Ancient biology meets modern ingenuity

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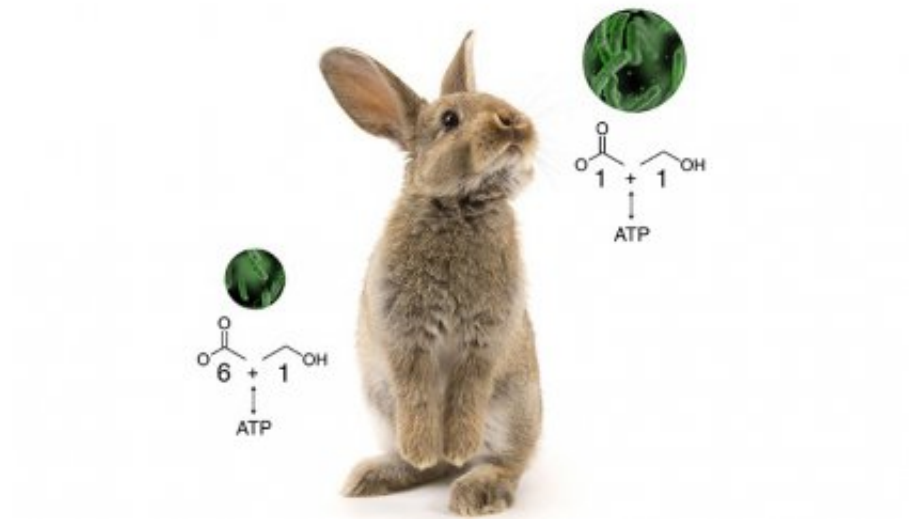

Clostridium autoethanogenum was originally discovered in rabbit droppings. Credit: University of Queensland

The average person might struggle to get excited about bacterium found in rabbit droppings – but it's potentially a knight in shining armour for our planet.

Researchers at The University of Queensland's Australian Institute for Bioengineering and Nanotechnology (AIBN) and US company LanzaTech have developed a computer model that harnesses ancient microorganisms for an environmentally sound industrial waste conversion method.

AIBN researcher Dr Esteban Marcellin said LanzaTech, a gas fermentation company, was particularly interested in a bacterium called Clostridium autoethanogenum, originally discovered in rabbit droppings.

"LanzaTech uses this bacterium (which falls under the broader class of acetogens) as part of its carbon capture and reuse process, whereby industrial waste gases such as steel mill exhaust are converted into useful by-products like ethanol," Dr Marcellin said.

"Acetogens are among the oldest living microorganisms and account for around 20 per cent of the fixed carbon on the planet, making them a major player in the global carbon cycle."

Through an Australian Research Council linkage project, LanzaTech teamed up with AIBN researchers to better understand the process by which the microbe 'fixes' carbon monoxide and carbon dioxide, and then determine how to modify the microbe so that waste gas can be turned into useful chemicals.

To achieve this LanzaTech researchers and Dr Marcellin's team developed a computer model of C. autoethanogenum's metabolic pathways.

LanzaTech founder and chief science officer Dr Sean Simpson said: "By including operating data from fermentations happening at steel mills around the world, the UQ team has made the most accurate model system published to date.

"The computer model is able to predict cellular metabolism of the microbe, which helps identify the best way to modify the organism so it can capture greenhouse gases better and convert carbon into desired products."

Lanzatech's director of synthetic biology Dr Michael Koepke said the model allowed scientists to predict what happened if certain genes were removed or overexpressed, or if an entirely new pathway was introduced.

"This opens the door to establishing acetogens as catalysts that can convert a variety of carbon-containing inputs into new products," Dr Koepke said.

The next step was to use the computer model to identify and modify gene targets in C. autoethanogenum, and then test the outcome at AIBN's gas fermentation facility, one of few non-industry facilities using instrumented fermenters and mass spectrometers for accurate gas data analysis.

The world-leading facility also boasts support infrastructure, which includes theoretical and computational science, and facilities that underpin capabilities in proteomics, metabolomics, biologics, stem cells, nanofabrication, and microscopy and microanalysis.

AIBN Director Professor Alan Rowan said that industrial biotechnology was one of the institute's key future research pillars and would "become the next industrial revolution playing a critical role in Queensland's future economy and that of Australia."

Research underpinning the AIBN and LanzaTech collaboration has been published in the journal *Cell Systems*.

More information: Kaspar Valgepea et al. Maintenance of ATP Homeostasis Triggers Metabolic Shifts in Gas-Fermenting Acetogens, *Cell Systems* (2017). DOI: 10.1016/j.cels.2017.04.008

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