

Bleach a possible key to life on earth

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Associate Professor Rowena Ball. Credit: Stuart Hay, ANU

Hydrogen peroxide - commonly used as hair bleach - may have provided the energy source for the development of life on Earth, two applied mathematicians have found.

The heat from ancient geothermal vents may have triggered the varying acidity that was vital for early life to form and spread throughout the oceans.

"The energy in hydrogen peroxide could have powered the living world before cells evolved," said Associate Professor Rowena Ball, from The Australian National University (ANU).

The research, published in the *Journal of the Royal Society Interface*, solves a number of scientific puzzles about early life and how it emerged on Earth.

Scientists have proposed that more than 3.8 billion years ago, before DNA evolved, non-cellular life forms existed based on a simpler molecule, RNA.

However, no one had found a periodic energy source which could power replication and amplification of RNA without cells.

Associate Professor Ball said hydrogen peroxide and thiosulfate, which also occurred in the ancient oceans, provide the answer.

"They undergo a reaction in which heat and acidity cycle back and forth every couple of minutes, providing the perfect conditions for early life to evolve," she said.

"These oscillating reactions have been studied for years as a curiosity, but nobody realised that their fluctuating acidity and heat could have powered early life before DNA and proteins evolved," said Associate Professor Ball, from ANU Mathematical Sciences Institute and ANU Research School of Chemistry.

"All forms of cellular life are powered by varying acidity, known as the proton motive force. Respiration and photosynthesis depend on it.

"Now we know that the proton motive force is extremely ancient, and it was present before the evolution of cells."

As well as the variations in acidity, the reactivity of hydrogen peroxide was important for the development of life, Associate Professor Ball said.

"Hydrogen peroxide has just enough oxidising power to cause mutations every now and then, which would drive evolution," she said.

The shape of the hydrogen peroxide molecule also solves another puzzle.

"Hydrogen peroxide occurs as two mirror image forms," she said.

"Specific interactions of biological molecules with one or other of these forms may explain why biological molecules developed as only one mirror image form, something that has puzzled scientists for generations."

Associate Professor Ball and co-researcher Professor John Brindley from Leeds University brought together knowledge of the [hydrogen peroxide](#) and thiosulphate reaction from organic chemists, who had studied the acidity cycles, and chemical engineers who had studied the reaction's heat cycles.

The result was a computer model with 10 or more coupled highly non-linear equations that took months to solve.

However, when the solution came, the continuing nature of the reaction cycles solved another mystery, of how life became independent of hydrothermal vents.

"Waves of acidity and heat could spread away from the original heat source, which would liberate life from narrow regions around hydrothermal vents," said Associate Professor Ball.

More information: "The life story of hydrogen peroxide II: a periodic

pH and thermochemical drive for the RNA world." *Journal of the Royal Society Interface*, [DOI: 10.1098/rsif.2015.0366](https://doi.org/10.1098/rsif.2015.0366)

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