Trends in Microbiology | Microbe of the Month

Methanosarcina acetivorans

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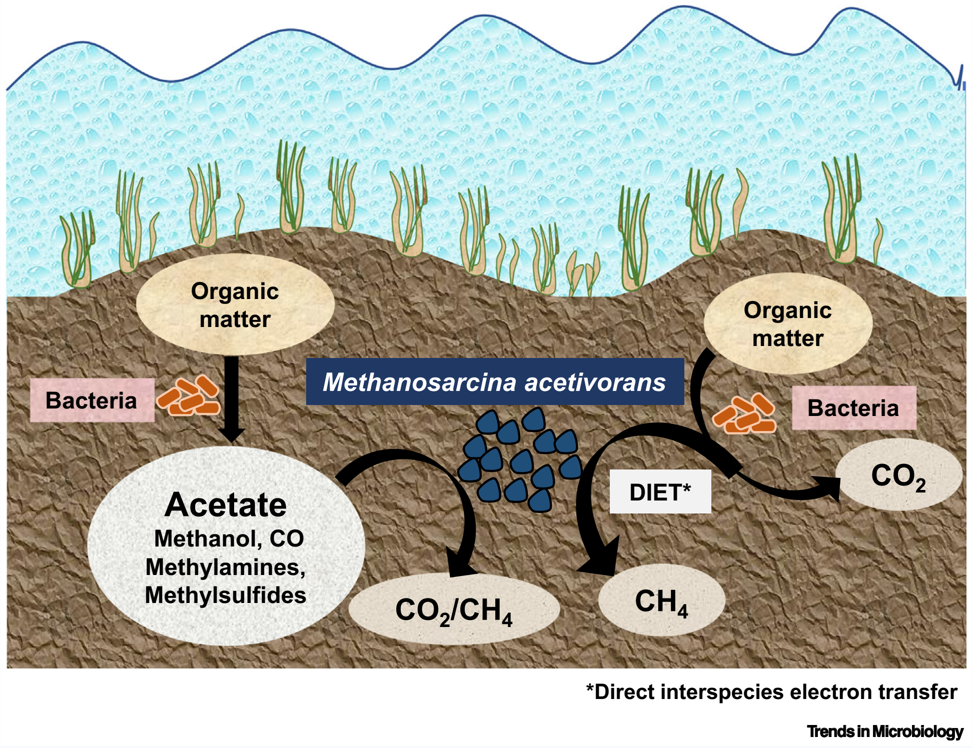
Methanosarcina acetivorans is a strictly anaerobic methane-producing archaeon (methanogen) that was isolated from marine sediment beneath a kelp bed in the Sumner branch of Scripps Canyon near La Jolla, California, in 1984. Over the years it has become a primary model to understand the genetics, biochemistry, and physiology of methanogens, microbes that play a critical role in several biogeochemical cycles, impact climate change, and have biotechnological value. The utility of *M. acetivorans* as a model is due in part to its extensive metabolic versatility. For example, it can grow by producing CH_4 and CO_2 using acetate, methylated substrates, or CO. Notably, *M. acetivorans* has been instrumental in elucidating key aspects of the aceticlastic pathway of methanogenesis in *Methanosarcina*, one of only two genera capable of using acetate to produce methane, which accounts for two-thirds of all methane biologically produced. *M. acetivorans* also has robust genetic tools. Genetic engineering of *M. acetivorans* has, for example, expanded its substrate range, increased its resistance to oxidants, converted it to an acetogen, and increased its ability to oxidize methane (reverse methanogenesis). *M. acetivorans* is also the first methanogen with clustered regularly interspaced short palindromic repeats (CRISPR) gene editing and CRISPR interference systems, firmly establishing *M. acetivorans* as a key platform for basic and applied methanogen research for years to come.



KEY FACTS:

M. acetivorans has one of the largest archaeal genomes (5.75 Mbp) that highlights its broad ability to adapt to changing environmental conditions.

M. acetivorans is among the most oxygen tolerant methanogens.

M. acetivorans lives in two distinct morphologies, as aggregates of cells encased in a matrix when cultured in low-salt medium or in single-cell morphology when cultured in high-salt medium.

Unlike most methanogens, *M. acetivorans* does not use hydrogen as an electron donor for methanogenesis.

Acetate, formate, and methylsulfides are produced, in addition to methane and CO_2, when *M. acetivorans* metabolizes CO.

M. acetivorans is capable of Fe(III)-dependent respiratory growth with acetate, indicating that it also contributes to the iron biogeochemical cycle.

M. acetivorans can accept electrons directly from bacteria to produce methane through the process of direct interspecies electron transfer (DIET).

Depending on growth substrate, *M. acetivorans* consumes and produces methylsulfides (methanethiol and dimethylsulfide), which are important intermediates in the global sulfur cycle.

The genome of *M. acetivorans* encodes all three types of nitrogenase and is capable of nitrogen fixation, indicating that it plays a role in the global nitrogen cycle.

TAXONOMY AND CLASSIFICATION:
DOMAIN: Archaea
PHYLUM: Euryarchaeota
CLASS: Methanomicrobia
ORDER: Methanosarcinales
FAMILY: Methanosarcinaceae
GENUS: *Methanosarcina*
SPECIES: *Methanosarcina acetivorans*

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Declaration of interests

No interests are declared.

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