What is the origin of life on earth?

The question of “where did we come from” is one of the oldest and hardest to solve. It has been a source of argument from before the formal science has existed. With the current advances in science it is possible to actually posit reasonable answers. There are two competing theories about the way life formed, this report aims to make the argument for the Deep Sea Hydrothermal Vent Theory as the origin of life on earth.

One of the fundamental requirements for life in the form that exists on earth is a proton gradient, any possible origin for life must have one. The way life processes energy is to add charge to an ADP molecule, turning it into an ATP molecule. This molecule can then give off that charge in an other location to do some work. This energy is required for building the proteins that form the basis of all life, without which life could not form. The charging of ADP into ATP starts with the conversion of glucose into pyruvate ions. This creates a spontaneous flow of electrons. These electrons are what drives a proton pump which moves protons across a membrane to great a proton gradient. When the protons are allowed to flow back through the membrane they power a complex protein called ATP synthase which slams a proton into an ADP molecule turning it into an ATP molecule. This process cannot occur without a the proton gradient created by the proton pump.

Life requires a proton gradient to process energy, so any theory about the origin of life must include the creation of a proton gradient. The way life creates proton gradients, described above, uses complex structures, these are far too intricate to form naturally (at least under our current understanding). The way these are built requires the use of energy brought by ATP molecules. So complex proteins are required for the creation of a proton gradient, but a proton gradient is required to create complex proteins. This means that the origin of life must occur where this paradox is broken. Either complex proteins need to form naturally somewhere or a proton gradient must occur naturally. The ATP synthase structure is incredibly complex and there is currently no evidence has for ATP

synthase forming without aid. This doesn't necessarily completely eliminate this possibility, but it does make it almost infinitely improbable. Naturally occurring proton gradients have been found near deep sea hydrothermal vents making them the most likely origin of life on earth.

ATP synthase, the structure that uses a proton gradient to power life, is universal across all forms of life. It is identical in archaea and bacteria which means that it existed before the first split in life, this implies that it existed in the last universal common ancestor. If the ATP synthase existed in, and probably before, what we believe was the first life it shows that life could not have evolved without it. The simplest possible form of life had to have this structure and this structure cannot exist without a proton gradient which implies that life evolved where we have proton gradients, near deep sea thermal vents.

The environment around deep sea hydrothermal vents is ideal for early life. It is well known that life requires water as a solvent for the chemical reactions that power the creating and sustenance of life. As the name implies, these vents exist in the ocean where water would have been available. Another early theory of life was that it evolved in puddles on land, but this was ruled out as the ultraviolet rays would have been far too damaging on the surface for life to form the structures required. This is not a problem for the deep sea hydrothermal vents theory as the vents in question form deep underwater where ultraviolet rays cannot reach. By being deep underwater early life was also protected from the chaos of the late heavy bombardment, a series of collisions with earth around the time life evolved. All of this does not prove anything about the origin of life, this just rules out many of the other possibilities. We can conclude that life probably evolved somewhere deep underwater as no other place would have water and keep early life safe from ultraviolet rays and the bombardment.

While there is no smoking gun pointing to deep sea hydrothermal vents as the origin for life there is heavy evidence for it and solid evidence against other options. Life must have evolved in a location where there is a naturally occurring proton gradient or under conditions where ATP synthase can form on its own. Life also needed to evolve in a wet place with protection from the sun and the late

heavy bombardment. Currently deep sea hydrothermal vents are the only real place where all of these conditions are filled. The vents create a natural proton gradient that can power life. They exist deep underwater which provides the necessary water and protection. All this combined make deep sea hydrothermal vents the most probable origin of life.

How is the nature and evolution of the Universe intimately connected to life on Earth?

The formation of the universe took many years of research to understand, but it was integral to understand the the origin of life on earth. Everything that forms life came from the evolution of the universe, if the universe had not existed neither would life. The energy that powers life on earth stems from the way the universe evolved. The specifics of the formation of the universe greatly shaped the way life on earth functions.

Life needs free energy from the origin of the universe. Almost every child knows how the food chain works, it always starts with the sun. The sun is the origin for all of the energy that passed around the earth. The energy that we get from the sun can been traced all the way back to the origin of the universe. The sun creates its energy through nuclear fusion. This requires putting molecules under immense pressure. This pressure is created due to the immense mass of the sun. The immense mass of the sun required a small variation in the gravitational field of the universe. These small variations were required to start the clumping of matter in the early days of the universe. Had the gravitational field been completely uniform mass would have stayed uniform throughout the universe. There would have been no aggregation of matter, there would have been no formation of stars, there would have been no fusion, there would have been no free energy, there would have been no life.

One of the values that have troubled scientists throughout history is the cosmological constant which is incredibly fine tuned to support life. The cosmological constant stems from the existence of dark energy in the universe to keep the universe flat. This value is tied to the existence of life. If the value of the cosmological constant was marginally larger the universe would be expanding more

rapidly. This would have resulted in things spreading too far apart and atoms would not have formed. There would have been no life on earth since there would have been no matter. On the other hand, if the cosmological constant had been negative the universe would have collapsed far too quickly for life to have evolved. The existence of life is conditional upon the cosmological constant being just the right value. This is a way in which the existence of life on earth is tied to the nature of the universe.

All matter that exists came into existence through the quantum nature of the universe. The universe is full of the constant creation and annihilation of particles. Virtual particles are are constantly being created and then colliding with each other and being annihilated. This happens everywhere, all over the universe. When this happens near a black whole some of the matter created gets trapped in the black hole's gravity. In this in case the matter does not collide the antimatter created. This also occurred during inflation when particles were spreading too far apart for them to find their counterpart and thus both became real particles. If the universe did not have quantum characteristic the spontaneous creation of particles would not occur. The creation of matter was vital to all life.

The matter that is essential to life on earth is not the simple form created during the big bang, it is the heaver molecules created in the hearts of start and during the explosion of super nova. The only reason there exist sections in the universe that have enough force to fuse heavier molecules is due to the quantum fluctuations that impacted the density of the universe. These fluctuations allowed gravity to amass and create the conditions for the fusion of heavier elements. Life on earth is carbon based and if the universe had this unique nature then there would have been no carbon for life to based on.

The universe had many different parameters in its creation. These are all vital to existence of life on earth. Had aspects of the universe been different life would not have come anywhere close to existing. The nature and evolution of the Universe is connected to life on Earth because life on Earth is entirely dependent on it to exist.