Discovering the ‘seventh

Scientists have been searching for decades for a biochemical pathway by which bacteria capture CO_2. Irene Sánchez-Andrea found the pathway in the course of a ‘hobby project’, and received University Fund Wageningen’s Research Award for her discovery.

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Some organisms can capture carbon dioxide (CO_2) and convert it into the organic carbon compounds they need for their growth. Until last year, six carbon fixation pathways were known to scientists. The most familiar of these pathways is the Calvin cycle used by plants in photosynthesis. Less widely known are the other conversion pathways used by bacteria and bacteria-like organisms called archaea for their growth. This microbial CO_2 fixation is very important in the oceans, for example.

SPECULATION

Ever since the 1980s, there has been speculation about a seventh mechanism for capturing carbon dioxide, says Fons Stams, chair of the Microbial Physiology group at the Laboratory for Microbiology when Irene Sánchez-Andrea developed the experiments and discovered the pathway in *Desulfovibrio desulfuricans*, a bacterium that lives in sediments and soils under anaerobic conditions. Stams started studying these bacteria back in 2008, and at that time he and his colleagues thought *D. desulfuricans* needed organic matter to grow. But Sánchez-Andrea discovered that this microorganism can thrive on just the combination of hydrogen, sulphate and CO_2, all inorganic compounds. After three years of laboratory experiments and computer analyses, the pathway that the bacterium uses to make carbon building blocks out of CO_2 was mapped out.

Sánchez-Andrea received University Fund Wageningen’s Research Award 2021 for the discovery of this seventh pathway – the ‘reductive glycine pathway’ – during the University’s Dies Natalis (Founders Day) in March. ‘It was my hobby project alongside my main research which focuses on metabolic conversions and pathways used by sulphur-cycling microorganisms’, says Sánchez-Andrea. ‘It was very time-consuming, and we faced a lot of challenges, such as making sure the growth medium didn’t contain any organic compounds. Chemicals or the glassware that you routinely use in the lab can contain organic compounds, but we couldn’t afford any contamination.’ She collaborated with researchers at the Max Planck Institute in

Irene Sánchez-Andrea does research on the CO_2 conversion route in the bacterium *Desulfovibrio desulfuricans.*

pathway’

Potsdam who were also looking for the seventh pathway, and with researchers at UC Berkeley who have specialized knowledge on the detection of the products of metabolic processes. The results were published in *Nature Communications* in October 2020, with Sánchez-Andrea as lead author. The discovery of the pathway is not only a scientific achievement but may also be of use for tackling climate-related problems and for developing a biobased economy. Converting CO_2 into carbon compounds requires an external source of energy, but *D. desulfuricans* appears to convert CO_2 into biomass and chemicals in a relatively energy-efficient manner. Sánchez-Andrea aims to take the research further by culturing the bacterium on a large scale to produce useful chemicals such as biofuels. ‘We can grow the bacterium in the lab. The next step is to expand the range of products by getting the bacterium to make more compounds. We also want to see whether we can introduce this pathway into other bacteria that grow easily in bioreactors, in the hope of producing chemical building blocks on a large scale with little energy, while capturing CO_2 at the same time.’ The Research Award jury praised Sánchez-Andrea’s work: ‘This is a terrific example of curiosity- and hypothesis-driven fundamental research with great potential for applications.’ ■

‘We hope to be able to produce chemical building blocks and capture CO_2 at the same time’

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