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Clip from Episode 2: Origins of Life Transcript

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Mysteries of the Origins of Life

Michael Gillings: So, this is another mystery. People have various ideas, all the way back to Darwin. So, Darwin was the first person to really think about this, and he thought about a tidal pool. Because on the early Earth, you have oceans, you also have tides, because the Moon is going around, you have rock pools. And the thing about rock pools is that they are exposed, and then they evaporate. And what that does it concentrates chemicals, and when chemicals are more concentrated, more complex things are likely.

David Christian: So, this like salt pans, where you where the evaporation concentrates the source?

Michael Gillings: Yes, yes, and if you go down to the beach and look on a rock platform, you'll see salt crystals around the outside of the rock pool. Now, of course, the ocean wasn't salty, at this point in time. But the same thing would have happened with the early organic molecules. They concentrate and concentrate and concentrate. So that's, that’s one place that might have happened. So, the other place that is gaining more popularity as a site for the origin of cells and replicating cells is the deep ocean. And the reason for this is where you're really deep in the ocean, the crust is quite thin, the solid crust and underneath is magma. Sea water…

David Christian: Magma is kind of like lava.

Michael Gillings: Lava, yeah, yeah, yeah. So, sea water percolates, goes in through the crust and gets heated up by the magma, by the really hot, molten rock, and on its way back out, it dissolves all sorts of minerals out of the crust, iron, manganese, sulfur, all of those kinds of things. And then it comes out from the base of the ocean as a little volcano, a little what's called a black smoker. It's called a black smoker because when the super-heated water full of sulfur hits the cold ocean water, the sulfur comes out of solution, and it goes black or gray. The reason why people think that that is a possible location for the origin of life is because the deep ocean is likely to be stable. It's got a heat source, but it's away from the ultraviolet light of the Sun. Ultraviolet light is bad for complex

David Christian: And there was a lot more ultraviolet life in the early planet, wasn't there, because there was no ozone layer.

Michael Gillings: No ozone layer. Yeah, yeah. The other thing is that there's a constant supply of iron and manganese and sulfur, which early organisms, early life forms, could use as a source of energy. They could convert those atoms and generate chemical energy, and that's how they grew. And in fact, there's still a whole range of organisms that still do that to the present day, including organisms that live around black smokers in the modern world.

David Christian: So, they eat iron, or they eat…

Michael Gillings: They eat iron, they eat sulfur, some of them eat hydrogen sulfide, which is rotten, rotten eggs.

David Christian: Yeah, wonderful.

Michael Gillings: And the waste product from that is sulfuric acid. So that is also a possibility, and particularly because in the history of the early Earth, up until about 3.9 billion years, there's lots of meteorites still smash it, because the Solar System is still settling down, and lots of meteorites are still smashing into the planet. And if you're on the surface and a meteorite lands, that's going to extinguish any early life forms, and it's going to basically fry all of the organic compounds, although those meteorites might have been bringing organic compounds as well. So, we know that as soon as what's called the heavy bombardment, which is where all these meteorites are smashing into the planet, as soon as that finishes, you've got the first isotopic evidence of life. And that means that there are kinds of atoms that you can say, hey, that must have come from a living thing. We don't have any fossils or any direct evidence of living things, but we've got a kind of a chemical signature of life almost straight away. So, it's possible that what is happening is that life originates very, very early in the deep ocean, and it keeps getting kind of almost extinguished, and restarts and almost extinguished, and restarts.

David Christian: So, instead of talking about the origin of life, what we're really talking about is lots and lots of experiments in which, in which things that we might want to call life under our fuzzy definition, appeared and then vanished and appeared and vanished, until the finally, one of those things, survived, and it reproduced, and its generation survived.

Michael Gillings: Okay, so that thing that survived to give rise to all of the life on our planet today is called LUCA. That is the last universal common ancestor.

David Christian: Right, I meant to ask about LUCA, yeah.

Michael Gillings: We know what that was because we can reconstruct it based on this one cell gave rise to all the living things on the planet today. And so, what we can do, we can say, well, what do all of the living things on the planet today have in common? They all have a few genes in common…

David Christian: Genes in common.

Michael Gillings: …and a few structures in common.

David Christian: And LUCA must have had those, too.

Michael Gillings: And so, LUCA has those. And those are it's a small, spherical body, a cell. It's what's called anaerobic, because there's no oxygen in the atmosphere. So, it survives without oxygen. It's got a DNA genome, so it's got a DNA that has a number of genes, and there's genes in there for DNA replication and metabolism. It probably survived by scavenging organic molecules that were still being created and were still in the early ocean, so it's a cell, and it's gathering sugars and amino acids and things from its local environment.

David Christian: So, it's eating unsuccessful experiments with life.

Michael Gillings: Yes, yes, yes, right now that's the organism, or the cell, that gave rise to everything that we know about today, but when LUCA was around, as you just said a moment ago, there were probably lots of other experiments in life that were coexisting with LUCA. It's just LUCA won out in the end, and we're still not sure that. To me, that's one of the most interesting unanswered questions is, what other kinds of living things might there have been.

David Christian: Fascinating

Michael Gillings: Because it's quite possible for those, because LUCA is dated at, I think it's maybe 3.4/3.5 [billion years ago] so you've got 400 million years there, between 3.9 and 3.5 billion years ago. There's 400 million years of things that could have been replicating doing all of the things that we mentioned at the beginning of this podcast that qualify as life but have not survived to the present day, much like you know, 99.9% of all of the living things that we know about on the planet are now extinct. These early life forms are now extinct as well.