The biggest question The scientist who's determined to find out what life really is

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All the brain cells of life on Earth still cannot explain life on Earth. The planet's most intelligent species has uncovered the building blocks of matter, read countless genomes and watched spacetime quiver as black holes collide. It understands much of how living creatures work, but not how they came to be. There is no agreement, even, on what life is.

If biology is defined as the study of life, on this it has failed to deliver. But enlightenment may come from elsewhere. Rather than biology, some scientists are now looking to physics for answers, in particular the physics of information. Buried in the rules that shape information lie the secrets of life and, perhaps, even the reason for our existence.

That, at least, is the bold proposal from Paul Davies, a prominent physicist who explores the idea in his forthcoming book, The Demon in the Machine. Published next week, it continues a theme of thinking that won Davies the $1m Templeton prize for contributions to religious thought and inquiry.

As director of the Beyond Center for Fundamental Concepts in Science at Arizona State University, Davies is well placed to spot the next wave that will crash over science. He says: "The basic hypothesis is this: we have fundamental laws of information that bring life into being from an incoherent mishmash of chemicals. The remarkable properties we associate with life are not going to come about by accident."

The proposal takes some unpacking. Davies believes that the laws of nature as we know them are insufficient to explain what life is and how it came about. We need to find new principles that describe how information courses around living creatures. Those rules may not only nail what life is, but actively favour its emergence.

To understand what bothers Davies, consider a hypothetical device: a life meter. Wave it over a sterile rock and the dial stays at zero. Wave it over a purring cat and it swings over to 100. But what if you dunked it in the primordial soup, or held it over a dying person? At

what point does complex chemistry become life, and when does life revert to mere matter? Between an atom and an amoeba lies something profound and perplexing.

Davies suspects information is the answer because it seems increasingly fundamental to both physics and biology. In recent years, physicists have shown information is more than the bits and bytes that course through computers. It can be converted into energy, for example, such that physicists now build little information engines and information-powered refrigerators. Similar machines are found in biology. Constructed from proteins, they chunter away inside living cells where they manipulate information.

"What we're seeing in the lab is these two worlds colliding in a very practical way," he says. "The physics is really connecting with the biology and that's why I think we're on the verge of this great new revolution."

Davies believes life will bear telltale patterns of information processing that distinguish it from non-life. "When you look at a living system, the way information is managed is very far from random. It will show patterns that could lead us to a definition of life. We talk about informational hallmarks and these might be used to identify life wherever we look for it in the universe."

It is not always easy to convert speculation into science. One of the hurdles Davies raises is the difficulty in describing biological information in terms of mathematics. It is a necessary move if new laws of life are to have any meaning. "I really think we need new physics to understand how information couples to matter and makes a difference in the world."

Find these rules and the future could look very different. Davies anticipates "digital doctors", who will analyse information flows in cells to spot aberrant patterns driven by early cancers and other diseases. When patterns are found, they could be corrected through some form of molecular shiatsu, he suggests.

Most radical is his proposal that any laws of information that shape life might favour its emergence, too. Life would not arise on habitable planets by chance, but be nurtured by "biofriendly" rules. It is the kind of teleological argument many scientists reject, but one Davies cannot help finding attractive.

"People often say that the probability of life forming by chance is so low there must have been intelligent design or a miracle. I find that anathema," he says. "Religious people have got to move on and get away from the idea that there's a superbeing who fits it all up. What I find more congenial and much more intellectually respectable is the notion of fundamental laws of organisation that turn matter into life, a life principle built into the laws of the universe."

Davies concedes: "It is wishful thinking because at this stage I can't demonstrate it." But he adds: "If we live in a universe in which the emergence of life is built into it in a fundamental way then we can feel more at home in the universe. It's no substitute for a caring superbeing ... but it would certainly be more comforting than to believe we live in an empty, sterile universe."

Davies once worked under Fred Hoyle, ex-director of the Institute of Astronomy at Cambridge University. Hoyle was a brilliant academic but among his more fanciful proposals was that flu pandemics were spread by viruses that rained down from passing comets. "He was one of these curious people who did some really great things and then some really

crazy things," Davies says. "What I did learn from Fred was not to be afraid of wild thinking."

'Physics is connecting with biology ... we're on the verge of a great revolution' Paul Davies