speaker 1

Chris puts the small hand full of rich dark back in the water and walks off.

Speaker 2

Luca was the little cell that looked good. Lucky, yes, lucky, almost certainly, but it also has life's greater survival trick.

Speaker 1

Luca appears through the murky water as a small elongated cell. It starts to expand in length and it splits it in two.

Speaker 2

Luca can copy itself well enough to keep its genetic line going, but not so perfectly that every copy is identical. With every new generation, tiny errors, mutations creeping to its DNA, and yet these so-called mistakes fuel evolution. The story of our modern living world has begun.

Speaker 1

Sunlight shines down through the dark waters.

Speaker 2

Now it's time to hit fast forward. I mean, you can't cover 4 billion years of evolution without skipping some chapters. Generation after generation, little mistakes lead to entirely new life forms. Some cells begin to capture the sunlight, the ancestors of plants. Others would adapt to feed on decay.

Speaker 1

Arcing streaks of light.

Speaker 2

Many stay small and simple. The hidden world of microbes.

Speaker 1

Millions of microscopic cells.

Speaker 2

The cells would give rise to the elephant. Take a very different path. Three and a half billion years after the Luca, when the Earth is in a deep freeze.

Speaker 1

The timeline moves forward to 650 million years ago. Huge rocks shift and move together under the water.

Speaker 2

This is a period of intense global cooling. Ice grip the planet. And food webs are collapsing. But somewhere in the cold and dark, one hungry cell is about to change everything.

Speaker 1

Stunned light through tall twist steps over a fallen log in.

Speaker 2

The need to feed is one of the great driving forces of evolution. Any creature that can find more efficiently is more likely to survive and pass its genes into the next generation. As was the case over 600 million years ago when a single cell was on the verge of The breakthrough, a breakthrough that would lead to the incredible diversity of almost all animal life to come.

Speaker 1

Dark water is a great organism appears.

Speaker 2

Meet the ancient ancestor of the elephant, indeed, of all animal kind.

Speaker 1

A coan is one domain you carry a supergroup or pick the counter.

Speaker 2

Now has mitochondrial energy, a nucleus for control, and a tail-like Jellum to move. But one thing hasn't changed. This cell is still tiny. 100th of a millimetre across.

Speaker 1

It's about in the water like a tiny tadpole.

Speaker 2

It's a small cell with a big problem. Food is. brutally scarce and that sells ancient hunger may have set life on a new course and you can see how thanks to a remarkable creature Alive today.

Speaker 1

Driver. Class, insect, genus.

Speaker 2

You might be wondering, what are the of insects like this got to do with an ancient single cell organism? Wow, the twist is the quest for food. They both came up with a similar solution and it's down to numbers. Single ants are not very good when it comes to overwhelming by simply too small. They don't have the strength. So what they've done is turn into a massive. killing machine. Each one of the individuals has become a cog in

that machine. And this means that they're far more efficient when it comes to handling whatever they're going to do. We eat.

Speaker 3

Ow.

Speaker 2

So quite.

Speaker 1

He plucked an from his arm.

Speaker 2

These ants act as one giant organism. Overwhelming their meals with. Cheer force of numbers. And when they swarm, almost anything is on the menu. Crickets, caterpillars, or if they're wounded, Even chickens, goats, and pigs by the of it, even a pack and there's the parallel with the single celled organisms because they were about to adopt a similar technique. which would change the world forever. Oh my goodness. My world has been changed forever, I think, to be quite honest with you. There's some of them in places that you won't be filming them. Get off.

Speaker 1

He tugs off another ant that's fighting him.

Speaker 2

Over 600 million years ago, Urko Anazoan is about to do something revolutionary. Its surface is coated with sticky molecules.

Speaker 1

It has 10 and a long tail.

Speaker 2

And when the time comes to divide, Instead of floating off to live independent lives, the two remains stuck together. They continue to divide. Right. More and more spells stick together. Until. A vast. Alliance.

Speaker 1

They create a large ball of quivering cells that turn it into an organism with hundreds of tendrons.

Speaker 2

Dubbed the Death Star. It's 100 times larger than a single cell. And it has something of the dark side to it.

Speaker 1

The tendrils poking out all start to undulate.

Speaker 2

When all the Jella wiggle, they can create stronger water currents, drawing in bacteria so that deaths start can fall. from cell sticking together became a new way of living. A multi cellular organism is formed. Over the next 100 million years, the Death Star's descendants continue to grow, not just in but in complexity as individual cells begin to specialise and kill something truly. Revolutionary emerges the first bodies on Earth.

Speaker 1

The timeline moves forward to 550 million years ago.

Speaker 2

The oceans have now warmed and they're full of life forms. And looking among them is the ancestor of the elephant.

Speaker 1

A dark Slug-like organism flocks onto the seabed, causing a cloud to go up.

Speaker 2

No trunk, no tusks. Just a word. three millimetres long, dragging itself across the sea floor. Evolution gave it a body, but one so small and simple, you Barely notice it.

Speaker 1

Crisp piles up sticks and strip makes a match.

Speaker 2

Building something bigger and more complex would require one vital ingredient. oxygen. Inside every cell in our body, a slow, controlled burn is happening, not with flames, of course, that would be concerning. But just like this fire, we need oxygen to release energy. Without it, we would simply sputter out and die. But for ancient animals, oxygen was largely out of reach.

Speaker 1

It's done. and Chris is holding a handful of worms.

Speaker 2

I've got some earthworms here, charming creatures, creatures of childhood, but not terribly sophisticated, particularly when it comes to breathing. You see, just like those early animals, they breathe through their skin. It's permeable, and as long as it's moist, they can extract oxygen from the air. But imagine you're living half a billion years ago, you're much smaller than this and living at the bottom of an ocean where the oxygen supply is pitifully low. Life was small, life was slow, life was stuck.

Speaker 1

The world on the bottom of the ocean.

Speaker 2

But this ancient worm has stumbled upon a new way to boost its oxygen supply. Tiny pores along its body. body used to filter food are now quietly adapting to a new role able to draw in a fraction more oxygen the beginning of a transformation that will allow creatures to grow bigger and stronger. And beat the competition is what it's all about.

Speaker 1

Zooming in on one of the tiny holes along.

Speaker 2

It's generation by generation tiny wrinkles inside the pores deepen folding twisting meaning more surface Area more oxygen until a whole new body part evolves.

Speaker 1

Again with rigid now a bird's eye view of monkeys running across rocks.

Speaker 2

In tracing the evolution of the elephant, for that matter, any other large land animal, the appearance of gills is hardly an obvious landmark moment. After all, elephants aren't famed for their deep sea. Dive in capabilities, but the emergence of gills was more than a minor upgrade. It was an evolutionary quantum leap.

Speaker 1

Chris opens up his tablet computer.

Speaker 2

This is the fossil, if you live in the around 500 million years ago. What is it? Well, it wasn't wasn't yet a fish, but what makes it interesting? is this. You can see these feathery structures running down here in rows. Some scientists believe that this is the first evidence that we've discovered of gills. Intricate folds like these can radically increase the surface area that is in contact with water, giving the animal the potential to

access much more oxygen. Of course, more oxygen means more energy. That can mean bigger bodies, faster movement. This innovation set the stage not just for fish, or for elephants, but also for you and I. We tend to think of gills as a fish thing, but once they were pretty much everyone's thing. Amphibious, reptile, bird, every man alive today descended from ancestors with gills. So, if gills were such a good idea, Here, why did so many of us ditch them?

Speaker 1

Chris is walking across fat rocks with reefy lots of water running over them, where a great fish is half submerged.

Speaker 2

Well, inside this Fish is a clue to one of the evolution's baldness leaps. Look at this extraordinary animal. This is Prototypic Terrapus, and it's no ordinary fish. I mean, superficially, it looks like an eel. It's got this long dorsal skin running all the way back down to this very spatulate cow here. Beautiful marbling. But look, he's wiggly living. that were merging 2 at the front here and two more at the back.

Speaker 1

It wriggles through the muddy water.

Speaker 2

Frankly, what are we looking at? I'm dodging the big issue. What makes it special is that it can live in very stagnant water, water which is almost void of oxygen. It can do that because it's a fish with a sea. Now it is very, very slimy. If I can try and pick it up. I've got to watch my fingers because it's well armed with powerful crushing piece. Come on. I just want you to be able to see its mouth because it's through that mouth that it's able to draw in deliberately deep gulps of air into a blood vessel blind sack where are the oxygen can diffuse directly into its circulatory system.

Speaker 1

Lets it go. It opens its mouth.

Speaker 2

Protopterus Ethiopicus, that's its scientific name, but that adaptation gives it its common name. This is not a fish out of water, so much as a lungfish on land.

Speaker 1

It gulps in the air through its mouth.

Speaker 2

This air gulping ability first evolved in fish 400 million years ago as a simple backup plan for low oxygen water, but lungs would become key to one of evolution's giant leaps that leap onto the land. We're jumping through time again. I mean, 300 million years as animals ventured into new territories. Limbs evolved disappeared, bodies transformed. We're picking up the elephant story.

Speaker 1

The timeline moves forward to 66 million years ago, somewhere in Africa missed hangs over. The forested mountains.

Speaker 2

In the age of the dinosaurs, I've gone truly XL. The largest animals to ever walk the earth.

Speaker 1

In a lush rain forest, a large leathery foot appears in a tiny furry mammal.

Speaker 2

But the ancestral of the elephant has stayed stuck at least small.

Speaker 1

The animal leaps away. It's an early Afro-therian class Amalia Superorder Afro-therian.

Speaker 2

It's got a long way to go before it can tower over the Savannah. Its small size is about to pay off. A rather large lump of rock is coming. It.

Speaker 1

Hits the earth.

Speaker 2

Time's up for the giant. Dinosaurs events don't go well for large animals. They need too much food when there's not much about. They're slow to reproduce. They simply can't bounce back quick enough. In order to survive, you need to be resourceful, adaptable, but above everything else, you need to be small, like this little chap here. Look at that. That is a tree hyrax. It's about four or five months old. What a little beauty. This tree hyrax is a orphan allowing us to get an insight into what. the elephant might have looked like before it bolted up. Because, believe it or not, the Hyrax is one of the elephant's closest living relatives. OK, he's coming, albeit slowly. Come on.

Speaker 1

He's gray and furry about the size of a large rabbit with a small nose and ears.

Speaker 2

About that tempted to use the C word. I mean, he's under not highly cute. size of those eyes. After the asteroid impact, it would have been mammals of this size that were left roaming the Earth. All of the big species would have been wiped out completely.

Speaker 1

The high racks scuttles back up the tree.

Speaker 2

And you can see that it's retained some of the characteristics that help them survive. It's nimble, it's cautious, undeniably, and it knows how to stay out of trouble. But that extinction event wasn't all about devastation. It also offered up a landscape of opportunity. A complete continent rock. a repopulation.

Speaker 1

The sun low on the horizon and beyond mountains and forest.

Speaker 2

With no giant dinosaurs for competition. Africa was an empty stage for evolution. to run right. The plants were no time bouncing back, but the ancestor of the elephant remained small and furry. To get big, it needs food and lots of it. But the hard part isn't finding dinner. It's eating it.

Speaker 1

A black beetle crawls across a twig. as Chris walks over to a tall trees standing alone on the plane.

Speaker 2

Plants must be easy to read, right? Can't run away, they can't fight back, and they are everywhere. Well, Not exactly, because obviously plants don't want to be eaten. So whilst they can't fight or all their way out of trouble, they have come up with a formidable range of defences, which means that all of this greenery here It's almost impossible to eat. For the ancestors of elephants, plants pose a serious challenge, just because of thoughts or toxins, but what their main Edo. Even modern mammals struggle to digest them. Who's poo?

Speaker 1

A beetle burrowing into dung.

Speaker 2

Well, those of you with and ponies will probably get this. is zebra poo. Look at that. We don't have too much time to admire it from the outside. Let's delve in straight away. I take this piece here. Look at that. It looks like. So this has been. It's been munched. It's gone through the stomach all the way through the gut of the zebra and yet it's barely digested. suggested. And that's because the bulk of the material you can see here is something called cellulose. It's the tough stuff that gives plants their strength and rigidity. But think about it. If a contemporary complex specialized herbivore, like a zebra, can't properly digest this stuff. What chance would those early mammals have?

Speaker 1

A giraffe walks past in the distance as Chris crashes examining the dung. Now the elephant's ancestor scuttling past ferns on the forest floor.

Speaker 2

In truth, we are not certain whether the ancestors of the elephant made the leap to plant eating before or after the extinction event. The fossil record is patchy.

Speaker 1

It creeps up on a big battle with the creep and black body and long legs.

Speaker 2

We do know the leap. And thanks to an unlikely alliance.

Speaker 1

It pounces and gobbles up the beetle.

Speaker 2

Not with the bugs it was hunting with something much smaller, you see. Inside the elephant's ancestor, an invisible army of single-celled microbes is a it's not an invasion, it's the start of a vital partnership. My goodness. Who says size is not important? This is not a termite. It's a termite. It's got to be 5 metres tall. Termites are. famous for eating wood and other plant material. But in truth, well, it's not the whole story. They do the chewing. It's other organisms that do the digesting.

Speaker 1

Off the pickaxe and the spade slug over his shoulders. He heads over to a small mountain of dark earth.

Speaker 2

Inside termite mounds, we find one of nature's strangest team ups.

Speaker 1

Hacks into the mound with his pickaxe.

Speaker 2

Now, Chris Packham, a bloke who loves animals. Why is he smashing up a termite mound? Well, I thought long and hard about this. Firstly, there are extraordinarily resilient animals. We build this really quickly, and the second thing is every night, all over here, animals will be breaking in stomach. Just consider me the human aardvark. Besides, what I'm looking for is just under the surface. Plenty of termites here. We can do something else. Another life form lives here. I think this is it. Small island. Yes, it is. And surprisingly. useful. Look at that. is termite fungal cone. Now the interesting thing about this fungus is that you can only find it in termite mounds. Nowhere out in the world. You see, the termites sort of farm it. They go out and they collect all that dead plant material, which they can't digest themselves, and then they come back and give it to the fungus. The fungus does digest the cellulose and then turn into substances which the termites can eat. What about that? And of course, it's not just termites. Almost every plant you can name has outsourced digestion for microbes.

Speaker 1

A giraffe chewing.

Speaker 2

The only difference is.

Speaker 1

A zebra.

Speaker 2

Most keep their microbial monsters safely tucked away inside their guard. Just as our bodies evolved, these sorts of partnerships evolved. It's difficult to know when to know because we don't have have any fossils of preastopic animals with bacteria in their guts. One thing we know for sure, and that is that over millions of years, many species have become dependent on these sorts of relationships. Without them, they would simply die.

Speaker 1

Chris pats the earth back into play some termite down with his speed.

Speaker 2

Sometimes evolution's boldest moves aren't physical adaptations. Partnerships. Now, thanks to its microbio, it's a good time to sample the salad bar generation. By

generation, the gut balloons into a fermentation factory filled with trillions upon trillions of plant munching microbes.

Speaker 1

A reconstruction of microbes rushing through lengths of gut.

Speaker 2

Just what you need for a plant based diet.

Speaker 1

The timeline moves forward to 50 million years ago.

Speaker 2

And less than 20 million years later, we get this charming creature, an early prophecy.

Speaker 1

Amalia, phylum called... It's like a small elephant with a not a trunk.

Speaker 2

Outstanding at a respectable 1 metre tall. But evolution has hit a problem of its own making. This policy has elongated front teeth for snagging vegetation.

Speaker 1

It plunges its head into the water.

Speaker 2

But big teeth can have drawbacks.

Speaker 1

The furry racks sitting on branch. Now a small animal skull with long curved inside of teeth. Quick, fix it up.

Speaker 2

This is the skull of an adult hyrax. It's got the piece massively. Over sized in size is there. What are those teeth for? Well, for seeing off predators, things like snakes and eagles, explained to rather high tracks and if they cross the line for seeing them off too. We've got to remember that this is a herbivorous animal. How is it going to be nibbling leaves with these in the way? Well, it's kind of a struggle and I can demonstrate that by adapting my own with some. in the size of my own, and then try and tuck it into a high direct cell.

Speaker 1

He tries to eat with two orange sticks poking out of his mouth.

Speaker 2

Frankly, it's just not working. So, look, what are big teeth? can be impressive and they certainly have their uses. If you're a herbivore, they can represent somewhat of an evolutionary challenge when it comes to grabbing your grub. Big front teeth come with trade-offs. For the it means eating food through the side of the mouth. But with the evolution went down a different path.

Speaker 1

A second come. to stand in the water.

Speaker 2

One individual was born with a slightly longer nose.

Speaker 1

The first proper city turns to look at it. Its nose is about an inch longer.

Speaker 2

It's the beginning of something special.

Speaker 1

Chris spotted an animal in the undergrowth. He craved his neck because the great animal darts past.

Speaker 2

There they are. To see what a flexible face can be capable of, we need a snout specialist. It's like a long time, isn't it? Going out warthog. Graceful? Not really. These animals built for getting the job done. Warthogs. So ugly, they've crossed that line and back into being beautiful. But we're not here if we're beauty pageants. We're here for biology. So let's concentrate on their noses. A remarkable multi tool. What hog noses are just for sniffing snacks? They're for digging boots and maneuvering food into place.

Speaker 1

A snout snuffling in the ground.

Speaker 2

It's tough. It's not a delicate nose like ours. It's really robust. But even The best nose has its limits, especially when your food is on the ground and your face isn't. When you see the standing up, you've got quite long legs and short necks. So, how do you get your nose down and closer to the ground? What do you do? Do it like that, kneeling.

Speaker 1

Down, kneeling on their bent front legs.

Speaker 2

Okay, so technically These are the creatures wrists. But either way, it's a brilliant example of evolution solving a problem of its own making. Certainly an effective solution. It's not the only way of challenge of getting closer to the ground. There was a creature that lived millions of years ago that met the challenge in a completely different way. We came up with something even more extraordinary, a tool if you like. that it could use for eating, drinking, smelling, and exploring the world.

Speaker 1

Speeding through the vortex of light.

Speaker 2

It would be the final flourish. of an extraordinary evolutionary journey. A journey that started 4.2 billion years ago with a single cell that multiplied splitting repeatedly. grew in complexity, gained a body, took a deep breath and jumped on to land.

Speaker 1

The small fairy mammal than the inside of its digestive system.

Speaker 2

Before teaming up with microbes, giving it the guts to go vegan. And now, after Countless generations, the nose gets longer. Tusks grow, stretching down to the ground, giving better access to food. so the body can continue to grow. And till we get an animal of mind boggling complexity and size that you might just recognize.

Speaker 1

It's ears grow a little larger until it looks like a small elephant with a very short trunk and tongue.

Speaker 2

It's got the trunk it's Got the tusks, big ears, still a work in progress. But it's a body shape we might finally call an elephant.

Speaker 1

It lifts up a bit short trunk.

Speaker 2

And evil solution didn't stop there. From creatures with bizarre jaw extensions.

Speaker 1

Has a longer trunk and long.

Speaker 2

Others with downward curving tusks.

Speaker 1

Dino-etherium.

Speaker 2

And of course, those icons of the Ice Age. The mammoths.

Speaker 1

With long curving white tongue and a furry coat.

Speaker 2

Giant obsidian and globe.

Speaker 1

We're slaying these pictures down in a forest.

Speaker 2

Africa, Asia, Europe and South America. We have evidence of our relationship with from all over the world in the form of these. carving and painting things. These were not just creatures that were living in that landscape. We evolved alongside them. Our history are uniquely intertwined.

Speaker 1

Carving of a prophecy.

Speaker 2

Some prophecy were lost to natural climate change, but for others it was the actions of our own ancestors.

Speaker 1

Rising up. the forest.

Speaker 2

Today, just three species of each emerging within the last 10 million years, the elephant and the biggest of them all a grass eating giant shaped on the open.

Speaker 1

The African Savannah Elephant with huge flapping ears and a natural trunk.

Speaker 2

You're wonderful, aren't you? Let's take one last look at these incredible creatures.

Speaker 1

An African savannah elephant.

Speaker 2

Made-up of a million billion cells powered by the largest lungs any land animal. And in a gut coiled up 20 meters long, packed full of microbes so it can digest all of this plant material. And then look at the front here. These tasks And between them this extraordinary modified no is its trunk strong enough to pick up and carry a human delicate enough to pick up a penny?

Speaker 1

An elephant munchy.

Speaker 2

The evolutionary journey created the bizarre and beautiful elephant is just one story. Because, thanks to Luca, that single cell last universal common ancestor, we are all part of an ancient family, a.

Speaker 1

Family that.

Speaker 2

Might be bad at keeping him in touch and maybe a little dysfunctional, but he is always undeniably miraculous.

Speaker 1

Chris is walking ahead of a family of elephants, the baby. just behind it.

Speaker 2

Look at this. I'm literally leading a group of elephants through the forest. Who would have ever thought it? Every living thing Everything that's ever walked, swam, or flown is all connected in that one tangled story, connected by that thread that runs through a 4 billion years. of life. Evolution is messy. Evolution is unpredictable and so grand. We're still really figuring out how it works. But there is one thing What we do know is that given time and the resources, it comes up with creatures that are as remarkable as this. And

we should cherish all Life on Earth not neglect it or destroy it because evolution is wonderful. Life is beautiful.

Speaker 1

A young elephant makes its head whacking its ears. A small baby elephant stands near its mother, and more elephants intertwine their trunks and munch on foliage. One swinging it's trunk back and forth.

Speaker 2

Next time, how your strip got the biggest egg on the planet? It's quite emotional if I'm honest with you. A billion year love story. From the first sex to conquering the land. An incredible journey of flirting. and giving rise. Look at this to one of the most extraordinary birds.

Speaker 1

Chris holds a baby ostrich then. stalking across grass evolution the evidence.

Speaker 2

But first, how do we know that all life on Earth has a common ancestor? For centuries, fossils have provided a window into the past, helping scientists reconstruct the tree of life.

Speaker 4

In the past, our understanding for how a fossil fits in this larger system of life on Earth was compared to anatomy and it worked for a long time and it was a beautiful tool.

Speaker 5

Scientists would look at what animals or other organisms had in common or didn't have in common to try to recreate their evolutionary relationships.

Speaker 4

One thing we have to bear in mind is that we're looking at the remains, what is left behind, and it's not always complete, so it's like trying to reconstruct a hand from a fingerprint, and we made lots of mistakes.

Speaker 1

Photo 51 and X-ray image of DNA.

Speaker 2

But in the middle of the last century, a discovery changed everything.

Speaker 4

The appearance of DNA really was a game changer. We couldn't study the tree of life with just comparative anatomy. You need DNA.

Speaker 5

We can compare genes to each other, compare those gene sequences to each other, look at the letters that those genes contain, and use that information to try to figure out how different organisms are related to each other.

Speaker 2

By analyzing DNA, some scientists have discovered that some creatures that look very different are actually closely related. Like the Afrotherian mammals, the elephant And it's also allowed us to trace the Tree of Life back further than ever before. All the way to.

Speaker 5

The last universal common ancestor to all life on Earth.

Speaker 1

It's the last organism we can point back and say this is a relative of not only us, but bacteria and elephants.

Speaker 4

And bananas I love thinking of Luca as being not just my great great great great great great great whatever grandparent but everybody's great great great great great great whatever grandparent.

Speaker 2

In a landmark study scientist analyze DNA of 700 different microbial species, searching for patterns that will help them reconstruct leuco genetic code.

Speaker 5

Our ability to sequence DNA has really unlocked our ability to look deep in time to four billion years ago and come to a better understanding of what our last universal common ancestor may have looked like.

Speaker 2

The study revealed that Luca was likely to have had over 2 2,600 genes, making it surprisingly complex.

Speaker 1

Dr. Jeffrey Mark.

Speaker 4

So it wasn't necessarily the first form of life. It almost certainly wasn't, but it's the one that got by from that one spark we see the origin of all the life that we see today in its incredible diversity.

Speaker 1

Dr Andrew Gillis a variety of species.

Speaker 4

Realizing that we all came from Luca The same seed of the tree of life is really humbling to me. It's a way of thinking about the world in a much more connected way. We all came from the same place.

Speaker 5

We've not only expanded our understanding of the tree of life, but it's changed our understanding of where we fit into the tree of life.

Speaker 1

Back to Chris in the forest.

Speaker 2

Do you want to know how an elephant is related to a clown? Fish. Discover more in a post from the Open University on the Tree of Life. Get your free copy, scan the QR code on screen, or ring 0300-303-3446 or visit connect dot open. Dot A/C dot UK slash evolution.

Speaker 3

While rugged beauty and the unique spirit and explores a place of arts, the West Coast. Vineland, a new series of the comedy podcast that takes history seriously. You're dead to me in every cut. I'll start a story with Altima and White House gone fishing.

## Transcript Episode 2

Speaker 1

The 2 toe feet tip an ostrich, their singles, their head popping up on a long neck, its thin downy covering, catching the light. BBC East Studios presents.

Speaker 2

The prettiest Chris Packham or the brightest and it's fair to say. They're a bit odd. But ostriches produce something truly astonishing. The biggest eggs on the planet.

Speaker 1

Farm South Africa. Chris kneels down beside a cluster of large pale eggs.

Speaker 3

Can I ask you to stop for a moment and think about something?

Speaker 1

Truly remarkable.

Speaker 3

Something so commonplace, so every day that we take it for granted. Life creates new life. And it's happening right here in front of me.

Speaker 1

I bend down.

Speaker 3

Oh, yes.

Speaker 1

I can hear it.

Speaker 2

I can hear it tapping. It's yearning to get out of the egg.

Speaker 3

Around 40 days ago, a chick that was just about to break out of here into the big wide world was just a tiny collection of cells.

Speaker 1

He carefully Pigs are the hatching egg.

Speaker 3

Look at this started. I can see it inside. I can see it's light.

Speaker 2

It's blinking at me.

Speaker 1

A section innovate. Shell has been back to work. It's.

Speaker 3

Quite emotional if I'm honest with you.

Speaker 1

Sunlight falls on the little chick.

Speaker 2

So how did this marvel of nature come to be?

Speaker 1

Moving shadows.

Speaker 2

To answer that question, we have to travel back way back the earth rotating before the earth. Before dinosaurs, before there were even eggs, following an unbroken chain of life, the stretch was back over 4 billion years.

Speaker 1

A breaking wet cave in reverse, then ostrich eggs hatching.

Speaker 2

This is the extraordinary story of how evolution gave rise to the ostrich.

Speaker 1

A flash of bright white light emanating from 2 single cells and travelling through a tunnel of leaves and feathers. Evolution. Lightning flashing across a cloudy sky and raindrops rippling the waves below. Against a backdrop of tiny microbe. Floating in water, a timeline moves back to 4 billion years ago, somewhere in the ocean larger capsule shape.

Speaker 2

These are some of the world's first living things.

Speaker 1

They move through the water.

Speaker 2

They can't see. They can't hear. But right from the very beginning, life on Earth was really good at one thing.

Speaker 1

We produce one organism begins to form into two.

Speaker 2

But back then they did it in a way that seems quite alien to us. They split themselves in half to create and identify. A clone.

Speaker 1

From above, Chris walks, leaving footprints over desert sand dunes.

Speaker 3

As soon as life appeared on Earth, it began reproducing. Once it stuck. It did so at a remarkable rate, turning out copy after copy after copy for billions of years. The problem is, though, that when you're just copying yourself, it means that life scope is quite limited. You see, for billions of years, we had nothing with eyes, nothing with legs, nothing with the brain, just single cell microscopes. And it looked like life was just going to stay like that.

Speaker 2

Imagine a world filled with nothing but microbes. No plants, no insects, no birds of any kind. and definitely no people.

Speaker 1

A vast tractive desert, half inch shadow, then Chris gazing out over the sand.

Speaker 2

You see, it's not that I've got anything against my crops. But let's face it. Life would be dull.

Speaker 1

Countless microbes floating in water.

Speaker 2

But for almost 2 billion years, that's it. exactly how life was. There was some mixing of DNA and different species of microbe evolved. But the chances of Life getting any bigger than a pinhead looks slim until somewhere in the sea of simple cells.

Speaker 1

The time time moves to two billion years. ago a revolution re-emerges Eucaria.

Speaker 2

Now it may seem similar to all the microbes that came before it but it is In fact, on a new branch of the tree of life, you, me, and the ostrich, we are all here today because this might grow up the sun.

Speaker 1

Things scandalous 2 microbes floating close together.

Speaker 2

It takes a shy to another microbe.

Speaker 1

They attach to one another as they move.

Speaker 2

Their cell membranes fuse, allowing all their DNA to mix. This is the first sex. And it would change the course of life on Earth forever.

Speaker 1

Under a clear blue sky, Chris walks through the desert, his shadow stretching across the sand. Then he sits down on some rocks.

Speaker 3

It certainly wasn't romantic and it wasn't earth-shattering, but the first sex was a very big deal. And to understand why, we need to understand what sex is. And I know what you're thinking, don't worry, no now. Fundamentally, sexual reproduction is about two living things coming together to share their genes to create new life, a new life which is unique, and that's Why? The first sex was so pivotal, because after billions of years of just copying, here was a chance for mixing. The first sex set life on a new path.

Speaker 1

Floating microbes.

Speaker 2

The offspring of this pair won't be clones of their parents. Instead, they'll inherit a random mix of genes from both. Sex creates variety and it sends evolution into overdrive.

Speaker 1

The Earth rotating sample multiplying and solutions freezing over.

Speaker 2

Let's fast forward to the next 1 1/2 billion years. During which time there is a sexual revolution. Some self. I'll join forces, leading to big, complex bodies. The first animals.

Speaker 1

Out of footage of fish, coral and sea life as the timeline moves on to half a billion years ago.

Speaker 2

By the Cambrian period, the oceans are filled with a huge diversity of Animal life from simple sponges to species with eyes, legs and shells.

Speaker 1

Millipedes like creatures on the seabed, but all.

Speaker 2

Share one thing in common:.

Speaker 1

What spots a potential mate?

Speaker 3

There are Randy Bunch

Speaker 1

white water froth thing over rocks in the shell hose.

Speaker 3

We have a good understanding of how rich and varied life was in the Cambrian seas, down to the enormous abundance of fossils that we recovered from that period. And you know how much I love a fossil. Look at this trilobite. What a beauty. You can see it's got a segmented body here. It's rounded smooth head compound eyes. And I can tell you that we've identified no less than around 20,000 difference. species of another fossil here. Look at this. is an eocrynoid, an animal that's related to the sea urchins. And we think that the bottom part of it here was rooted into the sea. seabed, and these tendrils here would have been wafting in the water flow, getting its food. So, there was a great diversity of life in the Cambrian seas, but also a diversity of shape and size, and that made its sex. altogether more challenging, because organisms like this couldn't we produce in the same way that they're ancient single-celled ancestors did by simply fusing together. I mean, imagine a couple of kilobytes like this, trying to get it on. It's not going to work, is it? With the hard exoskeleton of their legs, their internal organs, nature needed to come up with a different way.

Speaker 1

Churning waves and nature.

Speaker 2

Pollution is an extremely effective one.

Speaker 1

Pet milk, clouds and water.

Speaker 2

Back in the Cambrian, many animals have adopted it.

Speaker 1

Tiny particles released into the water resembling clouds.

Speaker 2

These tiny specs are eggs.

Speaker 1

Scattered white eggs drifting by.

Speaker 2

And these Even tinier ones must spur them. And they do exactly what those ancient microbes did. They fuse together and combine their DNA To create a new, unique life.

Speaker 1

Shifting patterns of light from the surface of moving across a sandy sea bed teaming with life.

Speaker 2

The Cambrian seas are quite literally fertile oceans. But for many creatures here, there's something unfamiliar about the way they go about reproducing.

Speaker 1

It's from above a small speck in the desert, then picking up a snail.

Speaker 3

A lot of people don't like snails. I'm not one of them. There's something about having them. slime up and down your fingers. These are a highly successful group of animals. There are more than 40,000 species in the world, and one of the keys to their success is their reproductive capacity, like many snails. It produces sperm and eggs. It's a

hermaphrodite. Let's think about the repercussions of that. When this snow goes looking for a potential partner, any other that finds of the same species and about the same size is a potential mate. And once they've copulated, they can both produce a batch of eggs, doubling the capacity to produce a lot more snails. Now, this is such an efficient and successful strategy that many scientists believe that the earliest animals were all hermaphrodite as soon as they could produce sperm and eggs they produce both, which begs the question: why aren't we all hermaphrodites today?

Speaker 2

It's hard to know for certain, but There's a theory that, during the campaign, something upset the status quo underwater footage, and it may have happened in a creature like this.

Speaker 1

Something moved along the seabed, shrouded by clouds of sand.

Speaker 2

It's so bizarre. It's hard to believe it really existed.

Speaker 1

A long tail or swishes.

Speaker 2

But for some evidence shows that it really did look like this.

Speaker 1

A swimming creature with a rounded blue body into two sections and a long flexible oranged nail.

Speaker 2

It's a It's not a fish.

Speaker 3

It's not a crust.

Speaker 2

In fact, it's unlike anything that lives today. And it's radically different from its single cell. Ancestors, but it has inherited a key trait of one mind.

Speaker 1

Approaching a possible mate?

Speaker 2

Now, if we assume that Tulacolians are hermaphrodites, that means that any member of the same species is a potential mate.

Speaker 1

The two overtulacolians swimming side by side.

Speaker 2

But when this pair come together to release their eggs and sperm, there's a problem.

Speaker 1

A cloud of eggs and sperm.

Speaker 2

You see, one of them was born partially sterile. It can't produce sperm. For many animals, this would be the end of their family line. But not for a amaphrodite.

Speaker 1

An egg falling through water.

Speaker 2

Because if it can still produce eggs, it can still we produce.

Speaker 1

Eggs on the sea bed.

Speaker 2

It's genes get passed down to the next generation, and some of them are born partially sterile, too.

Speaker 1

Walking on a sandy river bank.

Speaker 3

So, Think about it. In biological terms, that's snail. If it could only produce eggs, we call it a female. If it could only produce sperm, we would call it a male. So the reason is the possibility that the division of the sexes, the origin of males and females came down to a chance mutation. We were mistakes.

Speaker 1

Two birds wading in the shallows, their beaks in the water.

Speaker 2

Today, only 5% of animal species are hermaphrodites. The rest have separate sexes. It's thought that males and females evolve. involved multiple times in many different species, allowing females to specialize in producing fewer higher quality eggs, whilst males make faster, more.

Speaker 1

Numerous sperm, toads, and clownfish.

Speaker 2

Nature is of course flexible. Clownfish can turn into females. Seahorse dads get pregnant.

Speaker 1

Seahawk's baby is being released in the water.

Speaker 2

It really doesn't matter who does what. It's being a specialist that counts the fake.

Speaker 1

Of an infant to rank attack and click to a parent, then the main in the tulip Coleans.

Speaker 2

For animal life, this specialization is a turning point.

Speaker 1

Storm clouds. Volcat make eruptions under water As we.

Speaker 2

Jump forward 150 million years It acts as fuel to evolution's fire Fishes emerge.

Speaker 1

Flashes of tails and as creatures move in the deep, then a low sun of rugged hills and grassland.

Speaker 2

Eventually, some even brave a new frontier.

Speaker 1

The timeline moves to 380 million years ago. Sunlight on calm water.

Speaker 2

The fresh water streams.

Speaker 1

A large fish swimming up stream.

Speaker 2

This ancestor of the ostrich is looking for a safe place to lay her eggs. With streamlined bodies and powerful titles, her short stream with ease. But they're being followed.

Speaker 1

Now rain is rippling in murky water as Chris wades knee deep scanning the grounding trees and dense foliage. as he walks.

Speaker 3

If I were to time travel back to the Devonian, you would not find me waiting in a river like this.

Speaker 1

No matter how sweaty the swamps were, I would be tempted to take to the waters because I might lose my toes or even my legs. The rivers were filled full of predatory fish armed with sharp teeth for tearing through.

Speaker 3

Flesh, some of them the size of minnows, others the size of crocodiles.

Speaker 1

If you were a fish living in here, you'd have enough trouble protecting yourself, let alone your eggs. A pile of small orange coloured fish eggs on a river bed left on guard.

Speaker 2

In the ancient waters. Nutritious eggs don't stand a chance.

Speaker 1

A shadow loom as a predator approaches devouring eggs and staring up the muddy river bed.

Speaker 2

These fish need to find a safer breeding ground, or they'll be known next generation, but they have something on their side that other fish don't.

Speaker 1

An image resembling a fish skeleton on a tablet computer.

Speaker 3

This is a 3D scan of a fossil, one of those fishes. When you just look at it, looks pretty much like a modern convention. It's long, fairly streamlined, got a bit of a blunt head there. I would have had a tail at the back for propelling it through the water, and all of the fins are pretty much in the right places. It's a little bit like a salmon, but I'm close. So inspection. In fact, it's very different. Let's zoom in on this here. You can see that it's much longer and the bones that lead from it back to the core of the skeleton are much more could be that it was using these fins to propel itself along the bottom of the river. They're much stronger than those delicate rave fins that you see on modern fish. These It's a fin that you could stand on.

Speaker 1

A fossilized fin made-up of tapering bones, then a fish making for the river bank.

Speaker 2

The strong fins that help these fish move along the river bed, also allow them to do something revolutionary.

Speaker 1

Shimmering through the shell of the fish emerges from the water and hauls itself. up the bank using its strong front fins.

Speaker 2

Leave the river and walk on land.

Speaker 1

Golden sunshine in floods to green valley crisscrossed with narrow waterways.

Speaker 2

And beyond the main river lies a network of streams the predators can't reach.

Speaker 3

We can't be certain why those low pinned fish climbed out the water. I mean, they could have been looking for food, they could have been avoiding being food themselves, but there is the possibility that they were looking for somewhere safe to lay their eggs to spawn. But one thing's for sure, once they waddled out of the water and climbed onto land, there.

Speaker 1

Was no going back. A lobe-finned fish hauling itself up the riverbank.

Speaker 2

Fish with the strongest fins are more likely to reach the predator-free waters.

Speaker 1

An X-race limit showing both.

Speaker 2

They have more offspring which inherit their strong fins. Over countless generations, the bones get longer. Stronger and better for walking on land.

Speaker 1

It's showing bones dividing and lengthening until eventually.

Speaker 2

After millions of years, a fish's fin has become a limb.

Speaker 1

The boat instructor now resembles the fingers of a hand.

Speaker 3

There's absolutely no doubt that this was a pivotal environment. I mean, think about it. Life on Earth had evolved in water, and up until this point, almost all life was still living in water. OK, about 100 million years earlier, plants have made the difficult transition onto land, and insects have managed it too.

Speaker 1

But now, here is a new group, animals walking on land on 4.

Speaker 3

Legs and four feet for the first time.

Speaker 1

The amphibians.

Speaker 3

I'm about to show you something which is remarkable, astonishing even, and I think very beautiful. Take a look at this. This is a drawing of the bones in the foot of one of those ancient amphibians. It lived over 300 million years ago. But look at it.

Speaker 1

Does it look familiar?

Speaker 3

It should do. That's because these ancient amphibians were our ancestors. Not only our ancestors, but the ancestors of all The animals with backbones that have ever lived or are living on land today.

Speaker 1

Wooded hills stretching away towards the distant horizon, then microbes in water.

Speaker 2

If those ancient microbes hadn't discovered sex, bigger or complex animals may never have evolved.

Speaker 1

The virtue of Hulacolians.

Speaker 2

We wouldn't have miles and females with precious eggs that need protecting low fish swimming upstream and the answer. of every land animal with a backbone, including the ostrich and dust. I never have left the water and evolved. to live on land.

Speaker 1

Light shines through swirling clouds and a river for warms.

Speaker 2

Now we jump forward 10s of millions of years.

Speaker 1

The time in reach is 3. 140 million years ago.

Speaker 2

And the amphibians are the planet's dominant land and animals.

Speaker 1

From Murky water to a scaly lizard-like with vivid black and orange markings.

Speaker 2

But no rain lasts forever.

Speaker 1

Cassinaria Domain Yukaaria.

Speaker 2

This is Cassinaria. She can live happily in water and on land. But like many animals here, Cassinaria is in trouble.

Speaker 1

Rising above the small murky pool.

Speaker 2

Drought has set in.

Speaker 1

Cat scenario crawls out of the water and into the undergrowth.

Speaker 2

Swamps that once stretched as far as the eye can see. And now, little more than muddy puddles.

Speaker 1

Chris is clapping over the rocks near the pool.

Speaker 2

To understand why this was a problem, We only have to look at amphibians to die.

Speaker 1

He catches the frog in his hand.

Speaker 3

Clearly out of practice, but I did mention to catch one. This frog is not attractive, I have to say. Those are ice like little golden jewels. It looks slimy, but it's not. It's shiny and it's shiny because it's wet. And when it's wet, frogs like this can breathe through their skin. does need to be wet. So there's an inherent vulnerability there. They do need to return to the water. They can't dry out.

Speaker 2

And it's not just the adults. Their eggs need water too. Amphibians.

Speaker 1

Can't reproduce without water. Frogs born on the water's surface.

Speaker 2

In periods of drought, amphibians suffer.

Speaker 1

Cassinaria and dusty looking to rain.

Speaker 2

But Cassinaria has managed to cling on. Her survival is partly down to the park. Also, the unique mix of genes she inherited.

Speaker 3

Now, had I been a bit sharper and been able to catch another one of these frogs, and probably you and I, they would look identical, like clothes. Of course they're not because frogs reproduce sexually. They mix their genetic material to produce unique individuals. And this doesn't only make life more interesting, critically it makes life more resilient. think about it. At this point in time, this lovely stream is probably the perfect place for this fog to be. But what about if conditions change? What about if it got drier or wetter or the vegetation changed or something? Something much more subtle like the mineral content of the water.

Speaker 2

Well, because every frog is different, some will fare better than others. They'll live longer and have more offspring. And those offspring inherit the genes that helped their parents survive.

Speaker 3

Essentially, that's what we call survival at the fittest.

Speaker 1

He releases the little frog back into the water.

Speaker 2

Castaneri is unique mix of genes determines everything from her size to her skin colour, and it also determines her eggs.

Speaker 1

A pile of translucent eggs resembling small glass marbles.

Speaker 2

As luck would have it, they're better at retaining moisture than most amphibian eggs. And in these dry conditions, that difference means everything.

Speaker 1

From the egg pile of the water's edge to a single leg in a CGI graphic.

Speaker 2

The slight variation in the structure or composition of the egg is all it takes for one egg to survive when others don't. As generations pass, the egg begins to change.

Speaker 1

Gliding over the surface of the little round egg as its shape and texture slowly evolve.

Speaker 2

The surface gets tougher and thicker. Special membrane forms to prevent moisture loss. The egg gets larger, stronger. and takes on an iconic shape. Until eventually, after millions of years, something extraordinary has emerged.

Speaker 1

The egg now oval with a Protective white shell.

Speaker 2

An egg that can survive on dry land.

Speaker 1

A cluster of eggs on sandy soil. An escape flea body of a lizard.

Speaker 2

From dying swamps, entirely new groups of animals emerge. Among them, the reptiles.

Speaker 3

Look at this rock. Sadly, we don't have time to watch me falling in love with a lizard. So let's look at the similarities between this animal and those ancient amphibians. Well, firstly, it's got the same streamlined nose and long tail. Then look at her limbs, all four of those legs and feet strong with those sturdy bones that have been passed down generations from the low fin fishes. There are differences. too. The skin is a striking one. I mean, that is not shiny, moist and breathable. It's scaly and hard. It's about keeping moisture in. And then critically, this Tile doesn't need to return to water to breed. You see the amphibians might have been first to walk the earth, but they were always limited by that need for water. It was direct tile which really. conquered the land.

Speaker 1

Chris sets the long-tailed rock monitor back on the ground.

Speaker 2

Reptile eggs are far more sophisticated than the jelly blobs of the amphibians. Known as amniotic eggs, they have a tough outer and nutrient rich yolk, and perhaps most extraordinary of all. special stack of fluid in which the embryo floats in its own private pool. The amniotic egg is like a pond on dry land.

Speaker 1

Infant reptile is moving inside eggs in a small lizard.

Speaker 3

But when it came to sex, these new high tech reptile eggs presented some challenges. You see, an egg like this, and this is a crocodile egg, is no good on its own. it's got to be fertilised. But there is absolutely no chance of a sperm breaking through this shell. So what's the solution? Well, the solution is to get the sperm to the egg before What the shell goes on before the egg is laid. You see the reptiles didn't only have to reinvent the egg, they had to reinvent sex.

Speaker 1

A brown and old lizard developing inside an egg.

Speaker 2

The solution is found on almost every male reptile today. It begins to grow around the 10th day of life.

Speaker 1

He bugs like an extra limb and narrow points.

Speaker 2

It's a penis.

Speaker 1

Ostriches and pillow lizards and elephants.

Speaker 2

Reptiles were amongst the first animals to get penises, but they certainly weren't the last.

Speaker 1

Kangaroos, macags, and whales.

Speaker 2

The blue whale has the largest. Averaging 2.5 metres. The gorilla has one of the smallest compared to its body size penis is a shape like. Corkscrews. Cats are covered in barbs.

Speaker 3

Penises are as diverse as their owners.

Speaker 1

Bat upside down.

Speaker 3

Now, despite what some people say, penises are limited in size, even for the blue whales. So therefore, for the males to deliver the sperm where they need to, they need to get close to the female whales. They need to make ******* ******** making love. The terminology that we use in scientific balance is copulation, and the reptiles weren't the first to get at it, so ancient fish had been doing it. it for years, but when it came to life on land sex, as we know it, had been invented.

Speaker 1

A low sign over rugged hill, then reptile lies in close up with their sophisticated.

Speaker 2

Eggs and a new way to fertilize them.

Speaker 1

The reptiles went forth and multiplied A fossilized mescosaurus. Then you debate famous. From 200 and seventy-five to 200 and seventy-eight and 279 to 290 million years ago.

Speaker 2

Fossil remains have been found in abundance.

Speaker 1

Labidosaurus 2. 172 to 217 million years ago.

Speaker 2

But world domination wasn't the only consequence of their weak productive success.

Speaker 1

A barrel and rocky landscape.

Speaker 2

The egg, the.

Speaker 3

Penis, copulation, all of these adaptations helped with the mechanics of sex, but what was to happen next was all together different. You see copulation didn't only change the way that animals looked. It changed the way they behaved. And the consequences of that were extraordinary.

Speaker 1

A sun-lit valley, then shadow is passed across the earth. as it wrote dates in space at speed.

Speaker 2

Around 100 million years after the first reptiles emerged.

Speaker 1

The timeline reach is 210 million years ago.

Speaker 2

Some of them have evolved into the most legendary creatures to have ever walked the earth.

Speaker 1

Walking across a sandy beach.

Speaker 2

This is Coelophysis, one of the first dinosaurs. Just like his ancient ancestors, he has strong legs for walking on land. But like all early dinosaurs, he walks on two. Instead of four, bigger strides allow him to cover more distance, which is handy because this young male is looking for a mate.

Speaker 1

Potential partner appear.

Speaker 2

There are plenty of females around. The tricky part is getting their attention.

Speaker 1

A large gentelo with vertically striped fur and spiral shaped horn.

Speaker 3

So, how do you impress a female? Probably not the best person to answer that. I've been struggling all my life, but I reckon this guys with a chance. What a magnificent animal. So handsome. Honestly, this is an Nyala Southern African antelope. This is a mature male and he is very, very impressive. Certainly that female house point of view. Okay, doesn't have a small scar, doesn't need it. It's got those beautiful curled yellow tip horns. Doesn't live in a mansion, doesn't need that guy that has got those broad hats. powerful flanks. And what's more, it's not just those characteristics, it's the fact that he's lived long enough to be able to grow with them. I mean, imagine if this guy had been born short-sided with a limb. He would never have survived.

Speaker 1

A grazing female.

Speaker 2

His good looks are visible signs that he is fit and healthy. And ultimately, that's what the female was looking for.

Speaker 3

Getting pregnant, developing your youngsters, giving birth, then looking after it. Those females can't afford to bank on a male. They want the genes from the real feel like this guy.

Speaker 1

Chris aims his camera as the imposing Nyala flicks his tail.

Speaker 2

When it comes to reproduction, it tends to be the biggest, hairiest males that succeed. their genes get passed down, making future generations even bigger and hairier than the last, which is how you end up with exactly physical traits like this.

Speaker 3

Let's be very clear here. These physical characteristics are not necessarily directly related to survival. What they were about about is finding a mate, attracting that mate, and then successfully reproducing. Evolution is not always about survival of the fittest it's critically about getting your genes in. on to the next generation. That was as profoundly important to the dinosaurs as it is to these Nyala.

Speaker 1

A small dinosaur walking on its hind legs.

Speaker 2

Just like the good looks to a sign that the male is in good condition. And just look at that attractive.

Speaker 1

Pale, tuft on its head and neck.

Speaker 2

But what's a male to do if no one seems to notice him? Scientists suspect that some dinosaurs did what many animals still do.

Speaker 1

Today, a male sealer devices apparently dancing.

Speaker 2

They show off. It starts with head bobbing, followed by twirls. But to really impress her, he has one final trick.

Speaker 1

Standing tall, the male extends his long neck and rhythmically waves his hand like forelegs.

Speaker 2

It's irresistible.

Speaker 1

A female male stands watching the performance on a beach.

Speaker 2

His will inherit his attractive files and go on. to have fuzzy offspring of their own becoming part of an extraordinary evolutionary transformation. Over time, fuzzy strands get longer and wider. and split it into multiple filaments making any even bigger for display.

Speaker 1

Strands changing in CGI footage and.

Speaker 2

Till eventually, after 10s of millions of years and countless generations, those fuzzy strands are so exaggerated they've become Something new?

Speaker 1

The dinosaurs waving forelegs resembles small flapping wings feathers. An image of a fossilized feather.

Speaker 3

When the first fossilized feather was found, scientists were struck by its similarity to the feathers of modern birds.

Speaker 2

But this feather is 150 million years old. placing it firmly in the era of the dinosaurs.

Speaker 1

More feathers close up.

Speaker 2

We don't know for certain what drove their evolution. Insulation. And camouflage may have played a role, but we're now in little doubt that some dinosaurs had feathers and many. Scientists believe it was the need to attract a mate that transformed dinosaurs from scaly reptiles to flamboyant feathered creatures from a.

Speaker 1

Dinosaur displaying its plumage to wild grasses in a meadow, then a long ground feather with darkest markings either side of the central spine.

Speaker 3

This is the tail feather. of a ring neck pheasant. It's beautiful, isn't it? And whilst it still serves as a tail, as you can see, it's been given over to display. It's elongated. It's got this beautiful bronze colouring with all of these spots. And when it comes to display feathers, of course, nothing can be a male peacock. Look at that with that very distinctive eye. But this is a typical feather. Look at it, it's light, it's flexible, It's durable, it's essentially repairable, those barbs are falling apart, it can be fixed here, but it's also symmetrical, very much like the feathers that we first saw when they appeared on the dinosaurs. But 10s of millions of years later, something different crops up in the fossil record. Something like this, and you can see this is different because it's asymmetrical.

Speaker 1

The here all the ratchets, if you like.

Speaker 3

Is much closer to this side. Now, there is a theory which says that this was the result of a chance mutation, that this was a mistake. But if it was a mistake, it was a very fortunate one. Because by shifting the ratchets closer to one side, it means that when

this feather is pushed through the air, it generates lift like an aircraft wing. The dinosaurs that were equipped with these could fly.

Speaker 1

Sunlight, cats, catching the gen, at least to a grasses.

Speaker 2

Around 25 million years after the first feathers evolve flying dinosaurs killed the sky a bird in silhouette today we have another name for them birds.

Speaker 1

A huge, huge flock in flight.

Speaker 2

Almost 100 million years, they survived alongside their giant cousins. And they were there to win. This one of our planet's darkest days.

Speaker 1

A glowing fireball from the skies strikes the trembling ground and then shadow creep plunge the landscape into darkness. Now Chris is sitting on rock in the heart of flight.

Speaker 3

When we say that all of the dinosaurs became extinct, it's not technically true, is it? Because those that had evolved into birds survived. The ones that did best were the small ones they could hide away, and also those with a very broad.

Speaker 1

Diet.

Speaker 3

But as the earth began to recover, they had one another key asset, the amniotic egg. with that embryo protected from the inside, from the hostile world on the outside, they could continue to reproduce generation after generation to the extent that they didn't just survive, they thrive.

Speaker 1

Darkness giving way to light.

Speaker 2

The surviving birds were largely ground dwellers. Amongst them, the paleonites, some of whom would never return to the sky. Instead, they became big and heavy and better

adapted for life on the ground, and to allow their chicks to hatch fully before and ready to. run their eggs evolved truly gigantic sizes and one of this.

Speaker 1

Group the two toed feet of an ostrich produces a large.

Speaker 2

Just eggs of all.

Speaker 1

A head pops up. Common ostrich domain Eukarya Kingdom Animalia phylum or data sub phylum vertebra.

Speaker 3

Class avi, birds, ostriches, our largest birds. Look at them standing there on those strong legs with those sturdy bones that they inherited from low. Fishes. I can see those legs are covered in scales, so are their signs of their reptilian ancestry. And their feathers are no longer used for flying, they're the display. They are brooding their young. And of course they don't need to return to water to lay their eggs. These birds like just amniotic egg on the planet.

Speaker 1

Hatching ostrich egg.

Speaker 2

They lay them on the dry ground, just as their reptilian ancestors did, a chick emerging and safely cocooned inside each one. A new life begins floating in water, just as it's always done.

Speaker 1

From chicks breaking bit by bit through the shell of their eggs to fluffy hatchling. taking their first steps.

Speaker 2

These chicks are the next chapter of an extraordinary evolutionary story. Four billion years long that reveals how the and its enormous egg came to be.

Speaker 1

Mountains in silhouette, and.

Speaker 2

Although those ancestors are long gone. Their legacy lives long. Not just in the ostrich, but in all of us.

Speaker 1

Chris holds a check.

Speaker 3

Just like this chick, all of us started our lives in war. water floating in that amniotic fluid in the womb of our very own private pool. And that's because we share an evolutionary history with this bird. We share ancient ancestors in our wonderful, unbroken chain of reproduction, stretching back billions of years. And of course, we're not just connected to ostriches, we're connected to all life on Earth. Everything that walks Fox, flies, mice, slithers, slimes and claws. We are connected to it. And that's all around to reproduction. Over time, sexual reproduction has shaped us into different species. And sexual reproduction has one another absolutely extraordinary impact. It makes us all unique. Nothing exactly the same as me, you or her. has ever lived or will ever live ever in the entire history of this wonderful little blue planet we call home.

Speaker 1

Sitting on the ground is turned to look at the little ostrich and she does the same, meeting smiling gaze as the gold glow of a setting sun lights the horizon behind them.

Speaker 2

Next time, how the bat evolved to one of the most insane appetites on the planet. Look at this truly spectacular from a prehistoric ****. That caused a mass extinction. To go.

Speaker 1

Became jaws.

Speaker 2

And surprising new way of finding food. This is the incredible story of one of nature's most formidable feeders. Look at that evolution.

Speaker 1

The evidence.

Speaker 2

But first. How do we know birds are living dinosaurs? When most people look at a bird, they don't see a dinosaur.

Speaker 3

The first clue of the.

Speaker 2

Extraordinary evolution relationship between birds and dinosaurs came in the mid 19th century.

Speaker 4

The Jurassic species Archaeopteryx is an icon of evolution.

Speaker 2

Archaeopteryx. certainly looked a little like a bird.

Speaker 4

It had feathered wings, and yet upon those wings were fully functional three-fingered hands with claws, which is reptile like, and a long tail. It had a head like that of a bird, and yet inside its mouth were rows of sharp teeth.

Speaker 2

So, Archaeotrix wasn't just a bird, it was also a dinosaur. Other discoveries followed, but left no room for doubt.

Speaker 4

Birds are a type of a dinosaur. We can see be the evolutionary origins of many bird traits among their ancestors, the dinosaurs. Things like a beak, warm bloodedness, feathers, a wishbone, Tyrannosaurus Rex itself has a wishbone.

Speaker 2

But one key question remains:.

Speaker 4

What helped birds survive when all of their dinosaurian relatives went extinct? For me, it is one of the most fascinating questions in all of evolutionary biology.

Speaker 2

A question that could have remained unanswered if it wasn't for a child find.

Speaker 1

The first time I saw this fossil, I was not very enthusiastic.

Speaker 4

It's basically just a a block of limestone with a couple broken bones poking out from it. But we decided to take a closer look at it anyway.

Speaker 2

A CT scanner revealed what was hidden inside.

Speaker 4

Saw that skull on the computer screen. It took a second of silence and then I realized immediately that this was one of the most important fossil bird specimens ever discovered.

Speaker 2

Daniel stumbled across the oldest fossil of what we would now recognize as a modern bird, and it lived alongside dinosaurs just before the asteroid impact.

Speaker 4

It is toothless like modern. birds. Its beak looks quite a bit like a small chicken bill. That's interesting. It suggests to us that this animal was probably a generalist feeder. That is to say, it wouldn't have been very picky, just like living chickens. Being flexible was critical to surviving the asteroid impact. One of the best ways to survive was to simply have the ability to eat anything. And that might have been one of the important features that helped birds like this. one survived the mass extinction event.

Speaker 2

These small chicken-like ancestors and a few other bird species would make sure that not all the dinosaurs were lost.

Speaker 4

When I see an I see that the story of dinosaur evolution is not over. Today, there are over 10,000 species of birds. In some ways, we are still living in the age of dinosaurs.

Speaker 1

Doctor Steve Brusati University of Edinburgh.

Speaker 3

Do you want to know how an elephant is related to a clownfish? Discover more in a poster from the open University on the Tree of Life. To get your free copy, scan the QR. barcode on screen or ring 0300 303 3460 or visit connect.open.ac.uk/evolution.

Speaker 1

Meeting the dedicated people battling to save endangered species and environments across the UK and Europe. Barrett returned to the wild on iPlayer and back for a new series history lessons but never like this you're dead to me on Sounds listen now, yeah, thanks to gentle and show with Mortimer White House gone fishing.

## Transcript Episode 3

Speaker 1

Standing in the... Looks from towering rocks in dark after darkness.

Speaker 2

Look at this. What? And it's extraordinary flags.

Speaker 1

BC Studios presents.

Speaker 2

These caves are hope to a creature that is up under notably one of evolution's weirdest.

Speaker 1

Dozens of fluttering bats are caught in Chris's torch beam.

Speaker 3

Oh my goodness, look at that.

Speaker 2

Is spectacular. cave is caked in bats.

Speaker 1

Hanging upside down from the cave ceiling.

Speaker 2

Using ultrasonic clicks they can navigate in darkness, and with each longer Finger bones covered in a membrane of skin. Bats are the only mammals that can fly.

Speaker 1

The large ears wrinkle skin and glossy black eye of a bat in the sub.

Speaker 2

But there's something even weird about them. Each evening, they begin swarming. Oh my goodness me, look at that. Impulse they just can't deny an almost unrivaled need to feed.

Speaker 1

From Chris's gleaming torch. to a teeming mass of bats out side silhouette pitted against a pale sky, hanging vegetation and arch shrap towards the morning cave mouth as more bats dream out into the open air. Chris is sitting on rocks nearby.

Speaker 2

Floyd is an enormously energetically expensive exercise, and as a consequence, these bats have a gargantuan.

Speaker 1

Appetite.

Speaker 2

Each one of them is going to need to find thousands of tiny insects tonight. Keep half of its own body weight a bit like me eating 70 pizzas in just a few hours. Their whole existence is governed by a drive to find food and a lot of it.

Speaker 1

Moration swooping and spiraling against the twilight sky as bats fly a moving as one.

Speaker 2

So how did the bat become one of the hungriest animals on the planet? To answer that question, we must go back into time. Way back in time. Meet a handful of ancient relatives of the bat.

Speaker 1

I see. peaks darting fish and fang like teeth who between them hold the evolutionary secrets glowing up and rocky coastline.

Speaker 2

How the bats giant appetite.

Speaker 1

From eggs to bats in flight, came to be a flash of bright white light emanating from 2 single cells and travelling through a tunnel of leaves and feathers, evolution. The bat glimpses of movement through the translucent surface of an egg as a timeline rolls back from the present to 515 million years ago.

Speaker 2

Our story begins in the shallows of an ancient ocean.

Speaker 1

Small round egg is clustered on the city bed.

Speaker 2

Where today?

Speaker 1

New life is emerging a little flat fish moving in wave like ripples.

Speaker 2

This is a distant ancestor of the bat and all of us. It's home is an 8 billion looking ecosystem known as the garden. And its neighbours are some of the strangest animals to ever live on our planet.

Speaker 1

Swaying from rising from the green algae rich ocean floor.

Speaker 2

Now I know it might not look like much, but this little creature is about to play a pivotal role in the story of life.

Speaker 1

If on Earth one that would change eating forever, Chris sits down on a sand beach with the backpack.

Speaker 2

Now, the Ediatron is one of the most enigmatic periods in our Earth history. Not least, because it's the first time that we find fossils of large complex animals in the geological record. And I've got some casts of some of those in here. Just look at this. That's pretty good, isn't it?

Speaker 1

This is a leaf-like organism.

Speaker 2

I know it looks a little bit like a plant, perhaps like a fern, but some scientists can tell that at least some of these specimens were living in depths of water where plants

couldn't prosper. So, we think that it was an animal. Now, take a look at ****. Now that is special. That is a beautiful fossil.

Speaker 1

Round and flat. **** ** Sonia is covered with small ridges resembling a fingerprint.

Speaker 2

550 million years ago, these bizarre animals are thriving because they have plenty to eat. Why was that? show you the third fossil. I know what you're thinking. Well, that's not very special at all. That just looks like some ripples on the beach. You've got to look more closely. These are traces of millions, billions, trillions of tiny microbes.

Speaker 1

The rippled textured fossil is scattered with particles that catch the light.

Speaker 2

These microscopic organisms are The secret ingredient of the garden. So numerous, they form a nutritious green mat several centimetres deep that carpets the seabed in every direction.

Speaker 1

The grass like seabed.

Speaker 2

For the animals that live here. A floor is literally made of food.

Speaker 1

Dappled sunlight.

Speaker 2

A twenty-four hour All you can eat buffet means no one goes hungry here, including, of course, bats and sester.

Speaker 1

Small and brown, it's light brown in colour and swims. like a rat.

Speaker 2

Officially, its name is the urban.

Speaker 1

Vain like lions criss-cross its flat body.

Speaker 2

It spends its days leisurely grazing. Hoovering up microbial mat into its mouth, digesting, and then a while later regurgitating the leftovers, not terribly pleasant. And the evidence we have for all of this comes not from a fossil, from a creature alive today.

Speaker 1

The half centimeter long A seal is a pale and capsule shaped. Kingdom Animalia.

Speaker 2

This animal is called a seal. It's an organism, only a few kilometres in. length and you can find them from all over the world. This particular species is called Hofstenia Mia Mia, and it's a favourite of scientists that study early life. See, a seal is what we call basal animals. A long time ago, they went down a certain evolution wrote different than other animals, and they've obtained some ancient characteristics. Seals have a mouth opening into a very basic. gut shaped a bit like a sack.

Speaker 1

Footage is 1 grazing on smaller organisms.

Speaker 2

We think that this kind of gut was common in the diacron.

Speaker 1

The pale creature's body Flexes as it moves.

Speaker 2

So, for the... the simplest route for waste to come out is the same way the food came in. But this way.

Speaker 1

Feeding was about to get an upgrade.

Speaker 2

CGI graphics compared to the rest of its kind. This individual has a genetic difference, a mutation. that almost imperceptibly lengthens its body. A difference so trivial it doesn't cause it any harm. But when Past on will change the destiny of a tiny reproductive pore.

Speaker 1

A sequence shows the small dark of the underside of the body moving over many generations.

Speaker 2

Subsequent mutations lengthen the ball be further, driving the paw and the gut closer and closer together until they connect.

Speaker 1

A long, thin vessel is formed, running the length of it.

Speaker 2

Forming a continuous tube through its body.

Speaker 1

It connects to the mouth.

Speaker 2

A tube. that changes everything. This new animal was to all intents and purposes a work. You see, unlike simple creature that came before it had a new body part. Aside from a mouse to take food in, just like you, just like me, just like everything that walks, flies and slithers, it had another hole to excrete waste. It had.

Speaker 3

A bottom and a bum.

Speaker 2

Technically speaking, it had an ****. Now I know what you're thinking. If you're running through a list of evolutions, greatest innovations, the **** is probably not scoring near the top of it. then think about the alternative and the advantages become immediately clear. I mean, imagine that you have a lovely lunch and that you digest it, but before you can have your dinner, You've got to throw it up. See what I mean? The is a breakthrough.

Speaker 1

A worm weaving through the underwater ponds with a mouth leading to a that goes.

Speaker 2

All the way through its body. This new worm can do something that no animal has ever done before.

Speaker 1

A brown stream of waste dissipated in its wake as it swims.

Speaker 2

It can poo. This is a superpower. You see, it means the word and feed continually. Eating more than any animal that came before.

Speaker 1

It caught screws into the sea bed as it feeds.

Speaker 2

In their quest for food, the ravenous worms burrow into the microbial mat. powering it and churning it up. Disrupting an ecosystem that had dominated the earth since life's inception.

Speaker 1

A sequence showed plant-like creatures withering in the ocean floor. was once screen covering, giving way to rock.

Speaker 2

As the microbial act declines, almost all of the strange animals that rely on it for food die out. The evolution of the **** may have led to the first mass extinction of animal life on Earth.

Speaker 1

Now sunlight filtering. down through clear blue water.

Speaker 2

But the legacy of the **** would prove to be more than just an extinction event. It helped animal life take on a bold new form.

Speaker 1

Two secret creatures in a rock pool.

Speaker 2

The anemone and the new to Frank the Slug are two soft bodied green organisms. They look pretty similar. The extraordinary thing is. that I am more closely related to that nudibranch than it is to that anemone. So why is that? Well, it's because the anemone doesn't have an anemone. is descending from a group of animals that found its own evolutionary path before the development of that through gut. But the nudibranch, like myself, has a mouth, through gut and an ****. It can poop and the ability to poop has a profound effect on our body plants. The anemone has a circular body.

Speaker 1

But the nudibranch is symmetrical down the middle, dotted lines appear.

Speaker 2

It has what we call bilateral symmetry, just like our that ancient worm and the unleashed the full potential of this bilateral body plan.

Speaker 1

Worm is burrowing into the sea bed, and Chris sitting on a beach.

Speaker 2

Then you've got an animal with a mouth, a gut, and an ****. Essentially, you've got a front and a back, and a front where the mouth is, the bit that one. to find food. So think about it. That's the best place to put any sensory organs. It's like eyes to look for that food. And then if you've got the sensory organs there, that would be the best place to have the brain so they can react quickly when they find that food. So then you've got a mouth, eyes, and a brain in the same place. What you've got is a head, a head. And I absolutely love the fact that for Life to evolve ahead, it had to evolve first. I love that.

Speaker 1

Tree is parched, shrouded in mist.

Speaker 2

A head end and a tail end. Joined by us who got to be a winning formula.

Speaker 1

Rising up above the trees that stretch away towards hills on the distant horizon. Then a monkey's face as it perches a branch, and the colourful striped beak of a puffin.

Speaker 2

One that means today we see bilateral symmetry everywhere.

Speaker 1

The protruding eyes of an oyster toadfish, a hanging bat and a snake, then a bird's eye view of elephants in single file, and the moving body of a millipede resembling tire threads.

Speaker 2

Ninety-nine percent of Known animal species on the planet have this body plan.

Speaker 1

It's done under water for fish and a whale surfacing its mouth wide open all of us.

Speaker 2

Of that world changing the world.

Speaker 1

Chris walks along an empty beach between dense forest turquoise waters.

Speaker 2

It's hard. to understand what a revolutionary moment the evolution of the **** was. Microbial mass which for three billion years have been the dominant ecosystem on Earth all but disappeared today. find them in environments which are inhospitable to animals. Beneath the ice in Antarctica or in steaming hot volcanic springs. And for animals, the development of the through had far reaching consequences. This increase At least efficiency meant they could grow bigger, move more purposefully, and it cemented the bilaterally symmetrical body plan over other options. The drive to find food had changed the course of life on Earth, and it wouldn't be the last time.

Speaker 1

The worms unleash a new era of eating, churning waves themselves.

Speaker 2

Fueled by the extra energy they're gathering. Their descendants develop more complex bodies and keenness senses for finding food.

Speaker 1

The timeline moves on to 505 million years ago.

Speaker 2

Just 35 million years later, one of those descendants is a worm no more. We might even call it a fish.

Speaker 1

It swims, flexing its tadpole-like body that tapers to a pointed tail.

Speaker 2

A small fish living in A very big pond.

Speaker 1

Large creatures on the sea bed.

Speaker 2

The oceans of the Cambrian period are dominated by giants and arthropods, cousins of insects.

Speaker 1

A nastropod with striking black and orange markings.

Speaker 2

Among them, Earth's first top predators.

Speaker 1

A creature with a round gate and the secret to survival.

Speaker 2

This little fish comes down to its strange mouth.

Speaker 1

A tablet computer.

Speaker 2

Now, take a look at this. It's the fossil of a primitive fish, about 5 centimetres. logs called meta beginner. Just look at the detail that you can see here, particularly at the front of its head. These 2 black dots, those are its eyes, and under scrutiny, scientists have discovered that they are pointing upwards. So, it could be that this little fish was swimming along on the bottom, using those eyes to look up into the water column for any potential predator, perhaps those giant arthropods that might have made a tasty snack out of a tiny fish. Like this. Another photograph here. This time we're looking down on it. And what appear to be ribs here, we think not ribs, but gibs, structures which Support gills. As it swims, a constant stream of water flows into the fish's open mouth.

Speaker 1

Kingdom Animalia Sub Kingdom.

Speaker 2

This is how metas beginner breathes passing water over its gills supported by those gill arches. But this mouth. is multi-purpose, something else is extracted at the same time. Met is a filter feeder and getting both oxygen and food into Their body is fast, is critical if they want to survive these perilous waters.

Speaker 1

In CGI, a meta is picked off by a predator with spiky claws resembling a large Horseshoe shaped moustache extending down from its face.

Speaker 2

This is survival of the fittest in action, and it means this fish, it's strange mouth and the gill arches. hidden deep within are already on a path that will shake up the world of eating all over again. Scientists have found that just begin this fun. Gill arches are actually thicker and appear to lack oxygen absorbing gill filaments. A tantalizing hint that they may have jettisoned their old role for a new one. Keeping the fish's gaping mouth wide open.

Speaker 1

Fossil image in close up.

Speaker 2

Because thick gill arches lead to a wider mouth. food and oxygen and more energy to escape. It's an advantage that's part of the storm.

Speaker 1

CGI sequence shows the gill arches inside the sprig that look like a rib cage across countless generations.

Speaker 2

The gill arches continue to thicken.

Speaker 1

And strengthen 2 ends touch and fuse to get together.

Speaker 2

You structure zoom up.

Speaker 1

Pointed to the emerge and after 10.

Speaker 3

Of millions of years. What was once Gillard becomes a revolutionary new body part, which means this.

Speaker 1

Wispy low cloud hangs over thick forest and a river meanders through it. A lizard lies on a submerged log in swamp-like terrain, its tongue flipping out as Chris picks his way through the trees and mud.

Speaker 2

Many body parts have been lost to the passage of time while some dolphins have lost limb. and fish that have been groomed in pitched up cave systems have lost their eyes. Even the not so humble has disappeared on occasions. Jaws never jaws. simply too useful. Look, jaws didn't just change how animals eat, but where they ate. This little creature is a mudskipper. One of around 25 species of fish that you can find all over the world typically in all mangrove swamps like this. Now what's extraordinary about them is the amount of time that they can spend out of the water. Some of them, 90% of their lives, and they're able to do that because they've got some remarkable adaptations. Firstly, this little fish is breathing through its skin. so has jointed pectoral fins, which means that it can skip across the surface of the mud almost as if it were walking. So, there are some behaviours there that we can make with those fish. that struggled out of water on to land 375 million years ago to begin and amphithe this lifestyle. But here's one thing: I couldn't have done it without think about it if These and those fish dependent upon filter feeding dependent on that water carrying morsels of food into their mouth. That would mean that no matter how much time they could spend on land, they would have to return to water. to feed. The difference is jewels that can bite and you can bite just as well out of water as you can in the water.

Speaker 1

A skipper darting in to water from a log, then distant. geeks rising above the clouds and crawl on a fallen tree into a bridge over a woodland stream.

Speaker 2

Thanks in part to the evolution of the jaw, fish were no longer reliant on feeding in water.

Speaker 1

Opening up a new world of possibilities, elephants amongst the trees.

Speaker 2

Now, I know it's good sound of. But from an evolutionary perspective, at least, these elephants are, wait for it, jawed fish. Of course, they're highly modified jawed fish, but fish nevertheless, but then so my We use every other terrestrial animal that's got a backbone and a jaw. So, here in Borneo, that means 300 species of reptile, 150 amphibians, 650 birds, and 200 in 50 species of mammals, all of whom are descended from those fish that made that leap out of the water.

Speaker 1

Two elephants face to face, then a small sun bear, it's furred dark but for a pale snap out and distinctive smile-shaped marking on its chest.

Speaker 2

Globally, there are at least 30,000 species of vertebrates living on land with the dizzying array of jaws adapted to many different ways of feeding. Some are lined with teeth, others have become beaks, and some open and so far their owners can swallow meals wider than and their bodies.

Speaker 1

A hippo, then a python devouring its prey.

Speaker 2

What they began as a tiny diacran creature gave rise to a through gut. And I work with an appetite that upended the world and led to a fish with a jaw that could finally take a bite.

Speaker 1

Fish gliding through sunlit waters.

Speaker 2

From their aquatic origins. Drawed animals spread to all corners of the globe.

Speaker 1

Bones resembling those in fingers.

Speaker 2

And diversify to exploit new sources of food.

Speaker 1

The sun peeping from behind a rock stack, then a lump bring dinosaur until.

Speaker 2

Two 100 million years later, we find one of them on the move.

Speaker 1

The timeline reaches 165 million years ago. A squirrel-like creature with a bushy tail and pale Spots on it. It's brown.

Speaker 2

This is a.

Speaker 1

It scampers over to a muddy puddle.

Speaker 2

It's a female and she's tiny.

Speaker 1

The. in a dinosaur footprint the size of a she climbs along a.

Speaker 2

Branch with warm blood and fur. She's a primitive mammal who spends most of her time hunting insects in trees.

Speaker 1

The agilla de cadon is called closed in mid-dare as she leaps from a branch.

Speaker 2

But right now, it's not her own hunger she's concerned with.

Speaker 1

With the yawn, she settles down in her nest made in a hot low tree. With her young, it's theirs. Now, Chris is walking through the forest as a large millipede-like creature crawls along a bunch.

Speaker 2

Mammals have a quirky advantage over many other types of animals. You see, we don't have to find food for our babies. We don't abandon them to find their bone. We make it. And milk is the perfect food for a growing infant. And it's perfect, unlike so many other types of food, because evolution has driven it to be so.

Speaker 1

A monkey on a bra. It's long, straight tail hanging below.

Speaker 2

Of course, milk made by mammary glands has given us mammals our name.

Speaker 1

But the evolution of milk.

Speaker 2

Impacted more than just babies. It's changed how mammals feed at every age.

Speaker 1

The cloudy sky reflected in a tranquil river.

Speaker 2

I've got a couple of lovelies. skulls here. This is from a crocodile and this one from an orangutan. Now they're clearly very different in terms of their size and shape, but also their teeth. Let's take a look at the crocodile first. Its teeth are very simple, and they're pretty much all the same at the base peg like and sharp ideal for grabbing and then gripping their prey. But look, you can see that they don't fit together terribly well. There are large gaps in between them. Contrast that with the skull of the orangutan. It's teeth are not so simple. They come in range of forms. You've got these at the front here. These are the incisors that are used for slicing and nibbling. And then you've got these very powerful canines for piercing and gripping. And lastly, When I fit the drawer on as it could sit in life, look at these two at the back here. They fit together almost perfectly. These are the molars. One of the major reasons that molars Have been able to evolve comes down to milk, various teeth and jaws. The ancestors of mammals had simple reptilian-like teeth that were replaced continuously as the animals grew. But when they started to evolve milk, babies were no longer reliant on teeth to feed. Fewer sets were needed throughout life, so this allowed more complex teeth.

Speaker 1

To evolve.

Speaker 2

In the mid drastic, it's thought that the young of species is like a Gila decode on now will sustain entirely on milk.

Speaker 1

Suckling her baby is in the nest.

Speaker 2

It's only because they're adult molars don't emerge until their jaw was almost fully grown that they are. some of the first to interlock perfectly.

Speaker 1

Chris follows the park to a forest clearing where he stands, gazing up at the trees around him.

Speaker 2

And this helps to these mammals to do something that's surprisingly rare in the animal kingdom.

Speaker 1

A rainbow of the orangutan higher up in the tree tops. As Chris watches, she chews fruit before feeding it to an infant from her mouth.

Speaker 2

Take a look at this beautiful orangutan here. female, the nursing youngster, but put her beauty to work inside and concentrate on what she's doing. She is chewing. We can chew those. gentle movements of the lower jaw, those molars grinding up that fruit. Imagine you had to take that fruit into your kitchen and cut it up into chunks that you could would swallow. You'd have to slice it, you'd have to dice it, and then you'd have to mash it. But she's doing all of that with consummate disease. Her teeth are highly efficient food processing machines. What they're trying to do is to grind that food up to increase its surface area so that when it reaches the stomach and the gut, the digestive juices can act upon it far more quickly. It massively speeds up the rate of digestion. I mean, contrast it with those crocodiles. They swallow their food whole in massive chunks, and it takes weeks to digest it. But me, you, and the orangutan, we can have a meal and digest it. in just a matter of hours.

Speaker 1

The adult orangutan licks her fingers for climbing for other up the tree. Now CGI footage shows on a tree branch before leaping to catch a unsuspecting inspect. She eats it, standing up and gripping it with her smaller front legs for primitive. She munch is the still moving insect.

Speaker 2

This ability to chew helps drive a surprising evolutionary change X-ray.

Speaker 1

Face-style images show a pagilidic odon skull, then just teeth and bones of the lower jaw.

Speaker 2

Over generations, lower jaw made of several bones is gradually reconfigured.

Speaker 1

Bones besides changing shape.

Speaker 2

One bone gets larger whilst the other shrink until A single powerful lower jaw evolves. The old jaw burns wither away, but not all are lost.

Speaker 1

Two small bones, which are then lying on Chris's arm.

Speaker 2

These are the remnants of those jaw bones. They're called the malleus and the incus, although you might know them as the hammer and the anvil. They're two of the smallest bones in our body and they are disconnected from the rest of our skeleton. The key thing is when we were in the womb, they started off as part of our jaw and then migrated up to our ear where they are joined by this bone and this one is called the stapes or the stirrup and together they connect our ear to our inner ear. Greatly enhancing our capacity to hear, particularly a wider range of frequencies.

Speaker 1

A tiger in long grass.

Speaker 2

The evolution of the middle ear bones known as the ossipocles. Transformed hearing for modern mammals. Meaning that today mammals have some of the most sensitive hearing of all animals.

Speaker 1

From giraffes, half dolphins and bats. to an arctic fox detecting a lemming that's scampering along a tunnel under the icy tundra leaping into the air it breaks through the snow to catch its prey in Borneo.

Speaker 2

It's remarkable to think that over 400 million years ago, these tiny bones were part of an ancient fish's gill arches. This is the power of evolution. right here in the palm of my hand. No designer was involved in making these bones, which are currently floating in your head, allowing you to hear what I am saying. All that was needed. was life's relentless drive to find food. That's been quite a bit of time.

Speaker 1

Three tiny bones in his hand.

Speaker 2

And time of course keeps ticking.

Speaker 1

From flying dinosaurs to plants, flowering in time lapse footage.

Speaker 2

And mammals, now the cute hearing keep evolving for 10s of millions of years.

Speaker 1

The timeline reaches sixty-six million years ago.

Speaker 2

Until one morning a little mammal picks up a sound it's never heard before. A sound that once again would change everything.

Speaker 1

Dinosaurs in some woodland.

Speaker 2

By the time we get to the Cretaceous period, when T. Rex was on the prowl. Most of those traits that we consider to be typically mammalian are already there. Warm bloodedness, complex teeth in powerful jaws and acute hearing. And that acute hearing meant that mammals had already conquered the night, and it was going to prove to be significant. You see, that classic myth that mammals at this time were living in the shadow of the dinosaurs may not have been like that, contributed to the fact that they could find more food, those jaws could catch it and process it. They were getting more energy, they were able to build bigger bodies. In fact, some scientists think that those early mammals could have been well on the way to standing shoulder to shoulder with those giant reptiles. But of course, as we know, that story was going to be cut short.

Speaker 1

Wing fireball bursts through the clouds, hurtling towards the ground.

Speaker 2

The sound of the mammal heard had its origins thousands of kilometres away. Where an hour or so earlier, a rock 12 kilometres wide had plunged into the Gulf of Mexico.

Speaker 1

Plumes of smoke.

Speaker 2

In a moment, the world.

Speaker 1

Is changed irrevocably fire and ash going skywards.

Speaker 2

The day that asteroid plummeted into the Gulf of Mexico was probably the worst single day for life. those around 4 billion years ago. Because in that one chance moment, life's

progress was stopped dead, quite literally. And millions of years of evolutionary tinkering were wiped out in an instant. And it was such a twist of fate. Had that asteroid impacted just 30 seconds later, the Earth would have spun on its axis. It would have smashed into much deeper water and caused far less devastation. Never know. Those giant reptiles might not have died out. We might have had mammals, but not the mammal fauna that we've got now. There might have been no humans on Earth. Standing here in this. Oil palm plantation. I'll leave you to make of that what you will.

Speaker 1

From above, palm trees planted in straight, tightly packed rose extend out in every direction.

Speaker 2

And whatever happens, life will find a way.

Speaker 1

From wooded hills in the sunshine to snow falling from and skies onto a forest of charred leafless trees.

Speaker 2

Although in the 15 year winter that follows the impact. Three quarters of species are raised from the face of the earth.

Speaker 1

Creatures lying lifeless in the snow.

Speaker 2

A tiny fraction of mammal species endure.

Speaker 1

Sun-died cat, which is the falling flakes, then Chris is walking in the forest of Borneo.

Speaker 2

We know this, of course, because I'm here, because you're here, because all the mammals we currently share our planet with are here. But what do we know about our shared ancient ancestors? Those creatures that survived the storm of all storms, the almost endless night. We think they were small rodent-like animals, not a single species, but a group. group of them and they carried those traits like complex teeth, which would have enabled them to eat a broad diet, everything from rotting vegetation into insects, which would have bounced back quite quickly after that near catastrophy.

They might have also So they could get beneath the ground to avoid all of that climate chaos which was causing so many other species to become extinct.

Speaker 1

A blanket of cloud then rugged. geeks watched in the golden glow of a low sun.

Speaker 2

Just a few hundred thousand years after that apocalyptic day, you start to see the descendants of those surviving mammals in the fossil record.

Speaker 1

From 65 to between 50 and 58 million years ago.

Speaker 2

In a world vacated by dinosaurs, mammals rapidly die.

Speaker 1

Diversified from fifty-four to fifty-two million years ago, including Prottero Hippus.

Speaker 2

Among them, a remarkable new group that would use their our cute mammalian hearing in a truly innovative way. This is a replica fossil of an approximately fifty-two million-year-old creature called Tourists, and you might be able to guess what type of it is. Firstly, look at its fingers here, very long and narrow extended. I'll give you another clue by turning up this way. Yes. Those fingers have transformed into wings. This animal could fly. This is the fossil of a bat. Now there's a lot more we need to learn about the evolution. of bats. There's a big gap between that period when the asteroid hit and this 14 million years later. And the reason for that is that these delicate light little bones don't fossilize terribly well. We don't find many fossil bats. But scientists have X-rayed this skull and they found that inside the ear it has an enlarged cochlea and that alongside the fact that it had oxicles might suggest that this creature could echolocate. What about that? When creatures like this started to echolocate, we're not sure, but perhaps just after they could fly, At the same time, but it's a beautiful specimen. I can't put this like actually steal it.

Speaker 1

He's in silhouette against the moon.

Speaker 2

Fossils are so rare.

Speaker 1

We don't know exactly why bats first evolved powered flight. Night vision footage.

Speaker 2

But combined with echolocation, it's a temptation that pays off. Despite being so energetically demanding, flight allows access to a great untapped box of food in the night sky.

Speaker 1

From swarming back and a golden sunset, the slow ocean footage is one swoops down over calm water to catch a fish in its claws.

Speaker 2

Today, they're one of the most successful Mammalian lineage is on Earth.

Speaker 1

Skies over Mexico teaming with bats.

Speaker 2

With over 1000 species of echolocating bat.

Speaker 1

Then the USA inhabit.

Speaker 2

Continent except Antarctica.

Speaker 1

From bats in flight past lit up skyscrapers in America to Chris watching them in the night sky of Malaysia. His torch beamy loop eliminates bats hanging upside down from the roof of the cave.

Speaker 2

Here in Borneo there are more bats than any other type of mammal. Among them, those wrinkled-lipped bats that rooted in Gomantong caves in their hundreds of thousands, but bats don't. Just live in caves.

Speaker 1

The tree canopy in a forest. You can find the most unexpected of places with his torch checks for bats inside some tall part broken. Bamboo. Then his eye appears at the round end of another broken step as he checks more.

Speaker 2

Oh, yes, look at that. It's a little cluster. of bamboo bats.

Speaker 1

The tiny creatures moving in the torchlight.

Speaker 2

And this is where they like to roost in these hollow stems of bamboo.

Speaker 1

A bat's large ears folded wings Sharp teeth in close up.

Speaker 2

One of the smallest bat species in the world. One of the smallest mammals in the world. They go way up to five grams. It's about the same size as a large bum will be. Look at them all in there. I honestly didn't think we were going to find any.

Speaker 1

The bat's clustered together.

Speaker 2

Any minute now when the. these bats emerge to hunt, they'll be able to fly at speeds of several metres per second, and they're able to do that because they can digest their insect prey in about 30 minutes, quick enough to power their fiery metabolism. that allows them to fly. Then, of course, they've got that extremely acute hearing that can hear frequencies five times higher than I can. That means they can detect their echo location and calls find those tiny insects meters away out there in the darkness. So many ways they are extraordinary organisms. But then, in some ways, they're really quite ordinary, just like they're and that lived half a billion years ago, they're bilaterally symmetric. they've got a head end, a back end, and a through garden running in between, like 99% of all of the animals that live on Earth. And just like all of the vertebrates living on this island, they've inherited jewel from that ancient fish that struggled onto land. Their ears have those just like ours. Both born help. plus completely dependent upon our mothers. And the hormones that make them hungry are the hormones that make me hungry too.

Speaker 1

From the huddled bats in their bamboo stem.

Speaker 2

To eggs on the sea bed from the humblest beginnings millennia by millennia mouthful by mouthful The need to feed transformed life on Earth.

Speaker 1

The codon nested with her young tongue evolution is.

Speaker 2

That time was brutal, but also exquisitely beautiful and echoes of these ancestors live on crispy.

Speaker 1

Watching the bats emerge from the bamboo.

Speaker 2

And not just in the bat.

Speaker 1

A vast expansive forest sway lived in hazy sunshine, then risk amongst the trees.

Speaker 2

Now I share about 92% of my genes with these little bats. So you could say that their evolutionary story is my evolutionary story. is your evolutionary story. And so many of the things that make them extraordinary are the things that make you extraordinary too. And it's not a story that's come to an end. Life goes on. Evolution goes was on. So I want to ponder at this point, what if our species can finally get a grip on all the terrible damage that it's doing to this, our one beautiful home? Just wait. Where might evolution take us all next?

Speaker 1

Bat splitting about above trees.

Speaker 2

Next time, how did the dwarf get so smart?

Speaker 4

Absolutely.

Speaker 3

From the first animals to settle eyes on our world to the land waste ancestors who stepped back into.

Speaker 2

The ocean.

Speaker 3

We shaping their minds, giving the ice to the dolphin, and it's brilliant brain.

Speaker 2

Oh my goodness me, I've just been to dolphin in heaven.

Speaker 1

Evolution, the evidence.

Speaker 2

But first, how do we bring ancient creatures to life?

Speaker 1

Scientists viewing CGI images of the metasprigina.

Speaker 5

It's so cute. I love the mouth.

Speaker 4

Such a weird creature as well, isn't it?

Speaker 2

Throughout Earth's history, animals, have evolved into all manner of weird and wonderful forms how do we know what they looked like when they lived millions of years ago in this episode we met the delightful.

Speaker 4

Looks like he's screaming for his life.

Speaker 2

To paint a picture of this ancient animal, scientists have to start with the evidence.

Speaker 1

2012.

Speaker 2

And in the case of meta beginner, that evidence came in the form of a site unlike any other British Columbia, Canada.

Speaker 6

The is an exceptional presentation site, and That's because there was a big underwater mudslide that swept all the animals away into anoxic waters. And without oxygen in the water, the microbes couldn't decay their bodies.

Speaker 2

Meaning they were perfectly preserved, trapped on the layers of silt, until 500 million years later, their faces saw the light of day once again.

Speaker 5

It's almost like there has been and caught by surprise.

Speaker 2

In entire shoals of just beginner preserved perfectly.

Speaker 6

Most of the fossils we know and familiar with are things with hard parts, things like bones and shells. But the merger shell was exceptionally different in that you get soft body preservation.

Speaker 1

Everything from muscles to cartilage, even in internal organs.

Speaker 4

Metaspring is.

Speaker 1

Is tiny.

Speaker 4

The fact that we were able to get so much detail off of them after so many hundreds of millions of years is mind-boggling.

Speaker 1

Dr. Suresh A. Singh, the Open University.

Speaker 2

With this knowledge, we can begin to reconstruct That's exactly what a spooky look like.

Speaker 1

From fossils to CGI creation of the large mouthed creature. Dr. Emily G. Mitchell University of Cambridge.

Speaker 6

This was an animal with his or girls eyes, even something you might. Call of faith.

Speaker 2

Understand the appearance of an extinct animal isn't the only challenge.

Speaker 4

Fossils don't tend to move and so bringing these animals, these organisms back to life. is actually, it's a massive endeavor.

Speaker 6

The preservation is really, really exceptional. We can see so much of the details of the muscles, we can actually reconstruct how they move and how they swap.

Speaker 2

Looking closer, scientists noticed distinct W-shaped muscle lines in the fossils identical to those found in some modern day fish. Meaning, must have swum in a similar way, swishing its body from side to side.

Speaker 5

I think that the effect of reconstruction is outstanding and is true to how this animal would have moved in the water.

Speaker 2

Thanks to these discoveries, we can bring metaspagina back to her life.

Speaker 5

Metaspagina really did change our understanding of the story of the evolution of life.

Speaker 6

It's incredible to think these simple tiny little forms are the ancestors of such diversity of life.

Speaker 2

Do you want to know how an elephant is related to a clown? discover more in a poster from the Open University on the Tree of Life. To get your free copy, scan and the QR code on screen or ring 0300-303-3460 or visit connect.open. Dot A/C dot UK slash evolution.

Speaker 7

And you can watch the Dolphin episode of Evolution on I play now the Enfield Polter Guy. Are you team skeptic or team believer? This and everything across the BBC is made possible because we're funded by you. Thank you.

## Transcript Episode 4

Speaker 1

BBC, a diver working a motor scooter to fix their way across an expanse of blue ocean.

Speaker 2

These waters are home to an animal exquisitely adapt.

Speaker 1

I'm talking about the doll thing. A skill of speckled dolphins dive and curl around each other that can turn up to the surface where the divers start playing. Some light falls and changing patterns across the smooth features.

Speaker 2

In some ways we couldn't be more different and yet we share so much. my goodness. Like us, these wild animals are highly social, have sophisticated communication work together to solve problems. And there was interested in me as I am in them.

Speaker 1

The day for Chris has looked It is so cute. Come up looking.

Speaker 2

I've never experienced anything like this before. Absolutely magical. Driving this playful curiosity is a giant and complex crime star even larger than ours.

Speaker 1

They splash around him.

Speaker 2

Dolphins. are amongst the most intelligent creatures who've ever lived on Earth.

Speaker 1

Chris walks along a sandy beach.

Speaker 2

What is intelligence? Well, there's a question that's easy to ask. but a lot more difficult to answer. You can see across the animal kingdom there are a range of species that demonstrate intelligence. Some birds species, pigs, bees, even humans. Some of those animals are undeniably more intelligent than others. And here in these waters, the clover is by far are those dolphins. So the question is, how could the dolphin get to become so smart? to answer that question, we must turn back the clock and follow a remarkable type of transformation.

Speaker 1

Dinosaurs in a swamp.

Speaker 2

Back to a time before mammals.

Speaker 1

Prehistoric sea life and the Earth's blue surface.

Speaker 2

Anything could even think.

Speaker 1

A microscopic organism drew a ref pass online night if fish swim alongside the beach.

Speaker 2

Countless lives of two attributed to the story, but a few distant ancestors, each with remarkable lifestyles, left legacy instead of echoed down the generations, gifting the dolphin its brilliant brain.

Speaker 1

A flash of bright white light emanating from two single cells and travelling through a tunnel of leaves and feathers evolution. the Earth and space.

Speaker 2

The story of intelligence begins a very long time ago.

Speaker 1

Light from a bright star Floods across the vertical horizon.

Speaker 2

On a planet devoid of thought, ideas, curiosity.

Speaker 1

Moving back, it built a 3 billion years ago. Choppy waters under a cloudy gray sky.

Speaker 2

No animals live on ancient Earth.

Speaker 1

Drifting pale specks.

Speaker 2

But it is a home. single cells live a simple existence with not a single brain cell between them.

Speaker 1

In animation, a translucent capsule-shaped cell floats and pulses in the darkness.

Speaker 2

But after the Earth's billion years long dark age, Revolution is taking place.

Speaker 1

Sunlight cracks through the clouds and illuminates the underwater cell. All dark particles inside it draw themselves together.

Speaker 2

You see, these cells have evolved the ability to light.

Speaker 1

A dark rain forest crowded in mist Costa Rica. And the twilight Chris is walking through the forest. He's carrying an armful of hollow holes and the white sheet.

Speaker 2

Where those first sows developed the ability to sense the sun. The dark ages of life on Earth came to an end. It was truly a time of enlightenment. If you bear with me, I'm going to show you why it was so important.

Speaker 1

Erecting the white sheet, he switches on some light bars and hangs them so they dangle beside it and sex flutter around.

Speaker 2

Look at that. There's a huge beetle over here. Lots of flies of course. And then moths. Look at that beauty. Stunning thing. Of course they're turning up because moths are famously attracted to light. And the way moths detect the light is similar to the way that some bacteria detect light. And not just contemporary bacteria, the bacteria that were living in those ancient oceans and.

Speaker 1

Moth perched on the sheet.

Speaker 2

Modern animals like moths use a molecule called retinal. changes shape when it's struck by a photon of light, like a switch. This allows cells to sense light, and genetic techniques have feel something extraordinary?

Speaker 1

Sunlight pouring through the floating cell.

Speaker 2

Three billion years ago, those ancient bacteria set light using the sun. same molecule retinal. They did something else that in time would become the foundation of intelligence. They didn't just sense bite. They reacted to the light.

Speaker 1

Wearing a head torch, breast cooked, is a moth onto his finger.

Speaker 2

We think that moths are drawn to the flame, as it were, because they use what light there is at night to typically the moon and the stars to orient and take themselves in their environment. But what this is allowed is the development of a behaviour, a basic instinct. Now we mustn't confuse that instinct with intelligence. These moths haven't been able to think that innate behaviour and not be drawn to this trap. But that instinct fuelled by the ability ability to sense and react to light was a crucial first step on the route to becoming smarter. And for the next step. We need to jump forward through time and a half billion years. Life continues to evolve.

Speaker 1

Falling rain and a mountain range.

Speaker 2

Till we enter a new page of animals.

Speaker 1

Movement inside an egg 550 million years An animation a leaf-like organism pulls its way up from the ocean floor.

Speaker 2

This tiny creature is an ancient ancestor of the dolphin. And it's searching for a place to hide, but not for any predator from the punishing UV rays of the sun.

Speaker 1

Speckled creatures swim past rocks and seagrass to guide it.

Speaker 2

Has two light detecting spots that only sends patches of light and. Dark. So, finding shelter is no easy task.

Speaker 1

Other float by.

Speaker 2

Among this population of shade seeking animals, The dolphin's ancestor has a slight edge. It's inherited a series of mutations, genetic changes. Instead of being flat, it's like detecting spots ever so slightly inwards, becoming little impulse. Now, it's a difference so small it might seem insignificant, but they give it an unexpected advantage.

Speaker 1

The rainforest and daylight. Chris walks over a narrow rope bridge and past the green and black frog on a branch, a sloth in a tree.

Speaker 2

To understand all of this, we need to think a bit about optics is the basic demonstration. Imagine the flat surface of this plate is that flat pigment spot covered with all of those light sensitive cells. Now when it's facing the sun, it's fully lit, it's fully saturated. As it turns away, it's lit, and then it's not, it's in shadow. It's either or light or dark. Things are very different, though, with a dimpled surface. Look at this bowl. Again, if it's facing the light, And then of course it's fully lit, but look what happens as it turns away. Parts of it surface are in shadow, whilst simultaneously parts are lit. Of course, if it turns completely away, then it's in shadow. But this is the critical part. shadow and light at the same time, and this is what gives these early creatures the chance to rudimentary map of their environment using light and shade. For the first time ever, creatures are beginning to see the world. And in simple terms, these little dimples, these little buckets are the first proper eyes.

Speaker 1

He walks on above a dry river band, a leaf-like creature with two indents at the front of its body.

Speaker 2

For the dolphin's ancestor, these simple dimpled eyes. Allow it to sense more than just shades of grey. Instead, it sees the first blurry images.

Speaker 1

And distinct gray ripples.

Speaker 2

Giving it the ability to efficiently find a place to hide from the powerful sun.

Speaker 1

It's in the shadow of a rock while similar creatures swim past.

Speaker 2

I know what you're thinking. You're thinking, How on earth can you know that all of that is true? Particularly when soft body animals with tiny worm-like eyes don't fossilize particularly well. I can tell you that almost all of the Characteristics of those early eyes can still be found in living animals today.

Speaker 1

A segmented red on a fallen log.

Speaker 2

Simple like protecting spots. Exist in some jellyfish and inputs or copper eyes are seen in modern day flatworms and hiding in this forest. is a curious creature with darkness like tiny buckets. This is a fascinating animal. I've always wanted to see. What can it see? Well, looking out here a very crude picture of its environment, but very little detail. So, if I were to take this animal to the opticians, it would be declared legally blind. For the worm that seeks to dampen dark places to shelter, it's basic vision is more than sufficient.

Speaker 1

It has legs and two.

Speaker 2

But over half a billion years ago, dimpled eyes were just the beginning.

Speaker 1

The creature hiding behind a rock.

Speaker 2

Over generations dimples grow deeper. Protective of cells grow over the opening forming a lens which focuses the sun's rays on to a layer of light sensing cells. In a surprisingly short period of evolution, those spots transform into one The most complex biological instrument evolution has ever produced.

Speaker 1

The round black pupil at the centre of an eye, then the sun and a hazy red sky 500 million years ago.

Speaker 2

By the period, sophisticated eyes are everywhere.

Speaker 1

A secret creature with protruding eyes.

Speaker 2

Those that come in pairs.

Speaker 1

A spread in a two camera eyes.

Speaker 2

To bizarre evolution experiments.

Speaker 1

Open Benia 5 compound eyes, a black shape with five red nodules.

Speaker 2

You might be wondering why I'm talking so much about our eyes in the story of intelligence. That's because the senses and vision in particular played a critical role. They change the dynamics of life entirely. If animals can see the world more clearly, then they can also.

Speaker 1

See each other meta spread and swim along the seabed.

Speaker 2

To stay alive now, you need your bits about you.

Speaker 1

Which is that it two pins on a single outstretched arm meta spreading away chased by the larger creature.

Speaker 2

There was a sudden massive increase in the diversity of new life, so much so that we call it the explosion. There were a number of theories as to why this happened. It's likely that many of them come into play, but without ambiguity, one thing is certain the evolution of the eye play a role, but does it open up opportunities for new predator relationships that alone would have driven increase? But it's not just about the eye. Take a look at this fossil. This is an animal. It lived 500 million years ago as related to lobsters and this is a ferocious predator. in the Cambrian period, and these are its eyes. Look at the presentation here, and these are compound eyes, like contemporary insects, and they appear to be beyond stalks. We see that this animal could move its eyes independently of one another, looking in different directions at the same time. This was a massive increase in visual complexity, but how did the animal deal with it? look at this part here. This represents an organ which is very, very, very rarely fossilized. This is the animal was right.

Speaker 1

A photo on a tablet.

Speaker 2

It's thought that the first animals had simple. nervous systems. But it's only when complex eyes come on the scene that fossilized brains. We think these are the nerves passing all of that visual information. to the brain to be analysed. Now, brains have got their own evolutionary history. They didn't just appear overnight, but they got bigger and they got more complex, potentially to deal with all of that visual information. It's a beautiful fossil. Without the evolution of light sensitive cells, we wouldn't have eyes. Without the evolution of eyes, we wouldn't have brains as we know them today.

Speaker 1

The cloud demembrane opens on a reptile's eye, varied eyes on birds and mammals.

Speaker 2

The modern animal kingdom is full of eyes and grains attuned to perceive the world. Whatever way is most useful.

Speaker 1

A chameleon's darting chronicle eye, then two eyes on stalks.

Speaker 2

Compound eyes, the wide field of view to small brains. and eyes, the seal like a camera gather information in the depths and forward-facing eyes help large brains navigate a 3D world.

Speaker 1

A monkey He swings through trees and hangs from a vain.

Speaker 2

But 500 million years ago, animals and their newly evolved brains are just waking up to the world around them.

Speaker 1

Metas Virginia's based by the Five Eyed Opibenia. Time lapse footage of stars were falling in the night sky above an ocean.

Speaker 2

As we leap forward again, the strong officer survival. Waves brain needs to become more complex and more strategic.

Speaker 1

Forked lightning raging waves and a single eye for 125 million years ago.

Speaker 2

Welcome to the Saluian period. Where the hunted have become the hunters.

Speaker 1

An animated fish.

Speaker 2

This fierce looking animal is an early female placoderm.

Speaker 1

It has a large jaw, a dorsal fin on its back and a smaller pointed fin on its hand.

Speaker 2

And you Don't want to mess with her. You see, the prey arms race has turned her into one formidable fish.

Speaker 1

A crescent-shaped body of still water surrounded by hills and rainforest.

Speaker 2

Placoderms dominated the earth's aquatic ecosystems for 60 million years. And I've got a fossil on here. And what a fossil. Look at that. Very, very beautiful. It came from Scotland and it lived 380 million years ago. But look at the degree of preservation. Here you can see all the bones in its vertebrae, the dorsal fin here. This is the head end of course. Here's it. Look at that. Wow. I never got over the fact that I can put my finger on something which lived 380 million. million years ago. But getting back to Placoderm, you're going to say, you know, why is this fossil so important? There are loads of animals that lived and died out. Why is this one such a big deal? Well, these were some of the first animals that had a jaw and a backbone. So if we want to learn more about what we call the jaw vertebrates, and that's me, you, children, your grand, your pets, dolphins, and we've got to learn more. about placoderms. Placoderms of all shapes and sizes have been found on every continent on the earth. Yet all share one An intriguing feature bone plates covering their heads armor to protect the most precious weapon a predatory fish has in it. It's arsenal. It's brain. Predator prey army race had turned these creatures into very veritable little warships. I say little because this is a small one. Some of them grew up to 4 meters in length. Sadly, as we know, no amount of armor can protect us from some things.

Speaker 1

Dark sea water and beneath the surface.

Speaker 2

In the ancient waters, a hidden threat is lurking.

Speaker 1

A placard arm floats motionless, facing out of the shadows at the foot of an under sea rock.

Speaker 2

Despite its armour, this early placoderm has fallen victim to a tiny invader, a virus, one whose impact would ripple through time.

Speaker 1

Floating over leafy tropical trees towards the still water. A steep, densely wooded bank slopes down to the far shore.

Speaker 2

Viruses have always been pulling the strings of life. They're massive. the manipulators silently and ruthlessly invading their hosts to take advantage of them. We know how they work. They break into the host cells, hijack those cells, machinery, and then

themselves. over and over and over again until they burst out in a dangerous explosion of infection, giving us things like COVID, flu, common cold. but not all viruses acting this way. Some break into the cell and then insert their own genetic material into the host's DNA, potentially changing it. Forever. These are called retroviruses. We thought that over 400 million years ago, a retrovirus was in the oceans, infecting the bodies of many species of ancient fish. One of whom may have been this early placard. Luckily for her, however, her immune system kicks into gear and she recovers. But like a Trojan horse, some of the virus Makes it its way in to her egg cells and is passed on to her off.

Speaker 1

Young plucked arms swim out of the shadows after their mother and X-ray of 1 fish over.

Speaker 2

Generations. The hidden viral DNA does something extraordinary. It triggers one of the fishing genes to go into overdrive. During the way, it's nerves develop, causing parts of the brain to turn from gray to an eerily pale. But instead of causing harm. The brain is changed forever.

Speaker 1

The placodorum is dark archive.

Speaker 2

These infections likely happened multiple times in multiple species. Scientists think their effect has been profound.

Speaker 1

Oh my God.

Speaker 2

So Jesus Christ Lizard.

Speaker 1

Small reptile on a log.

Speaker 2

I used to look at drawings and read about these things in my childhood animal encyclopedias. And it's named after the Son of God. Not because it's so much walks on. water as run very fast across the surface. It's also got lightning fast reactions. So how does it manifest all of this speed as it were when it comes down to its nerves? Each of its nerve cells have long fibres called axons. Those axons are wrapped in a fatty sheath of a substance called myelin and it insulates them. And what that means is that

each nerve cell communicate with the other far more quickly. And that happens in its brain and it happens from the nerves that run from its brain to the muscles around its body. It's as if it's got a super fast process. Nerves signals can travel up to 200 times faster in axons insulated with myelin than those with doubt, and therefore we can make the argument that the origin of my was the single most important development when it came to the evolution of the vertebral brain. Now, all we need this little lizard to do is something biblical.

Speaker 1

It springs off the log and runs on its hind legs across the surface of a stream. Chris, which is it splashes its way to the opposite bank and beam music sight is the monkey hummingbird. seal and some hippos.

Speaker 2

Today my island is found throughout the jaw vertebrates. All of these animals have my island. I thank for the far Signals inside their brains.

Speaker 1

A red squirrel leaps over a brook and scientists.

Speaker 2

Have found that nerve insulated with can't be produced without a retroviral DNA, which has been transmitted down the generations from fishes that caught a virus over 400 million years ago. Evolution. You just can't beat it, can you? can, but because it gets better. You see, Marlin didn't just speed things up. It allowed brains to develop more computing power. It allowed brains to evolve to become more compact, more complex, more powerful. It was a life. just got a hardware upgrade. And this was therefore a significant step up in the evolution of intelligence, because for the first time, the vertebrate brain was on the cusp of doing something I think it had never been able to do before. Thinking.

Speaker 1

A sharp toothed placoderm swims towards us. The Earth's rapidly a sunlight flashes past.

Speaker 2

Cost 10s of millions of years. Fast thinking vertebrates dominate the oceans. But for the next chapter in the story of the dolphin, it's a We need to step out onto.

Speaker 1

Land 245 million years ago, a four-legged creature with a rounded snout.

Speaker 2

This strange, hairless, burrowing animal is a cynodont, an ancestral of mammals, including the dolphin. It lives under the ground for good reason. reptiles roam outside.

Speaker 1

The animal shrinks back into the shadows.

Speaker 2

But at some point, it's got to venture out to eat.

Speaker 1

Sun sets over mountains.

Speaker 2

As the day comes to an end, there's an opportunity. But there's just one problem. It's getting dark. Soon, it's vision won't be much use.

Speaker 1

A low sun above the rainforest, Chris walks under palm trees.

Speaker 2

Imagine what it was like for those little cynodonts. Now, I've got a cast of one of these animal skulls here. You can see that little is the appropriate word. This skull is about the same size as a rabbit. So they were small opportunistic hunters. The problem was that when they ventured out particularly in broad daylight, there was a very good chance they could be hunted themselves. There were loads of predators stalking around the Jurassic. But when these little creatures ventured out of their burrows into the night, there were distinct advantages.

Speaker 1

After dark he shines a torch through the forest.

Speaker 2

At night there are fewer predators and reduced competition for food.

Speaker 1

Loth and a tree frog.

Speaker 2

But of course, in the dark, food can be harder to find.

Speaker 1

A snake curls around a branch.

Speaker 2

What they would have experienced. It's just pretty much what I'm experiencing now. Human eyesight isn't brilliant in the dark, but it's not that bad either. So if I close my eyes, now I'm effectively blind. And what happens? Well, I immediately start to Concentrate on my other senses, of course, firstly hearing a bit of bird song, wine of insects, crickets, bit of rustling over there, incoming mosquito. What about smell? That smells good. I can smell all of that decomposing leaf litter. That's what I call forest fruit cake. A really rich, delicious mix. And I'm not bragging, but I like to think that my sense of smell is quite well attuned in nature. I've been sniffing it all of my life. So out here in the dark, I would be fairly confident using my sense of smell to help me navigate. Perhaps you wouldn't be quite confident, and that would have been exactly the same for the sign of the once. Part of their population would have had senses which were more finely achieved. Those would have been the individuals that went out to forage Found food and then made it safely back to their bars.

Speaker 1

I feel the moon in the sky, Chris carried Sonic exploring with his torch.

Speaker 2

Super sensing sign of the fed. better navigating at night. And it's thought this allowed some groups to become nocturnal. And as these synodons senses sharpen to the night, We think a flood of new information being gathered kick-started a monumental transformation in their descendants' brains. Over 10s of millions of years, the brain changes shape, areas involved in smell and touch expand, and the brain increases in by over 40% to process the new information. We see a game changing region develop in the top layers of the brain. gradually expanding lobes and with it a new type of animal. In under 50 million years, those burrowing cynodonts evolved into something a little bit like this.

Speaker 1

The first mammals, rats, rattus nor vegetables.

Speaker 2

Now I know that many of you probably aren't that keen on rats. I love them. I love their little whiskers whisking. way. Those stiffen hairs are rooted in skin, which is packed full of nerves, sending masses of information to its brain. And then you've got its twitching nose, a nose far more sensitive than ours, capable of smelling things like explosives, even human cancers. And it's ears, now come on. Those are the prettiest little ears,

radar dishes, listening out for the rustle of any potential predator. Of course, all of the This extrasensory information needs to be processed. So it was about this time that an area of the brain called the neocortex began to develop more fully. And that was utterly. utterly transformational allow these animals to solve problems, to learn, to develop memories, and with all of that extra sensory processing to map their environment. and plan their next move. The neocortex was an extraordinary mammalian innovation, and that neocortex. is the outer layer of the mammalian brain, sometimes smooth, sometimes wrinkly and folded. It receives and processes complex sensory information. and it links it to other regions of the brain.

Speaker 1

I'm a cat picks up a rock in today's mammals.

Speaker 2

It's essential for learning. Planning, prediction, decision-making, the foundation of what we'd call intelligence. Now, of course, mammals aren't the only intelligent animals. Birds have a structure called the that performs a similar function to the neocortex.

Speaker 1

A bird drops a nut from a tree.

Speaker 2

And octopuses have one centralized brain, 8 mini brains, one.

Speaker 1

Sunlight on an upside down.

Speaker 2

But 200 million years ago, for the mammals, the neocortex helped unlock a more intelligent way of life. And to continue Their story. We need to take another leap through time.

Speaker 1

Shifting mountain ranges with vigilant reflected in an eye and forked lightning.

Speaker 2

It's the mammals to turn to take center stage.

Speaker 1

50 million years ago, a river meandering into a lake.

Speaker 2

By now, those mammals have radiated out and died. Versify across the globe.

Speaker 1

In animation, a four-legged creature walk through long grass and briefly freeze is.

Speaker 2

And it's here that we find one unique group on the ver. of an extraordinary transformation.

Speaker 1

It stops again and twitching its ears with one leg raised.

Speaker 2

This is in go high. The size of a cat with deer like legs and the snout of a dog. Quite frankly, it's a bit of a weird though.

Speaker 1

It's long tail switches.

Speaker 2

Tiptoeing on little hooves, it's on the lookout for lunch.

Speaker 1

A large winged shadow passes over the animal.

Speaker 2

But it's not the only one. This diminutive plant eater is easy picking for predators circling above, but in the higher has an escape plan.

Speaker 1

It stops beside some rippling water, a real set of three toe hooves walk through grass.

Speaker 2

A strategy adopted by another of evolutions on boards.

Speaker 1

Chris approaches the brown for animal which is grazing beside a pond.

Speaker 2

In the higher was a lot smaller and more painty, but I give you The tapir.

Speaker 1

Beard's tapir. It flexes its short trunk.

Speaker 2

What an animal. I absolutely love tapirs. I've liked them since I was a kid. I don't know what it is about them. I think it's because they're weird. But what else have they got in common with indoharvas? Well, they're both herbivores, and as a consequence, They need to be thinking about avoiding carnivores. This beds tapia can be predated by jaguars. So how do they avoid that? Well, one of the things they've done is develop an aquatic lifestyle. And you don't want to be buoyant if you're in the water. And on that account, when they go into the water, they sink to the bottom. They can walk across the bottom of rivers, lakes, and lagoons. And that is the same as Indo. and Ohio had heavy bones.

Speaker 1

The tapir wades through mud and into the murky pool.

Speaker 2

In fact, trying to evade predators on a day-to-day basis was that the of driving one of the most revolutionary transformations in revolution.

Speaker 1

One ear then the other is flat and back against its head which sinks below the surface. Animation show was the prehistoric creatures standing on the river bank.

Speaker 2

For in Ohio and its heavy bones, water is a refuge.

Speaker 1

It's 1 foreleg bent and raised above the surface for plunging it into the shallows.

Speaker 2

And stay away from land. to turn out to be a master stroke.

Speaker 1

It's long tailed red body swims through the water.

Speaker 2

This new world offers up plentiful food and new opportunities. Over generations, their relatives become much more streamlined. Limbs are replaced with paddle-like flippers. My great fur away from their long snouts, tails get flatter and more powerful, and the once hoofed mammals are now How completely aquatic?

Speaker 1

Silhouetted in the light from a low sun. Crest drags a bulky wooden crate along a sandy beach with a rope over his shoulder. Seabirds fly over hand.

Speaker 2

This was one of the most astonishing body transformations in the course of evolutionary history. In just over 10 million years, these tiny through your tiptoeing animals and transformed into sleek, streamlined swimmers. I've got the cast of a skull of one of them from here. This is and it lived. 40 million years ago, and the teeth do all of the talking. Look here, these massive canines for catching and gripping the prey, and then these teeth here for shearing it into tiny pieces. This would have been an impression. impressive animal, but not the biggest. One of its relatives, Basilosaurus, grew into the length of the bust. Those puny cat-like animals had transformed into monsters. Superb. But of course, things didn't stop there. This is a cast of the skull of Simocetus, a distant relative of Duodon, and it lived 32 million years ago. But look at the skull, pretty radically different. It's much shorter or to it's far more structured, complex on top here. was part of a new group of mammals. The Odonto seeds. or two white hills. Look at this depression here. We think an organ called the melon might have sat here. It's a fatty sphere. Sounds produced from the nasal passages are focused through it like a lens. and projected out into the animal's environment. When they bounce back, they're captured by the lower part of which is hollow transferred to the inner ear, which sends the information to the brain. You know what I'm saying here, don't you? Echolocation had evolved. Echolocation. What about that? But we think something out radical might have been happening at the same time. We think that animals like this might have been that the start of a journey from being solitary hunters to hunting together forever. And this social behaviour would have a profound effect on the development of the brain.

Speaker 1

On the beach, then an assortment of skulls.

Speaker 2

As the tooth whales continue to evolve, it's thought that many of them became more and more social. A fossil record shows evidence of their brains getting larger until around 11 million years ago, an iconic family emerged.

Speaker 1

Norris the office of the family Delphinid. Dolphins sleep great mammals leap and dive.

Speaker 2

Today over 40 species. piece of dolphin can be found worldwide from the tiny to the giant.

Speaker 1

Tomerson's Stauffen then Orca.

Speaker 2

They live in groups and have complex social relationships.

Speaker 1

Carmen bottle most often and.

Speaker 2

Some species are amongst the most intelligent. Ancient animals on Earth.

Speaker 1

For dolphins from looking for information, leaving clouds behind them, gliding over a stretch of calm turquoise. Chris swims with the dolphins pulled by his scooter, a pair of small black turbines linked by a handlebar. The dolphins have dark specks on their paper gray undersides.

Speaker 2

This group of Spotted dolphins have spent their whole lives in the Bahamas.

Speaker 1

Atlanta takes spot to dolphin.

Speaker 2

And their social lives govern on their behaviour.

Speaker 1

Surrounded by a port of seven.

Speaker 2

Mothers, cousins, friends, even rivals, all roaming together in the waters they call home.

Speaker 1

More dolphins come rising up from the depths and to the dappled sunlight. Chris glides around them. Bob is on the surface with his goggles pulled back over his forehand.

Speaker 2

I'll just. to spot a dolphin. I can tell you that was absolutely incredible. At one point I was just wrapped in a vortex of spinning dolphins.

Speaker 1

My goodness, that's me. Moving together. There are two dolphins brush the surface and dive back down with rippling motions of their smooth with bodies.

Speaker 2

We know that they all know one another, not just now, but throughout the course of their lives. Memory.

Speaker 1

Air bubbles erupt from a dolphin's blue pole.

Speaker 2

To think that they are down there experiencing emotions like joy. You were feeling joy, was certainly feeling joy, but then we know that we can even experience grief as well.

Speaker 1

A dolphin's small eye near the edge of its long beak-like mouth.

Speaker 2

Constant picking. They take all the time. They're communicating to one another. There's dispute among scientists as the weather. They have a language, but from my point of view at the moment, I'm quite happy to because I would love absolutely love to know what they were all saying to one another. Honestly, so, good.

Speaker 1

He pulled his goggle back down and down again.

Speaker 2

This is the soundtrack of a fire living underwater a society.

Speaker 1

Chris. Floats amongst the pod, a great tinted image of a brain.

Speaker 2

Underpinned by one of the most complex brains on Earth, relative to their bodies. are the biggest of any animal, with key regions thought to be involved in self-awareness, communication, and understanding emotions. And that uniquely mammalian neocortex has become one of the most intricately folded brain surfaces on the planet.

Speaker 1

Dolphins swim away together.

Speaker 2

Brains are amongst the most energy expensive organs to run in the body. But boy are they worth. that cost, because if you put a large complex brain like those dolphins, it gives you the capacity to develop intelligence. And the dolphins use that intelligence to change their behaviour on a day-to-day. They can learn things. They can then copy things from golf in sort of learning things. They've got cultural learning capabilities and this social intelligence is the most important. in the box when it comes to survival. They evolve intelligence in a world which is completely alien into hours. Evolve it on the water. We may never truly know what goes on inside the mind of a dolphin, but it's brain tells a remarkable story. In years of sense of struggle and survival. Bodies transformed.

Speaker 1

A pair of ends grow largely formed on the end of a long tapered tick. The pod of dolphins are silhouetteed by a setting sun.

Speaker 2

Dolphin's minds, like ours for that matter, are remarkable pieces of biology. It's for very good reason that we think of our brains as being the most complex objects in the known universe. They're still surrounded by an aura of mystery, of magic. But here's one thing that we know for certain. Our brains, our minds simply would exist without the power of evolution. That blind journey of change of innovation of exquisite beauty.

Speaker 1

Sunlight reflects it on the incoming.

Speaker 2

Next time, how the horse became one of nature's greatest athletes. Just look at her. She's absolutely gorgeous, aren't you? first steps to racing hearts and limbs built for speed. See them in action. This is a slithering swimming. Quinting Odyssey with one fine twist us.

Speaker 1

People on her respect.

Speaker 2

But first, how do we know? The ancestor. of dolphins once walked on land.

Speaker 1

Dolphins are part of a larger group called which includes dolphins, whales, and porpoises.

Speaker 2

Cetaceans have the largest range in bodies size of any group of mammals on the planet.

Speaker 3

From really small little harbor porpoises that are only a few feet long to the blue whale, the large and everything in between.

Speaker 2

And their origin can be traced back to an ancient city that once stretched between India and Asia. and international scientists have been searching for fossils in India and Pakistan over many years, where they found the remains of an intriguing mammal.

Speaker 4

What I'm holding in my hand here is a real fossil of the skull of the highest. There's four of these in the world. I've got one right here.

Speaker 3

The name Indohyas actually means India's pig.

Speaker 4

From the chemistry of the teeth, we can tell that this animal ate land plants, mostly leaves and flowers and fruits.

Speaker 2

From first appearances, Indohyas Looked like a regular land mammal until a chance event revealed a critical structure hidden deep within its skull.

Speaker 4

I had a foster or beard name was Rick who cleaning this up, he said, I'm very sorry, but I broke part of this in the Ohio and then I noticed that the airborne actually showed that's only present in whales and dolphins.

Speaker 2

Is a region of the earbone that has thickened. In modern day situations, it amplifies vibrations transmitted in the skull, enhancing their ability to hear under water.

Speaker 4

So, that's really the smoking gun that in Ohio is closely related to what has involved.

Speaker 2

Evidence that it was already adapting to a life under water, completing remarkable. story of how land mammals evolved into marines cetaceans. It is one of the best.

Speaker 3

Fossil records we have, so we got a lot of pieces of the puzzle to tell us what happened.

Speaker 2

Other transitional fossils have been found across the region that was once the ancient Tethys.

Speaker 4

We have whales and dolphins that look like crocodiles. We have whales and dolphins that look like seals or otters.

Speaker 1

Lions Dr. Lori Marino.

Speaker 3

It is probably one of the most dramatic transformations in all of the evolution of life. highest was not the kind of animal you would look at and say you're going to get a blue whale out of that you're going to get a brain like a dolphin brain out of that but that's what evolution does it makes Big change is.

Speaker 1

The animal walking through grass and a real dolphin in the sea.

Speaker 2

Do you want to know how an elephant is related to a clown fish? Discover more in a poster from the open universe. on the tree of life. To get your free copy, scan and the QR code on screen or ring 0300 303 3460 or visit it connect.open.ac.uk.uk/evolution.

Speaker 3

Watch the next episode, The Evolution of the Horse on iPlayer now. Every second counts in the hunt for killers, real life cases, the new series of murder 24/7.

Speaker 2

On iPlayer.

Speaker 3

Also there, a new series with Aberdeen detectives, Lindo and Bart, what granite are but now.

## Transcript Episode 5

Speaker 1

And. I'm talking about the stuff of myth. The white horse stroking its neck.

Speaker 2

Just look at her. She's absolutely the horse. to you and I. This is a creature. Beamly shaped to move.

Speaker 1

There may be. Gallop through the shallow water, picking up clouds of white spray from above to churns. As the horses charge through it, the golden light of the.

Speaker 2

Sun mighty muscles at a heart the size of a football. The horse is one of the fastest and most powerful animals on the.

Speaker 1

Planet.

Speaker 2

They don't call it horsepower for nothing. So, how did the horse become? To answer that, we must travel back in time.

Speaker 1

Rapidly winding millions of years.

Speaker 2

To meet the key movers and shakers before who thundered. Back to a time when almost nothing at all moved.

Speaker 1

Flashed with bright white light. Emma from two single cells and traveling through a tunnel of. leaves and feathers. Evolution. The horse. Long lush green grass ripples in the wind.

Speaker 2

And in fact, the story of movement can be traced incredibly right to our own doorstep. This is English landscape. I was standing here just over half a billion years ago, the view would have been very different. In fact, I would have been standing. I would have been sort of emerged deep in the ocean floor. And over millions of years, these rocks of the history of that time, a history written in sand and silt, a history with some fascinating cloaks. the planet, but millions of years of weathering have warped these rocks, making them very hard to stop.

Speaker 1

Now, I did tell you they were tricky to see, but there is one right in front of me here. Just follow the bottom of my fingers. It starts up here, and then the arch is down. You can see the ridges in the rock, particularly visible here, and then it comes up towards my shoulder, and this bit follows right up past my head. These would have been made by fonds, and they would have been attached around the center point. here. This is a fossil of the gate here. And I know it doesn't look like much. It might look like an old cabbage that has been pressed in the rock to you, but it wasn't an old cabbage. It wasn't a plant at all. This is a very, very important fossil. This is a fossil of one of the earliest animals that ever lived on Earth.

Speaker 2

Half a year ago, this flap of rock was found to smoke the very first animals.

Speaker 1

Plants, like creature, is swaying underwater. This is a peaceful life. One of the creatures has front.

Speaker 2

The... They call them to the ground. They must lie on the ocean to bring them what they need. Animal life could remain stuck in this way forever. This is a cast of a fossil that was about 500. which means it formed around the same time. When the scientists first looked at it, they were initially confused. It's quite difficult to see. Look, it starts up here and it runs down here. It's almost as if someone has been grinding their fingertips over some soft mud and they terminate down here. But if you look here, you can see there were a few little half moon shapes. The reason that the scientists They were usually confused as they were probably looking for a fossil of an animal, but this is not that. What it is, a fossil of something an animal left behind. The story goes something like this: In amongst the creatures stuck to the city bed is a tiny animal, a little more than a gelatinous block. Like other animals, you'd eat specks of food that drift on the ocean currents. But today, the current has shifted and is now Carrying the meager colossals just out of reach. Deprived of food, the only option for this stationary population is to sit and wait for their luck and to change, but this animal is a pioneer.

Speaker 1

A tubular creature crowned by a ring of stubborn eats and ticles. You see? This little block can do something the other animals can't. The dark pink animals waves back and forth. The sea floor turning up a small cloud of dirt.

Speaker 2

Abandon the sea of its own and move.

Speaker 1

Its tentacles whip around as it moves. The muscles in its body rippling under its skin.

Speaker 2

Leaves a mark. Some of the earliest animal tracks on the planet.

Speaker 1

Small particles drift through the gloomy water over the creature's uneven tracks. It rocks its body as it crawls further.

Speaker 2

One small step for this tiny BLOB. One giant leap for animal kind.

Speaker 1

Chris is walking through this sun dappled stretch of forest.

Speaker 2

We'll never know exactly when. The first step was taken. We presume that there were some missteps, evolutionary stumbles, if you like. But that leap between being sessile and motile was profound.

Speaker 1

Today, 2 dolphins.

Speaker 2

Our planet is an escape of a dancer of motion. Next to 97% of animals are moving in wild and wonderful ways. and none of this would be possible without one key ingredient.

Speaker 1

A large herd of wild horses gallops towards a carrot. It's a big valley.

Speaker 2

To understand just how powerful muscle can be, we need a demonstration from an expert. I give you I know not everyone's favorite animals, but it won't surprise you to know. What are they? They've got a type of worm and there are about 700 species in the world. Many like this one are parasitic. This is a medicinal leach and it's been used by medical practitioners to suck the blood from being What about its movement? Let's take a look at their body. First thing you will notice is that its body is made-up almost entirely.

Speaker 1

Of muscles, the black beach drags itself across Chris's palm.

Speaker 2

We sometimes call them. Muscle fibers, while an animal like a horse contains millions of them. They work, thanks to their super power, their ability to contract. Now, this muscle cells. muscles which run from one end to the other. So how exactly does it? I'll try and demonstrate that here. Come on.

Speaker 1

In line.

Speaker 2

It stretches forward using those circular muscles and then contracts its longer tunal muscles and pulls itself forward. slowly inch across the palm of my hand and down my fingers. Something that I find quite separative.

Speaker 1

As sunlight shines through the tree is on his hand, Chris watches.

Speaker 2

Today it's easy to take muscles for granted. Half a billion years ago, it was primitive muscle cells that turned contraction into action, allowing.

Speaker 1

To take a deep into the beyond and the importance of.

Speaker 2

This simply can't be under. From this point on, movement will become one of the most powerful driving forces in animal evolution. To reach the next step in the story of the horse, we must take it.

Speaker 1

A river of love, mud, cracking a storm. dense stars moving across the sky over mountains.

Speaker 2

Muscles stretch and shape animal life and more and more time spent.

Speaker 1

The go 520 million years ago in a CG rendering orange fish like creatures glide across the sandy sea floor which is painted in ribbons of. Unlight.

Speaker 2

They say necessity is the mark of intervention. That would certainly be the case for animals experimenting. with early locomotion. Down here, every trip across the sea floor to enhance energy. And to get from A to B, it's thought that the ancestors of the horse had evolved to use muscle in its house in a new way. Incredibly.

Speaker 1

Everyone will see that it can still be seen today.

Speaker 2

Inside, this will have a beautiful animal. And it's to coordinate, which means we're actually related to this. I know it's true. And the benefit of looking at this particular species is that it's transparent.

Speaker 1

I can see inside tube running around its body.

Speaker 2

That tube is filled full of oxygen, minerals and sugar. It gets its blood. That tube is contracted The way the muscle contraction of pushing out blood around the body. Fundamentally, this is a system of whole heart. It's thought that the system looks like this. to enjoy an active lifestyle.

Speaker 1

Cordate Kingdom.

Speaker 2

Just like the best of its kind, nutrient-rich blood is being pumped through its body, its muscles with energy. Now, most of these creatures would spending their energy just wiggling along the city bed. The ancestral of the horse seems to have had an extra boost. Me.

Speaker 1

What creatures?

Speaker 2

It can grow harder, better, faster.

Speaker 1

The creature which hasn't. Long, translucent and running along its back, and another swims just below the water surface, thin beams of sunlight washed across its orange and gold body as it rubbed through the blue water.

Speaker 2

Its remarkable athletic ability is thanks to an innovative use of muscle. That I unlocked the full potential of that park.

Speaker 1

This is walk along a sun soaked rocky coastline.

Speaker 2

Any muscle to control, it requires a stimulus and all that comes in the form of a tardy electric disaster. Took charge and started to extend out of rhythmic zaps and all of the surrounding muscles. by contracting and generating a single, powerful pulse. Now, these mutants have scales of all animals have. We have a single And as soon as those ancient pacemakers began to pulse, they instigated. In the ancestor of the horse, those specialized by makers have now clustered together in the localized region, giving it hard. and over many generations, the beat gets stronger. The muscles around the make us. Directing flow around the body becoming an iconic life sustaining organ. One that transformed animal locomotion. to a more complex mechanism. It led to a step challenge in the evolution of the world. It allowed animals to become bigger, stronger, faster. It allowed them to get off that sea bed into the world of bark. From that point on, life could have come... walking, running, jumping, climbing, and the future. Dirty across the globe. are pumping oxygen through all sorts of bodies. Around 2 1/2 billion heartbeats will supply your muscles with the energy they need. From your first breath, it's a rhythm that connects us all. First. Years ago. To take a leap forward. To those early swimmers, the bigger, stronger, and faster... This is an ocean of. powerful bodies but here it's not how many masters you've got that counts it's how you use them Now, there are many forces shaping evolution. The need to find food, the need to find mates. But there are even greater forces that apply. because forces which shape the entire universe. I'm talking about the laws of physics. When it comes to locomotion, harnessing these would be key. And fish can achieve that with a remarkable innovation. Something that's startling in its simplicity, but significant in its importance. That's

helped me finish the success story of our oceans. Attached exterior blind bodies. Structures of flesh, cartilage and bone have evolved. It can be. I'm talking. And certainly, I couldn't make it to be a million years ago. The answer to the horse was a fish with fins like this. You can see the fin here. Look at the base, strong bones which anchor it to the body, and they would have been covered with powerful muscles. And it's this store or lobe which gives this group of fishes their name. We call them the low fishes. Now, I've got to be honest with you, in the open ocean, this setup probably didn't confirm them, which might have a competitive advantage, but under certain circumstances, It proved to be unrequitable by goodness.

Speaker 1

A duckfish with a rounded snout and a thick paddle-like fin on each side of his sport to be a.

Speaker 2

Predator as big as a crocodile. Its size should be an advantage, making on its codecs a formidable fire. But when it's as quick, the water around it is churned up. Giving the game away.

Speaker 1

Ripples rise through the ocean.

Speaker 2

So how does this ocean giant catch its dinner?

Speaker 1

The shadow at the surface. Sitting in a rolling boat.

Speaker 2

The answer lies in those low fins. Inside there is a tool that's just begging to be used. A tool with enormous potential. I'm talking about.

Speaker 1

He shifts one more than the other into the water.

Speaker 2

You see, the relatively small distance travelled by my hand and arm here is magnified out there. which is moving far further. When it comes to movement. Muscles are fantastic, but they do have their limitations. The lever is life's great multiplier.

Speaker 1

A small shape from the dark water.

Speaker 2

Look, my arms in the boat allows me to how the boat forward. Not exactly with Olympic prowess, I have to confess, but with a degree of efficiency.

Speaker 1

Arose on in unison and pulling them back.

Speaker 2

I thought this principle. Help this hulking fish to move with incredible delicacy by doing something very unfish like.

Speaker 1

It's lower the sea bed.

Speaker 2

Using four of its loaded fins, with the physics of the deepers, only turns minimum effort to maximum movement and propels itself stealth. across the sea floor.

Speaker 1

Brush the bottom, lift off again, pushing it along in a slow gliding motion with its tail.

Speaker 2

Swimming for walking. It's safe. It's energy.

Speaker 1

Fish moving past is suddenly snapped up.

Speaker 2

Thanks to its four low fins. Onicodus is a master of the ambush.

Speaker 1

It's off in a cloud of dust.

Speaker 2

So with skills like these you could expect there to be plenty of low fin fish in the sea but today they have almost entirely vanished from our waters.

Speaker 1

Chris rose his boat to a sandy shore.

Speaker 2

That was a bit of a good workout. Now, look, levers are very useful in water, but they could become even more body useful for some type of house. When fish like onnicodus begin to use to walk rather than swim, they set off a chain reaction.

Speaker 1

Small bones making up the limb over millions of.

Speaker 2

The muscles surrounding them shift and alter. No longer fins at all. And today there were more. More than 30,000 species inhabiting every continent.

Speaker 1

Flamingos, young mountain goat, and a penguin.

Speaker 2

A diverse supergroup. Old sentence of those fins and now putting them to use in very difficult words, including the horse.

Speaker 1

A what? Horses trotting in slow motion across a field.

Speaker 2

For many to detect pods today living on land is second nature for their ancestors crawling out of the sea. It was a very different story. Moving from one ecosystem to another, which is completely different, requires a pretty slow process to add that. But the creatures that were making that transition looked a little bit like this.

Speaker 1

A green and black amphibian.

Speaker 2

Oh yes. Look at that. That's special. One of nature's jewels. Absolutely beautiful. This is a marvel. You can see how it got its name with that marbling running down its back there. It's an amphibia. It spends its spring in ponds going through its breeding cycle. And then at the end of summer, it emerges onto land. the rest of the year. But of course, it's gone through millions of years of evolution, which are now to exploit the best of both worlds, the West and the dry.

Speaker 1

But what about this movement?

Speaker 2

What about on that?

Speaker 1

Let's give it a go. He sets on the ground, the new starts crawling, pauses for a moment and carries on.

Speaker 2

They're tentative, they're slow, they're look gorgeous, they're calculated, they're little bodies, but they're getting some exercise as they take a while to the environment. I've never seen a new galloping or spot looking, I'm never going to. But this does tell us something very important. Movement on the land is hard, very hard.

Speaker 1

Onto a wet rock submerged in the stream.

Speaker 2

Get away with having four left feet because in a pinch it can. to a habitat that it finds easier to negotiate. First down, mossy rock, 350 million years ago. If the ancestors of the horse were to pursue a life solely on solid ground, they would need to be far more coordinated. And the answer to their coordination conundrum came once again with an evolutionary innovation from the ever adaptable muscle. Inside almost every muscle in my body, I have something called a stretch sensor and stretch are highly specialised muscle fibres that are constantly monitoring how and when those muscles are moving. The key thing is that they are all linked together in a complex web. So each individual master knows exactly when every other master is. Now, despite the fact that this is an incredibly complicated system, I bet that you've never even thought about it, and that's because You don't have to, despite the fact that it was crucial that every single.

Speaker 1

Move that we make. In a forest, Chris jumps off a tree stump, then steps over the tumble down remains of dry stone and warm water.

Speaker 2

Tiny stretch sensors allow the microsource to communicate with the central nervous system, giving us and most of the giving tetrapods the ability to with the astonishing precision. Often faster than you can think.

Speaker 1

He spits down in a clearing and spins a zoetry. The spinning trant shows an image of a cat and drink a horse. in a cylinder.

Speaker 2

Just look at the legs there. Part of them is moving independently in our isolation at the same time.

Speaker 1

And then the weight, that's got to be balanced. between all four feet.

Speaker 2

And running down those legs, I'm just going to speed it up.

Speaker 1

That are ripples of muscles.

Speaker 2

That's the glutes, that's the quads, that's the hamstrings. in unison.

Speaker 1

What's the animation?

Speaker 2

Without these stretch sensors hiding in muscles and the complex network that joins them all together, animals with bodies like this. not able to evolve.

Speaker 1

The horses then break down.

Speaker 2

It was down to this innovation that animal bodies could become radically more coordinated than those whose tiny little bones hidden in Those fishes fins could really come into their own. Those animals could put one foot in front of the other with the extreme prostitution. And this was a game changer.

Speaker 1

There's a script showing the animal mated horses. It was time for us to move.

Speaker 2

Over the next 300 million years, the tetrapods scattered across the Earth.

Speaker 1

And dinosaurs in England and an asteroid in space.

Speaker 2

It was never fully.

Speaker 1

Into a new fifty-six million years ago, the way you move can be a matter of life. A mammal with a sloping head.

Speaker 2

This is for.

Speaker 1

Small, twitching idiot is a great.

Speaker 2

I think it looks pretty serene, but for must constantly be on guard because.

Speaker 1

This world is full of expert movers. Hearts straining muscles will only take you so far.

Speaker 2

Faced with a situation. To the survival. Come on, City.

Speaker 1

Come on.

Speaker 2

Do you know how sometimes people say why poodles? Why the poodles, they say? I think the seriously reply are the other breeds of dogs. I mean, look at them. Boundless energy, incredibly loyal. And they can also help us with an important part of our story. You see, here is the need This curly fur here is a crucial step change in evolution. Now, I don't need to tell you about my foot and leg. You've got to start off at the toe, goes across the foot to the ankle, and you've got the shin in the knee. We put our feet down onto the ground. We plant them flat on the ground like that. We're what we call plant degrade animals. It's quite an efficient way of walking. Nancy on the other hand, is altogether different. Take a look at her back leg here. You see her toes stretch from here to here. The rest of her foot bones all the way up to here, which looks like a backward pointing knee.

Speaker 1

This is in fact her.

Speaker 2

Her ankle, her knee is all the way up here. So Nancy is effectively standing up on her toe bone. She's a digital grade animal and that's all together a bit different. It means you can move, doesn't it? Show them.

Speaker 3

Come on, let's go.

Speaker 2

Come on.

Speaker 1

He walks off the two poodles behind him along the path, which is at the top of it. Right, good.

Speaker 2

This change in anatomy allows the leg to become longer, the stride to become longer, and more efficient use of all of that elastic energy stored in the muscles and tendons above. Look at that cat, bouncing about. Alacrity, agility, critically, speed. That is a happy poodle. And this adaptation has occurred a number of times in terrestrial animals.

Speaker 1

But having said that, if you.

Speaker 2

Really want to be a creature living life in a fast lane, evolution can offer you one more. Come on. When it comes to speed and efficiency, plant to grade, that's us, will get you from A to B. Digital grade. 56 million years ago was on the verge of something new, not just bouncing. pushing off from the very tips.

Speaker 1

Future generations take the concept and run with it.

Speaker 2

Expose elongate. Let's spend more and more time until the process find the most. Large, powerful shock absorber.

Speaker 1

Is outwards at the end.

Speaker 2

Look at this. is clearly a cast. of a fossil of a hoof. A hoof at the end of a very long leg. A leg that's clearly all about movement. A leg though that is surprisingly different than ours. You see a eventually it's foot all the way from here to here. This is the equivalent of our ankle. The bone here will be like those in the sole of our foot and down here it's balancing on a single tiptoe. roof itself would have been made of just like our fingernail. And also what's interesting is the other legs wouldn't attach the skeleton. They were embedded in a heavy mass of powerful muscle. And this gave it the capacity for a greater stride. You see this groove here, running down here, would have been a tendon, perhaps half a meter long, giant elastic band. But it is a leg. with compromises. I mean, you can't pick anything up with the hoop. You can't manipulate anything. It's lost all dexterity at the expense of speed. This 3 million year old hoof tells us of the arrival of a new group of animals. Animals we call.

Speaker 1

He stands in the sunset, holding the leg. The hills below him, trenches of chalk make up the giant outline of the.

Speaker 2

These single-hooved mammals first evolved on the plains of North America. Before spreading across the globe, among them is 1 remarkable species. No. It's probably shaped generation after generation by the evolutionary. . But there's one final twist in the story of the horse, because Equus Ferocus was about the character and the evolution.

Speaker 1

A white horse wades over to a muddy shore where Christmas is standing.

Speaker 2

Another species on an evolutionary journey of its. Opposable thumbs and an over inflated stems of self worth.

Speaker 1

Long rods leader heard of white horses?

Speaker 2

4000 years ago that us inhabit. much of the planet. We had cities, states, and agriculture, empires were beginning to grow, and in Europe and Asia, we begin to see evidence of a growing relationship between horses and humans. Now, no one is exactly sure how the first horse Maybe someone caught one of those captivity of its shelter, food, cared for, loved it, and tried to need it. What we do know is that in a pretty short

time, we took these strong efficient, powerful animals and turn them into our perfect companion audience. And we didn't just tagging them over generation after generation, we bred them. Choosing those characteristics which favour the we wanted horses to be. So, in the end, we took the wild horse and we turned it into the wild horse.

Speaker 1

A horse can position circles around a fence door. Pacing with it goes past.

Speaker 2

We chose the strongest. We chose the most powerful. also chose the friendliest, the most amenable race is what better or for worse. Over the generations, the horse was the modern horse were pretty wild bunch, not only in terms of but also with their genetic makeup. About 4,000 years ago, we see two G variants appear. One of those appears to make them less aggressive, more manageable. And the other, which appears to give them a stronger back, making them easier to ride. Now, what's interesting is that within this place of just a few 100 years, we spread those gene variants throughout the population. The wild horse was effectively gone. We had one species selected by humans. Yes, I know. It wasn't my fault. I wasn't around.

Speaker 1

A horse is licking his hand, and the horse goes by.

Speaker 2

When you know Equus Ferrous Cabal. we've travelled to every corner of the globe, side by side, and side by side.

Speaker 1

Chris walks through the...

Speaker 2

We often think of evolution as a battle between species, a game of winners and losers, a game of survival of the theatres. But very occasionally, species come together and there was great to the next sum of their parts. Now, there's no doubt we've played a hugely instrumental role in the evolution of the horse, but then the horse has had an impact on the past too, because without help this remarkable animal. As our greatest partner, we simply wouldn't be the speed we are today.

Speaker 1

What is the evolution journey?

Speaker 2

It's just one threat. an extraordinary tapestry that weaves together every animal, in fact, every living thing on our planet. It's They can fall billion to get here, but has life come from the south the began it all. to sex, to competition, to predation, and protection.

Speaker 1

And make the very past his daughter animals.

Speaker 2

For the oceans to land, and for some.

Speaker 1

A dolphin and a calf on the sky.

Speaker 2

There was a change of the word. To love. Complate. Begin to understand our own origin.

Speaker 1

Astronauts in space and deep sea divers.

Speaker 2

A journey of knowledge that we're still on today. Mistaken idea that we humans are the be-all and all of the evolution, that everything we've explored, everything we've shown you in this series was just about making the perfect. the power of life on Earth. But it's simply not true. We're not perfect. We weren't made. We've been shaped by exactly the same forces. They've shaped every organism that's ever Lived on this planet, and through a startling fight, we are now having a profound effect on evolution, dramatic, rapid, and scary because of what we're doing to our environment and because we're driving a massive extinction event. Now, evolution does feast on extinction. It loves the opportunities. So, whatever we do now, life will be beautiful, life will be wonderful. In terms, what about us? Could we become shorter or short sighted? Might we become smarter? I don't think it matters about anatomy. at this point. I think what matters is how we think, imagine and create our way out of our situation.

Speaker 1

I think that what needs to be driving.

Speaker 2

It's hope.

Speaker 1

Grace walks away from the dark sunlight in a cloudy pink sky. rising over the flat dotted with bushes and stretching into the back lagoon.

Speaker 2

How did we bring the story of evolution to life?

Speaker 1

The evidence.

Speaker 2

The way that one animal over millions of years can transform into something Radically different. It was a mystery that took time.

Speaker 3

We have to talk about the story from start to finish. However, with evolution and fossils, some of those pages.

Speaker 2

In 2004, paleontologists in the Canadian Arctic discovered a groundbreaking fossil.

Speaker 3

So, this is a cast of tectalic. Tectalic lived about 375 million years ago, and it's got the scales very much like modern day fish have today. And what's quite unusual is that it actually has a neck. These phones around there are collar shoulder. It looks like a cross between a fish and an amphibian, and that's because that's exactly what.

Speaker 4

Tiktok was really this kind of unique and evolutionary time at this key. moment for the water to land transition.

Speaker 3

So it's a perfect example of a transitional fossil.

Speaker 4

Transitional fossils are incredibly rare. They play the really important role of filling those gaps, filling tweaked morphologies that we but we don't really know exactly what they might have looked like.

Speaker 2

Transitional fossils represent just one out of millions, possibly billions of individuals that over generations contribute Coming up with the way to illustrate this posed a huge challenge to the visual effects team behind the series.

Speaker 3

Evolution does not move in a straight line because it is purely opportunistic. and slightly haphazard.

Speaker 4

It's tinkering, it's messing with what's already there rather than kind of always necessary.

Speaker 3

It's all about great grand experiment and just see what happens.

Speaker 2

The team spent thousands of hours, crafting and animating computer-generated models to bring animals back to life. To illustrate the randomness and variations seen as life evolves, they need it to After consulting scientists to accurately model the key evolutionary changes, they used to create hundreds of variations representing countless generations. and by hand selecting and merging the best results with their original animations, they were able to condense millions of years of evolution inside into a matter. of seconds.

Speaker 3

In reality, this would take millions of years.

Speaker 4

This is a fantastic way to illustrate the evolution of form. This is how I imagine it playing out in my head.

Speaker 1

Animated but stretching and shifting their crawling lizard and floating cell divide into two.

Speaker 2

This has been over 4 billion years in the making. That's so simple beginning endless forms most beautiful and most wonderful.

Speaker 4

One of the big key life lessons that I've learned from studying evolution is that change is constant and change is the norms. So things have always changed and will always continue to change and life will always continue to adapt.

Speaker 3

That's how it's always been, and there's no reason to believe that's not how it's going to continue to be.

Speaker 1

The middle toe of a skeletal foot grows and horses gallop through the shadows of the marsh under a pink skull. yeah.

Speaker 2

Do you want to know how an elephant is related to a clownfish? Discover more in a poster from the OP University on the Tree of Life to get your free copy scan QR. code on the screen or ring 0300 3033460 or visit connect.open.ac.uk/evolution. You thought long summer evenings were for chilling.

Speaker 4

Well, they are this kind of chilling new uncanny summer specials on sales, and our favorite Jersey detective is back, but not as we know him, the new Jim Bergerac.

Speaker 1

On iPlayer.