Hi this is Steve Nerlich from Cheap Astronomy www.cheapastro.com and this is *Panspermia or not.*

OK, I should start by declaring myself to be a panspermia skeptic. I just can't see the point of it. Which is to say - I can accept the possibility that maybe life originated elsewhere and was somehow transported to Earth - but a) this just moves the problem of the origin of life to another location and b) it seems close to impossible to transport intact any biological material we are familiar with across the vast distances of space over the vast stretches of time that would be required.

So weighing up the odds of life occurring spontaneously on Earth versus panspermia - I'd put my money on life occurring spontaneously on Earth as the more likely scenario - but I will happily pay up if I'm wrong. After all, it is quite possible that we will be able to answer this question one way or the other in the not too distant future.

But anyway, let's do the podcast. If panspermia works at all, this is how it might work. A meteor impact on the surface of a life-bearing planet throws up debris - a tiny proportion of which achieves escape velocity. From this point, there’s much more likelihood of a tiny dust grain leaving the stellar system as opposed to a large rocky object. This is because the dust grain is small enough to be propelled by radiation pressure alone - while a reasonably massive object is only going to get flung out of that stellar system's through a sequence of statistically improbable gravitational interactions.

But a dust grain offers no protection for any biological material clinging to it. As well as the danger of stellar radiation - you also get the damaging effect of cosmic rays, which are a combination of stellar wind and other high energy particles originating from outside the stellar system.

An alternative to the tiny dust grain scenario is to imagine some kind of biological material, lying beneath the surface of a more substantial object like an asteroid. Staistically, it 's much less likely that such an object will get flung out of an alien stellar system But, even if it is just a one-in-a-million chance that biological material, buried within the asteroid, would be protected from stellar radiation and from cosmic rays, increasing its likelihood of being able to be transported to a distant destination. However, travellling between planets or even starsmeans that asteroid is is going to get extremely cold, which seems a significant problem for any life forms depending on liquid water.

Of course, the universe may be full of life forms that don’t need liquid water and that may also be highly resilient to radiation and cosmic rays. But, the whole idea of panspermia, is to offer an explanation for the origin of life on Earth. So once again we're back to the point that it seems far more likely that life as we know it arose within the liquid water environment that was already here on Earth - protected by a radiation and cosmic ray shield created by the atmosphere and the magnetospehere.

So, really the only reason you might have to appeal to panspermia as the origin of life on Earth is if you argue there just wasn't enough time for it to happen on Earth - because it did have to happen somewhere.

For Earth, the potential timeframe for life to spontaneously arise is from the point when a relatively stable and non-molten environment was established - which is thought to be around 4.3 billion years ago up until the time of the first evidence of life seen on Earth, which is about 3.8 billion years ago. So that's maybe half a billion years – which seems like a lot.

There is a perhaps spurious argument - based on the concept of information theory - where it has been calculated that even over half a billion years, the random molecular interactions of a population of organic molecules can still only generate 194 bits of information - while your typical virus genome carries 120,000 bits of information - and the genome of an E coli bacteria carries about 6 million bits of information.

A counter argument to that line of thinking is that replication in a competitive environment with limited raw materials will always favor those chemical entities that are most efficient at replication - and this continues to be the case generation after generation – which means there is point at which you can longer consider that you are just dealing with an environment of random molecular interactions.

When we are trying to imagine what that first chemical or molecule capable of replicating was – it's worth thinking about viruses. Apparently many viruses contain genes for ~~viral~~ some proteins that are not found in any cellular organism – even though the viruses are entirely dependent on those cellular organisms to make these proteins for them. So this could mean that viruses were around before anything else was, since we can't find any other biological source of these specific viral proteins.

Nonetheless, this still leaves you with the problem of whether the chicken or the egg came first, since the viruses cannot make proteins themselves. Ribosomal RNA represents the fundamental mechanism underlying protein synthesis. After all, the gene for Ribosomal RNA is present in every cellular organism on the planet.

So - perhaps there was a pre-cellular ecosystem dominated by ribosomal RNA and viruses – and whether you would call either of these entities alive becomes a fairly heavy philosophical question.

Anyway, all of this leads to another way of looking at panspermia. Since it does seem extremely unlikely that anything could survive an unshielded passage between star systems - well maybe those things did die, but they still brought with them an information template, that then informed the production of new life on Earth. And so people say, maybe what we should be thinking about is necropanspermia.

And again, sure it's possible – but is it more likely than life just spontaneously arising on Earth? I mean if a dead virus crash-lands on Venus, it's going to be toast - or if you like even more dead than it already was. So if Earth 4.3 billion years ago was at a state of being ripe for a seed to kick start the whole life process - is it really more likely that that seed was a dead interstellar virus rather than just a random juxtaposition of a few nucleotides and amino acids that we know were already present on the planet.

Either way, what's really special about life on Earth now is that you get things like Conan the bacterium. Conan, also known as Deinococcus *radiodurans* - is not only an extremophile bacterium - but a polyextremophile bacterium - able to endure extremes of cold, dehydration, vacuum, acid - and of course radiation.

Hit Deinococcus with a dose of 5,000 Grays - which are units of ionizing radiation - and nothing happens. A chest X-ray or an Apollo mission exposes you to about 1 milligray. A dose of 5,000 Grays can introduce several hundred double strand breaks into an average organism's DNA - which will kill a human outright.

Deinococcus manages what it does through sustaining multiple copies of its DNA and can rapidly isolate and repair any breaks. As a demonstration of its nucleotidal fortitude, in 2003 a research team translated the song *It's a Small World After All* into a series of DNA segments 150 base pairs long, inserted these into Deinococcus' genome, and they were able to retrieve that information without any errors 100 bacterial generations later.

And rather than Deinococcus being some kind of circumstantial evidence that life could have evolved somewhere else and was transported to Earth - I prefer to think that Deinococcus is an indication that life on Earth just kicks ass - and is ready to start populating the cosmos - perhaps with a little technological assistance from us humans.

Thanks for listening. This is Steve Nerlich from Cheap Astronomy, www.cheapastro.com. Cheap Astronomy offers an educational website for information-philes with extreme tendencies. No ads, no profit, just good science. Bye.