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Chemist Fazale Rana Investigates the Origin of Life

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Knight & Rose Show - Wintery Knight and Desert Rose

Wintery Knight and Desert Rose interview Dr. Fazale "Fuz" Rana about the appearance of first life on Earth. What are the minimum functions of a simple living system? When did life appear on the Earth? What are the best naturalistic hypotheses for the origin of life? Are any of these scenarios plausible? What is the best explanation for the information and algorithms in the cell? Is design a better explanation?

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Transcript

Welcome to the Knight & Rose Show, where we discuss practical ways of living out an authentic Christian worldview. I'm Wintery Knight. And I'm Desert Rose.

Welcome Rose. So today we're delighted to welcome a guest onto the show, Dr. Fazale Rana. Dr. Rana is the President and CEO of Reasons to Believe.

He holds the BS in Chemistry from West Virginia State University and the PhD in Chemistry from Ohio University. He also did postdoctoral work at the University of Virginia and the University of Georgia. Dr. Rana taught at various universities and spent several years in the private sector working as a senior research scientist for a Fortune 100 company before going into full-time ministry with Reasons to Believe.

Dr. Rana has authored over 30 articles in peer-reviewed science journals. Dr. Rana, welcome to the Knight & Rose Show. Well, Wintery and Rose, thanks for having me.

We're excited for you to be here. Yes. So we wanted to focus on one of the areas that you've published the most in, and that is the origin of life.

So the origin of life for our listeners is an event that occurred in natural history. Christian theists think that the appearance of first life is due to intelligent causes and not just by physical mechanisms. But naturalists, you know, they have to come up with some kind of scenario for this that doesn't involve any intelligent causes.

So that's what we're going to be discussing today. Yeah. So why don't I kick us off? Dr. Rana, you're the expert.

So tell us, what is the origin of life and why is it important for Christians to study it? Yeah. Well, Rose, you know, in my experience, a lot of lay people don't really understand what the origin of life is. Many of them will argue that it's essentially a reference to the entire history of life on Earth and how life emerges throughout Earth history.

But in fact, what you see is that most scientists understand the origin of life to be in reference to the origin of the very first cells. And they think, as you've already alluded to, Wintry, that this process is driven by chemical processes. It's a chemical evolutionary analog to biological evolution, where it's a process that's unguided and undirected, driven by unintelligent causes.

So this is very important from a Christian perspective, because if we can show that the origin of life indeed requires the work of a mind, the work of a creator, then it gives strong support to Christian theism and at least challenges the idea that evolutionary processes can account for the totality of biology. Yes. Okay.

Yeah. So when we're talking about the first living system, we're talking about the least complex organism that can perform the bare minimum functions to be considered life. So what are the minimal functions of the simplest living system? Yeah.

And this is a question that biochemists and origin of life researchers continue to study, but what we know from work in genomics, and this is referred to sometimes as a top-down approach to the origin of life, is that for life to exist in its barest form, you have to have about 400 genes that code for proteins, where each of these proteins carries out a distinct, unique task inside the cell. Now, these entities would be minimal life, but they're not capable of living independently. They are either parasitic organisms or they're organisms that can be kept alive in a laboratory because the growth medium has nutrients and other materials that these cells cannot produce on their own.

Now, for life to exist in its minimum form and function independently, now you're looking at a requirement of about 1,300 to 2,500 genes, where again each gene encodes a unique distinct protein that carries out a specific role inside the cell. And the range is because different types of metabolic lifestyles have different requirements. So what are known as heterotrophs require about 1,300 genes.

When you're looking at chemoautotrophs, you're in about the 1,500 to 1,700 gene range, photoautotrophs about 2,200. And it looks like some of the both chemoautotrophs and photoautotrophs were some of the very first cells that were present on Earth, giving you a sense for what is the complexity of the very first cells. But at the end of the day, these different proteins are working collaboratively to sustain a cell boundary so that the cell's interior is segregated from the exterior environment, provide the means for the cells to replicate, which includes DNA replication that provides the cell with the capacity to extract energy from the environment and to acquire nutrients from the environment.

And this means that you've got to be able to produce workhorse molecules or proteins, which requires a protein-synthetic apparatus. And so these activities pretty much correlate with the idea that you need, again, 1,300 to 2,200 gene products in order to have life in its minimal form. And why this is problematic for naturalistic approach to the origin of life is that when you look at the process of chemical evolution, you're looking at life emerging in a stepwise manner where the complexity becomes gradually greater and greater over time.

But for most of these intermediate forms, they wouldn't have the capacity to function as a living entity. And you have to question whether or not these types of entities would have any kind of sustainability beyond coming into existence and then disappearing. Because if they can't replicate, you don't have the possibility of these entities persisting long enough for chemical evolution and eventually biological evolution to grow them in complexity.

Yeah, it's almost like the parts of a machine. If you take away a component, it doesn't perform its purpose anymore. So that all has to be there at the start.

Yeah, that's exactly right. You're looking at what you might call an integrated or an irreducible complexity to the very first cells where these core basic systems have to be present for that entity to exist in a living form. All right, let's see what the naturalistic scenario is for explaining the origin of life.

So it looks like from my studying of this, it looks like there are two problems. The first problem is they need to be able to generate the building blocks of a living system. So I'm thinking about things like amino acids and nucleotides.

Those are like simpler components that are then sequenced into larger components like the proteins that you were mentioning, maybe nucleic acids as well. And it's those larger components that perform those minimal functions of life that we were just talking about. Let's start with the building blocks.

How do naturalists see the building blocks of life being formed without any intelligence? Yeah, yeah. And before we get to that, in light of what is required for chemical evolution, in a sense, you have to explain the origin of three aspects of cells. One is, as you're pointing out, information harboring materials that provide the molecules that will carry out different activities in the cell, and also molecules that will store the information to make those protein components, these workhorse components.

You also have to have the emergence of what is known as intermediary metabolism. This is an ensemble of reactions in the cell that are highly organized that involve the interconversion of small molecules one into another. And this is necessary to make the building blocks that are needed to build DNA and proteins and RNA molecules, as well as cell membrane components, but is also the pathways that are used to extract energy that the cell can use.

And then you have to have a way to form cell membranes. And these three requirements have led to three different models for the origin of life known as replicator-first scenarios, metabolism-first scenarios, and membrane-first scenarios, where the researchers debate which of these three systems would have emerged first, and then what are the other systems that would subsequently follow. But in all cases, you have to create building block materials.

Some of those building block materials, again, would go to form most likely RNA molecules. Other building block materials would be used to make cell membrane components, and others would be part of the ensemble that is referring to intermediary metabolism. And so people have explored different sources of building block materials.

For example, some have argued that maybe there are chemical reactions happening in the atmosphere where gaseous molecules are exposed to high energy sources, either lightning in the atmosphere or high energy cosmic radiation that would drive the production of small organic molecules that then could be converted into the building blocks. Others argue maybe you have something happening in volcanic emissions where there's volcanic lightning and gases. Others argue that it's hydrothermal vents where these reactions are taking place, where the gases that are being vented under high temperatures and high pressures interacting with minerals would generate building blocks.

This typically is the site for metabolism-first scenarios. And then you also have the possibility that maybe these building block materials were delivered to the Earth through comets and asteroids, dust particles. So these are some of the major sources of prebiotic materials.

And the bottom line is that all of these sources are reasonable on one hand in that there are these chemical pathways that you could conceive of that would occur in these environments. But also at the same time, there are also some significant chemical and physical problems with each of these approaches such that we don't really have a good understanding as to where the building block materials have come from. It's mostly at this point speculation.

Yeah, there's not really a consensus as far as I can tell. Yeah, so it seems like it would take a whole lot of time for the natural processes that have been proposed to be carried out. So is there a lot of time that was available for these processes to occur or is that another problem? Yeah, well, this is, to me, one of the more significant challenges to a chemical evolutionary origin of life is you look into the literature in the earlier days of origin of life research, which dates back into the early 1950s, most people were arguing that, look, the origin of life must be a process that requires hundreds of millions of years, maybe even up to a billion years to transpire.

And that was kind of the mindset that people had all the way in through the late 80s, early 90s. And then what we began to discover is that as soon as the earth could reasonably support life, we see the appearance of the very first cells on earth. Wow.

And these cells are bacteria and archaeal, so they're the simplest types of life forms. But even then, they are unbelievably complex from a biochemical standpoint. These cells are capable of a wide range of different metabolic lifestyles, including photosynthesis, that they were actually part of a complex microbial ecosystem.

It wasn't just a single cell type. Yeah. And so this is a really significant problem because we know even though the earth is four and a half billion years old, for the first few hundred million years, it's unlikely that you're going to have an origin of life at all because the earth would have been in a molten state.

And about 4.2 billion years ago, there is some evidence that there might have been liquid oceans on the earth, but these oceans would have also been subjected to impact events. Yeah. Where comets and asteroids would have pummeled the earth.

Some of these impactors would have liberated so much energy, would have literally converted the oceans on the earth into steam. It may have even melted rock on the surface and the subsurface. This is still debated as to how hostile the environment was.

But then at 3.8 billion years ago, you have the late heavy bombardment where there's something that causes asteroids and comets to pummel the inner solar system planets, including the earth. One estimate that I've seen is about 17,000 plus impact events over a relatively narrow window of time, geologically speaking. And then as soon as the earth recovers from this, we see evidence for life in the microbial life on the planet.

It's almost, again, in a geological instant. So this is a deeply problematic concern. Now, what's interesting is, original life researchers are now adopting a different posture where they say, well, look, we see that life originates very quickly on the earth.

So that means that the origin of life must be easy. And it must happen rapidly, right? Yeah, well, I mean, your laughter is appropriate because this is essentially circular reasoning at its finest. And there's not any evidence.

It's one thing to say, look, life originates rapidly. Now, do we have viable mechanisms that support that rapid emergence? And the answer is no. And so original life researchers are speculating it's easy and it's rapid because it appears to be rapid.

But there's nothing in the chemistry that would suggest that it should be rapid or it is, again, a real issue confronting, you know, natural process explanations. But now think about it for a minute. You've got complex life appearing in a geological instant as soon as the earth can support life.

That looks like a creation signature to me. This is what our experience is. If I, you know, get up, if I write code for a living, if I get up from my desk and I know that I have to get a certain bunch of code written for a card in order to move it, I go and get a coffee and I come back and it's been written.

I'm not going to think that somebody just dropped a bunch of building blocks on my keyboard because there just wasn't enough time. It had to have been done by an intelligent agent. That's the only kind of thing that can generate these kinds of effects that we're seeing that we're familiar with in the time available.

Anyway, I cut you off, but it's just, it seems reasonable to me to say if you don't have enough time to do this, then you're going to have to appeal to an intelligent agent to do it. You won't be able to do it by just throwing things together. Yeah, that's a great analogy, Wintry.

I love it. It's a great analogy. All right.

Well, you know, you mentioned the places where the assembly of the building blocks might take place. You said that each of them have problems. I sent out some of the questions we want to ask you for review and somebody replied and said, ask them about prebiotic soup.

There's no evidence for that. Is that correct? You know, that's the one that I've heard the most as a possible environment. You know, what's wrong with that one in particular?

Yeah, well, the fact of the matter is there is absolutely no evidence that a prebiotic soup existed on the early earth.

And, you know, if there was a prebiotic soup, we would expect to see a geochemical residue from it and the oldest rocks on earth. And we've got rocks that date very close to four billion years on earth. And that these rocks show no evidence whatsoever, again, for a chemical residue.

But they do actually have a geochemical signature that suggests that the organic materials left behind are the product of biological organisms. And there are certain signatures that biological organisms will leave behind in organic materials that are distinct from the signatures that would be left behind if these organic materials were produced through abiotic means or through just chemical reactions. And so we don't see any evidence whatsoever in the geological record for a prebiotic soup.

And when you think about the capacity to generate organic materials in the early earth, when you start doing the calculations for how much or a prebiotic compounds you could produce relative to the size of the earth's oceans, even if you could produce these materials and there was a prebiotic soup, it would be so dilute that you're not going to have any kind of real chemical evolution because you have to have pretty high concentrations of organic materials to get reactions to go. And you wouldn't have that available to you on the early earth. Now, I also mentioned that there's the idea that maybe you could have, you know, like an asteroid or cometary delivery or even delivery on dust particles of organic materials.

And that maybe was the source of building block materials. But again, we can rule that out because we don't see the right chemical signature in the geological record that would suggest extraterrestrial delivery of these materials. There's a distinct signature that these materials would have if they come from an extraterrestrial source.

So basically, we can rule out at least atmospheric chemistry as the source of materials for the origin of life and a type of panspermia extraterrestrial delivery. And so you really have as your best option hydrothermal vents. But there the problem is you have such high temperatures that as these materials would form, they would be very rapidly broken down.

And the only way they could escape breaking down is if they essentially diffuse the way from the hydrothermal vent. But now you're diffusing them into the earth's oceans, eluding them to such a degree that no chemistry is going to take place. All right.

So let me ask you a different question now about the environmental hazards. So for chemical evolution to work, it has to have solutions to threats that it might face from the environment. You know, you've already talked about one of those when you talked about the sterilization events.

But I've heard that molecular oxygen is both necessary for the naturalistic chemical evolution to work, but also that it is bad for those processes as well. Is that correct? That's exactly correct. Because when you don't have oxygen in the atmosphere, you're not going to have protection from short wavelength UV radiation.

So, you know, oxygen in the atmosphere is going to react to produce ozone, which will shield the earth from short wavelength UV radiation, which is the wavelength that will actually break apart the chemical bonds and organic materials. And so if you don't have oxygen, you wind up with, again, an environment that's going to be largely hostile to some kind of chemical evolutionary scenario because of the UV radiation. But if you did have oxygen, that oxygen is actually going to inhibit at least atmospheric reactions that would generate building block materials.

And so you basically have what is called the oxygen UV paradox that, you know, raises questions about, again, could the atmosphere be the source of prebiotic materials, which drives you to other sources like hydrothermal vents. Yeah. So one of the problems with making the building blocks of life in the lab is that certain gases are needed to make the reactions work.

So experiments in the lab seem to require methane, water, ammonia, and hydrogen to work. Is that the environment that would have been present on the early earth? Yeah, that's a great question, Rose. And that's in reference to the Miller-Urey experiment.

And so this is an experiment that everybody that's had high school biology would be aware of. And it's essentially an experiment in which Stanley Miller in the 1950s was trying to simulate the conditions of the early earth. And so he had a flask that had boiling water, which represented the earth's oceans.

He set up a glass apparatus above it, evacuated the headspace to make sure there was no oxygen in the system. And then he added hydrogen, ammonia, and methane and showed that a continuous electrical discharge could generate some amino acids and things called alpha hydroxy acids. And so this was considered to be the very first experimental validation of the apparent Haldane hypothesis and really initiated the origin of life research program as a scientific program, as a laboratory science.

So historically, very important experiment. Now, it turns out that there's a lot of criticisms of that experiment. One is the continuous electrical discharge.

That doesn't really mimic the atmospheric lightning, right? Number one. But two, it turns out that Miller in follow-up experiments showed that you had to have a highly precise gas composition of methane and hydrogen and ammonia in the headspace. And if that composition wasn't fine-tuned, you very quickly lost productivity in the reaction.

But then, later on, people discovered that the conditions that Miller used are not valid conditions for the early earth, that instead of having an atmosphere of hydrogen, methane, and ammonia, what we're looking at is an atmosphere of water, carbon dioxide, and nitrogen. And in that gas mix, nothing forms. It's a non-reactive gas mixture.

And so most people today think that the Miller-Urey experiments are irrelevant. They're historically important, but they are irrelevant to the origin of life. And it's for this reason that people have really abandoned the atmosphere as a source of prebiotic materials for the origin of life.

So since we're talking about experiments in the lab, I'm wondering whether there are cases when the experimenters are trying to replicate the process on the early earth, but in order to get results, they have to interfere a little bit to help it along. Have you noticed that that happens? Yes. And in fact, this is actually a problem that's acknowledged almost universally today by origin of life researchers.

And sometimes I hear it referred to as unwarranted research or involvement. Yes. And in fact, this was actually the theme of a book I wrote in 2011 called Creating Life in the Lab, where I raised this concern and actually then argued that this becomes not only a challenge to chemical evolution, but we can use it as a way to make an argument for God's role in the origin of life.

And we can revisit that in a minute. But interestingly enough, in 2018, 2019, an origin of life researcher by the name of Clement Reicherts wrote a critical review in Nature, where he basically pointed out this problem. And so we actually anticipated this problem almost a decade before the origin of life research community acknowledged it.

And the point here is that when you go into the lab and you do these prebiotic simulation studies, where you're trying to replicate different steps that you think could have contributed to the origin of life, researchers are doing these experiments. Now they have to, by definition, they have to. And the question becomes, at what point do the researchers actually become part of the experimental design and are contributing to the successful outcome? So when an origin of life researcher does a simulation study, one goal is to ask the question, is this even possible? You might say it's a proof of principle.

The other goal is to understand mechanistically what's happening. In both of those instances, researcher involvement is irrelevant, because you're just trying to say, does the chemistry work? And if it does, how does it work? And so there, you almost want to have researcher intervention in order to really understand those two questions. But now, when you're saying, can this process contribute to the origin of life? It has to be geochemically relevant.

And this is where you now have real problems, because the researchers are in the lab and they're setting up some kind of apparatus. They're carefully selecting the right solvent. They're adjusting the pH of that solvent.

They are mapping out a chemical reaction. And then they are adding the right materials at the right concentrations with the right order of addition. They're monitoring the reaction.

They're stopping the reaction before it goes beyond its intended endpoint. And voila, they've got success. And so this doesn't translate to the conditions of the early Earth for obvious reasons.

And so the concern now is, is the success really an artificial success where it's essentially attributable to the researcher's involvement. And practically every prebiotic simulation study that I've seen published suffers from unwarranted research or involvement. It's just inevitable.

And what this work is highlighting is that this chemistry that would be necessary to contribute to the origin of life is very persnickety, very finicky chemistry that has to be just right in order for it to work. Now, the way in which you can turn this into an argument for design is to point out, look, empirically we now know from 70 years of work in prebiotic chemistry that intelligent agency has to be involved in order to affect the chemical transformations you need for the origin of life. That means that it's reasonable to think by analogy that on the early Earth, there had to be intelligent agency that was somehow operating to generate the emergence of the very first cells.

So it's not only a critique of chemical evolution, but we can now turn it around and use it to make a positive argument for the role of a creator in the process because I'm not sure that I understand it fully myself. But what I've learned from watching videos on the origin of life is that we were talking about this before about how there are sequences of components and people can think of like Scrabble letters. There are larger components that are built up from sequences of smaller components.

And what I've been told is that it actually, each of these smaller components, they have a handedness to them. So if you kind of look down at your hands when you're listening, don't do this if you're driving, but if you look down at your hands, you see your hands are very similar. But one of them is like the mirror image of the other.

And what I was told is, is that in origin of life, the only like, in some places, only left handed versions of a part are used. And in other places, only right handed versions are used. But when you're trying to generate these things naturally, without an experimenter, you get a 5050 yield.

And I'm wondering, is that a problem that you get a kind of a bunch of the ones you don't want, you know, when you're trying to generate them in the lab? Yeah, this problem that you're describing is one of the most significant problems confronting a chemical evolutionary approach to the origin of life. I've seen people work on this problem easily for the last 3035 years, without any kind of real insight into how you could generate what is sometimes called chiral enrichment of on the order of 100%. And you're right, for example, amino acids have to in proteins all adopt a left handed configuration, a left handed chirality.

And if you introduce in a protein chain, even one right handed amino acid, it essentially disrupts the hydrogen bonding interactions that lead to the three dimensional structure of proteins. Wow. And so it's an absolute requirement that you're operating at 100% chirality.

And people have been rather clever in terms of suggesting different physical mechanisms, or chemical mechanisms that could potentially generate chiral enrichment. But in most instances, the chiral enrichment is of maybe 10% or 15%. It's not even close to 100%.

The only process that I've seen that could give you chiral enrichment that encroaches on 100% is a particular reaction called the Frank reaction that this chemist developed as a theoretical reaction in the 1950s. And it wasn't until the late 1990s that a Japanese researcher actually ran a successful Frank reaction in the laboratory. It's a reaction called asymmetric autocatalysis.

But that reaction that he ran was irrelevant to the origin of life. It involved compounds that had no bearing on the origin of life. And in even in those reactions, you do get very close to 100%.

But as the reactions proceed, you start seeing a decay away from 100% down towards about 80% where it stabilizes. So even then you can't get that 100%. So the bottom line is that nobody knows how homochirality originates.

And if you don't have homochirality, you can't form the higher order three dimensional structures in proteins or in RNA molecules for the RNA world. You can't form them in stable structures. So this is a strict requirement that is absolutely non-negotiable.

It's one of the many Achilles heels of chemical evolution. I noticed that both of your postdoctoral projects were about the biophysics of cell membranes. How were those relevant to the origin of life? Yeah, well, the reason why both of my postdocs were in cell membranes was because that's my area of expertise.

I'm a lipid and membrane biochemist. And so as somebody who has expertise in cell membranes, I've often felt like this has been a neglected area when we talk about the design argument. Because cell membranes at first glance look like they are just this mess of molecules without any kind of real structure whatsoever.

But it turns out that cell membranes in order to form as the single layers have to have a precise molecular composition. And if you deviate ever so slightly from that composition, the single membrane collapses into a stack of membranes, which would be devastating for a cell. And so not only that, but you also have components of membranes are also organized into these hierarchical structures that are necessary for its activity.

And believe it or not, cell membranes actually harbor information in the composition of the components of the membrane as well as in sugar molecules that are attached to cell membrane components. So all of these collectively indicate that these systems have the signature of design. These are the qualities that we would recognize as being design signatures.

But then when it comes to how do you explain the origin of cell membranes, this again is an area that's deeply problematic. In fact, a few years ago I worked with a chemist named Jackie Thomas and she and I wrote a critical review article that was published in a leading original life research journal, critiquing all the different models that are out there for the origin of cell membranes. And the article was published because the critiques were considered to be valid.

But for example, origin life researchers don't think that the very first cell membranes were built from phospholipids. This is the backbone component, if you will, of cell membranes. It's what forms the matrix of the membrane, these molecules called phospholipids.

And they basically argue, look, these molecules are too complex. They require complete dehydration in order to form from their building block components. It's unlikely that they could have ever emerged on the early earth.

Instead, they argue that the first cell membranes must have been made up of fatty acids, which are the simplest lipid molecule that you could have. Now, usually fatty acids will form what are called micelles. These are solid spherical structures that would be irrelevant to the origin of life.

But under certain conditions, you can get fatty acids to form vesicles, single membrane structures that have a hollow interior. And so people have said, well, it looks like maybe this is how the very first cell membranes formed. The problem is, is to get those bilayer structures, it requires that you have a pH that's exactly at the pKa value of the fatty acid.

That's kind of technical terms. In other words, you have to have a very precise, exacting pH that depends on the particular molecular components. You've got to have the just right fatty acid compositions.

They actually need other materials, in addition to the fatty acids, to stabilize the bilayer. And you have to form them in effect, pure water. And so this is such an unrealistic set of circumstances that it's unlikely that this could ever, these certain environments could ever exist on the early earth.

And if they did, it would be fleeting, and these structures would appear and then disappear without any kind of persistence. So the bottom line is that you're looking at these fine-tuned, highly optimized systems that suggest design. And the explanation for them is wanting from an original life standpoint.

Very good. Yeah. Okay.

So another way to describe the sequences of amino acids that form proteins is to describe them as information. The sequences are like computer code, as Winter Knight mentioned. When I'm teaching this to children, I'd like to use Scrabble letters as the amino acids, and we make words that are the proteins.

Is there any known naturalistic mechanism that can generate the information contained in the proteins of a living system? Yeah, that's a really interesting question. And this is a place where I depart from what you oftentimes read from Christian apologists. Because the more that I've looked into this question, the less certain I am that this is necessarily a sound critique of chemical evolution.

And there's some highly technical reasons why that's the case. But I will say this, that biochemical systems are information systems, and that the information that we see in biochemistry is eerie in terms of its similarity to the ways in which we would structure information in language or the way that we would structure information in computer code and things like that. So I think it's a real signature for design.

I'm just not convinced that the improbabilities that are often cited to generate the sequences that you would need to make a protein are actually valid in improbabilities. I think for technical reasons, this may not be as significant of a challenge to chemical evolution as we might think. Oh, interesting.

Now, having said that, what you're talking about here, Rose, is what's called syntactical information. It's not just simply a sequence, but there's also meaning attached to that sequence, so it's semantic. And again, that to me is highly suggestive of a mind.

In and of itself, it's suggestive of a mind. But what I've been working on recently is this idea that the real problem isn't how do you explain the origin of syntactical or semantic information. The real problem is how do you explain the origin of algorithmic information? And so algorithmic information is a distinct type of information that essentially involves instructions, right? So like for a computer program, that's a set of instructions.

And the very simple systems, the instructions are relatively simple. Like if you wanted to make a protein that had alternating alanine and glycine residues, the algorithm for that would be add an alanine, add a glycine repeat, right? And so that's a very simple. So that algorithmic information correlates with syntactical information.

If you've got a protein of 100 amino acids where there's no repetition in that sequence, well, then the algorithm to make it be the sequence itself. So the more complex the system, the greater the information content, the more complex the algorithm, right? So that's algorithmic information. But it turns out that in biochemical systems, and this is an insight that comes from Paul Davies and Sarah Walker, what they found remarkable, and I agree with them, is that biochemical systems have algorithmic information instantiated into the molecular structures themselves.

So it's algorithmic information, but the algorithm is literally built into the molecular design itself. And an analogy would be something called a finite state machine. There are two types of finite state machines.

One are what computer scientists use. The other are actual physical finite state machines that are mechanical computers. And these machines are actually around us everywhere we look.

So like a vending machine, a turnstile, these are all examples of physical finite state machines. And they are just simply machines that can exist in different states, and that the machine will transition from one state to the other based on the input given and, you know, the state that it's in. So like with a turnstile, it's going to be two states locked or unlocked, and the input would be the right coinage.

And that will then cause it to transition from a locked state to an open state. And then it will return after you enter through the turnstile back to the closed state. That's an example of a finite state machine.

Well, it turns out that biochemical systems have algorithmic information built into their structures, and they literally are operating as physical finite state machines with very complex algorithms, again, built into the molecular design that tells these machines how to operate. And so a lot of times you'll hear people say, well, biochemical systems act like they are cognizant or like they are intelligent, right? But what's happening is they're not intelligent, they're not cognizant. What is actually happening is they are algorithmic.

They have algorithmic information built into them, and they're programmed to transition to these different states based on inputs. And these can be fairly elaborate systems. And in fact, this is a project that I'm working on right now is to argue that, in a sense, biochemical systems are finite state machines.

But the point here is that nobody knows how algorithmic information could originate in that nature of that type. And in fact, Paul Davies says that this is the real question that origin life researchers need to focus on is how do we account for the origin of algorithmic information? And so, from my perspective, I think this is a maybe even a more profound challenge than how do we explain the emergence of semantic or syntactical information. But the fact of the matter is the information that we're seeing is real information that suggests the mind.

And there are very real challenges in terms of how do you account for the generation of that information. And all of our experiences, information comes from agents, from intelligent agents. There's no other experience that we have other than that.

All right. With respect to the information in the origin of life, I think that that's one of the minimal factors that we identified before, a storage of information. So that has to be there right at the beginning.

And I was wondering what is the best naturalistic scenario to account for that information at the beginning? And do you think it's plausible? The only explanation that I've seen is essentially chemical selection. And so, where there's somehow a particular preference given to certain sequences over other sequences, which could very well be the case from a chemical standpoint. However, for those sequences to actually have any kind of function would be remarkable if they actually did.

And if somehow you had chemical selection, generating sequences that turn out to be precisely the types of functions you need for life to exist, that would suggest a teleology or a design built into the evolutionary process. So the bottom line is there's really not an explanation, I think, for how you would generate information. How about this RNA world hypothesis? Is that a good answer? Not really.

I mean, it's the leading model. And I've heard many origin of life researchers very openly and honestly critique the model as being deeply flawed. But they argue that it has to be an RNA world, because if you didn't have an RNA world, you'd wind up with what's called the chicken and egg paradox.

And the only way to resolve it is if there was an RNA world that emerged first and then later evolved to give rise to the DNA protein world. So people hold to this idea in part out of necessity, not because it's a compelling model with tons of experimental support. When you look at contemporary biochemistry, a lot of times people will say, well, DNA is a self-replicating molecule, but it really isn't.

DNA has to be replicated using proteins. And the information needed to make those proteins that replicate DNA have to be stored in the DNA. So there is this interdependency where you can't have DNA assemble or replicate without proteins, and you can't have proteins without DNA.

So it's a chicken and egg problem because of that interdependency. Now, people have noted that in biochemistry, RNA serves an intermediary role. So to go from the information in DNA to the information in proteins involves different types of RNAs that serve different functions, like messenger RNA, transfer RNAs, ribosomal RNAs, and some other RNAs that are playing a regulatory role.

And so because of their intermediate state, people have argued, well, maybe these are molecular fossils that reflect an earlier history in biochemistry where we basically had RNA molecules that then constituted both the information storage molecule as well as the molecules that would carry out different functions. And this idea gained an enormous credibility when Thomas Chek discovered that RNA molecules could function as catalysts, and these are called ribosomes. And people have made ribosomes that can carry out all kinds of different biochemical operations.

They've done this through a process called in vitro evolution. And so this gives some credibility to the RNA world. But the problem is, is that, for example, how do you generate the RNA building blocks? How do they combine to form RNA? How do you get RNAs once they form to actually evolve, you know, on early Earth to create a wide range of functional molecules? Nobody's been able to create a self-replicating RNA molecule.

You can replicate parts of a RNA molecule, but you can't replicate the whole thing. And so that is like the holy grail for the RNA world. But even then, if even if you could do that, you still don't have, you have all kinds of other problems that nobody knows how to solve.

I heard Leslie Orgel at an Origin of Life conference, who was that scientists that proposed the RNA world initially say that it would be a miracle if a strand of RNA ever appeared on the primitive Earth, right? And so, you know, and so this is the problem. But I also heard Orgel say it has to be an RNA world, right? Because otherwise you have the chicken and egg paradox. Yeah.

So Dr. Stephen Meyer talks about a method of reasoning called inference to the best explanation. Humans are already familiar with intelligent design as an explanation for how parts are sequenced. We do it every time we write code or write emails or play Scrabble.

If all the naturalistic explanations for the information and living systems fail, then why can't intelligent design be the best explanation for the information? What's going on there? Yeah, you know, this is a this is a great question. And it ultimately has to do with philosophical considerations more so than anything else. Because in science, you know, the way in which people propose theories is constrained by certain requirements, namely that those theories are undergirded by mechanism, that you have natural process explanations where there are mechanisms that are central to to generating a particular phenomena or explaining a particular phenomena in nature, including the origin of life.

And so to appeal to intelligent agency is considered to be a violation of the tenets of methodological naturalism. So that is an explanation that is off the table a priori before you even begin to try to explain things. So even if the problems are intractable, nobody will entertain the possibility of a miracle or of a creator or intelligent agency, because again, it's a violation of the tenets of methodological naturalism.

You know, it is possible to to actually formulate a scientific model based on intelligent agency as the mechanism. You know, for example, SETI, the search for extraterrestrial intelligence, is predicated on the ability of scientists to measure electromagnetic radiation emanating from distant objects. And then based on the characteristics of that radiation, determine if it's from a natural source or from an intelligent civilization.

And there's actually criteria that they've worked out that allows them to discriminate that. Or archaeologists do the same thing when they pick up a rock and say, well, this was shaped by a hominin versus this is shaped by natural processes. And again, they're they're utilizing the same criteria SETI researchers.

And in fact, I've written a series of blog articles where I basically show that using that same criteria and applying it to biochemical systems, we come with the conclusion that these systems are the work of a mind or work of an intelligent agent. So here's a strictly speaking, a scientific investigation that leads you to a design conclusion without violating the tenets of methodological naturalism. So it is possible, but it's ultimately, I think, a philosophical bias that's baked into the modern day scientific enterprise.

So a common charge against Christians who make a case for the Christian worldview using science is that we're committing what they call the God of the gaps fallacy. That is, that we are just kind of punting to God, you know, as a word, just saying, well, God did it as an explanation because we don't know yet because there are gaps in our scientific knowledge. So with respect to the progress of science on the origin of life problem, how would you respond to that charge? I'm sympathetic to that criticism, by the way, if we just simply said, look, there is no explanation for the origin of life through chemical evolution, as things currently stand.

Therefore, God must have done it. We are in effect committing a God of the gaps fallacy, not to say that it's not unreasonable in light of that to entertain the possibility of design. But if that's the sole piece of evidence for design, then indeed you are committing a God of the gaps fallacy.

But for example, in my book, The Cell's Design, I make a modern day version of the watchmaker argument, or, you know, making the case that biochemical systems have the appearance of design. And that does that appearance of design is based on some very rigorous criteria as to what do design systems look like, at least those that are produced by human beings. And so, you know, that is a positive argument for design based on the features of biochemical systems.

So then when we couple that with the inability to explain those systems through chemical evolution, you now have not only an explanation for why chemical evolution can't account for these systems, and it's because these systems are designed, but you're making a positive case and coupling it with a critique of evolutionary mechanisms. And then, as I mentioned earlier, we could take that critique and utilize the concept of unwarranted research or involvement to make a third argument for design, which would be, look, it takes intelligent agency to affect these reactions in the lab. Why wouldn't that be the case on the early Earth? So we're really looking at three interrelated arguments that are making the case for design.

So it's not a God of the gaps argument, but it's an argument based on the characteristic of biochemical systems, based on empirical observations of what it takes to create different steps in chemical evolution successfully, and then also then on a critique of the mechanisms that are being proposed by scientists for the origin of life. So it's a fully orbbed argument where the conclusion is supported by multiple lines of reasoning that are all pointing in the same direction. Excellent.

Would you tell people the titles of your two books on this topic in case they want to dive deeper and then where they can find you and follow your work? Sure thing. Well, actually, there's four books now on the origin of life. The first book was Origins of Life that I co-authored with Hugh Ross.

There's another book called The Cell's Design. There's a book called Creating Life in the Lab, and then a book that's my most recent, which is called Fit for a Purpose. And so these are all dealing with the idea of the origin of life and of biochemical design, which those two topics in my mind are intertwined.

And if people want to know more about me and the work we do at Reasons to Believe, go to our website, reasons.org. You can go to our YouTube channel, Reasons to Believe, or follow us on social media, RTB underscore official. All right. Well, thank you so much for coming on the show.

So listeners, if you enjoyed the episode, please consider helping us out by sharing this podcast with your friends, writing us a five star review on Apple or Spotify, subscribing and commenting on YouTube and hitting the like button wherever you listen to this podcast. We appreciate you taking the time to listen and we'll see you again in the next one.