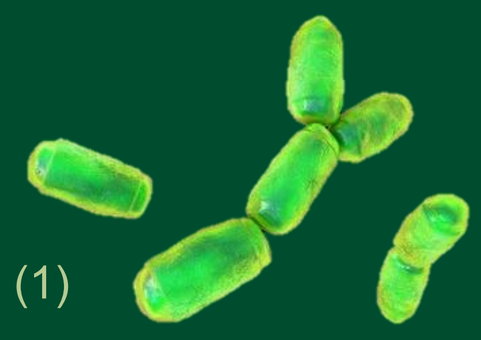

(1)

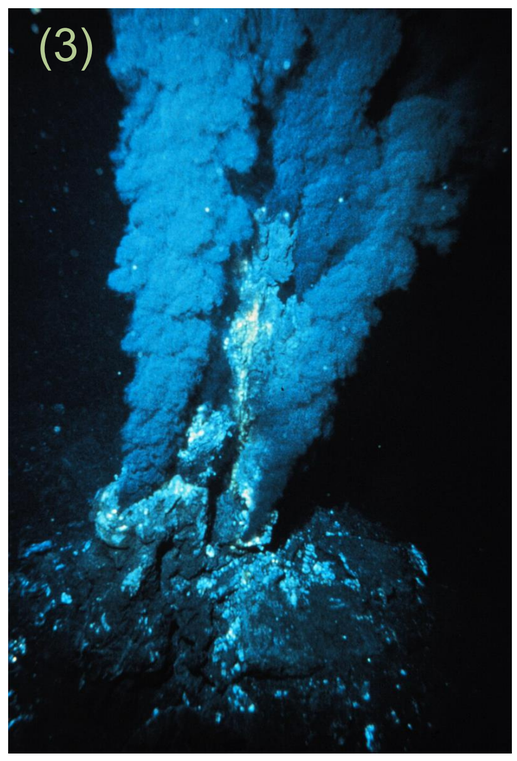
ANCIENT MICROBES, MODERN CLIMATE

METHANOGENS: ARCHAEA SHAPING EARTH'S CARBON CYCLE

WHAT ARE METHANOGENS?

Methanogens are a group of archaea that produce methane (CH_4) as a metabolic byproduct in strictly anaerobic (oxygen-free) environments Methanogens are commonly found in wetlands, marine sediments, hydrothermal vents, and the digestive systems of ruminant animals such as cows. Methanogens also have a significant impact on Earth's climate.

(2)


(3)

METHANOGENS AND THE GLOBAL CARBON CYCLE

In oxygen-free environments, bacteria first break down organic material through fermentation, producing compounds such as hydrogen (H_2) and carbon dioxide (CO_2). Methanogens then use these products to generate methane (CH_4) through methanogenesis.

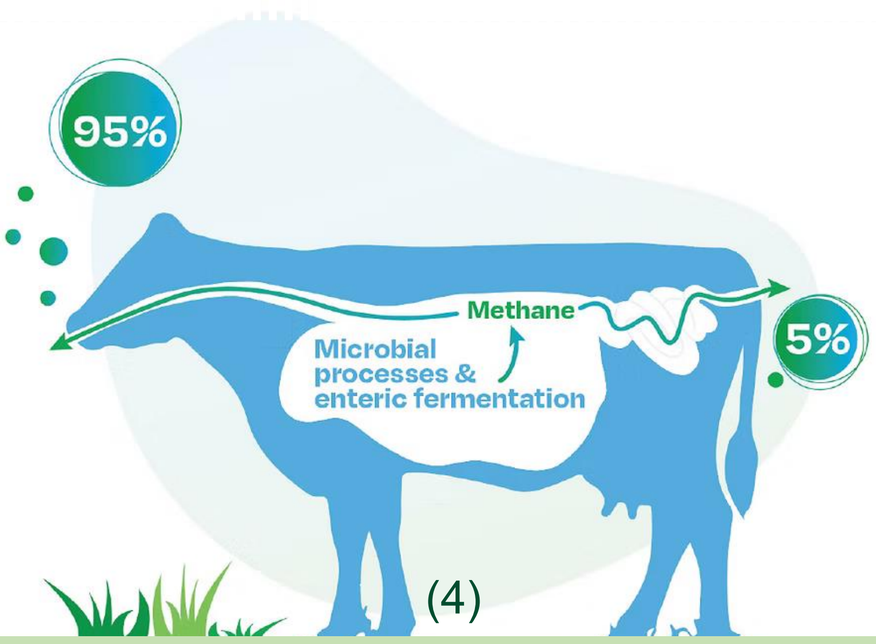
$$CO_2 + 4H_2 \rightarrow CH_4 + 2H_2O$$

The methane released into the environment can later be oxidized back into CO_2 by methanotrophic microorganisms, linking methanogenesis to the broader carbon cycle and climate system.

METHANOGENS AND EARLY EARTH

Methanogens are thought to represent one of the oldest forms of microbial metabolism on Earth. Many methanogens inhabit environments with high temperatures, pressure, and anoxic conditions which may resemble environments present on early Earth.

Did you know? *Methanopyrus kandleri*, are capable of growth at temperatures up to 122°C.



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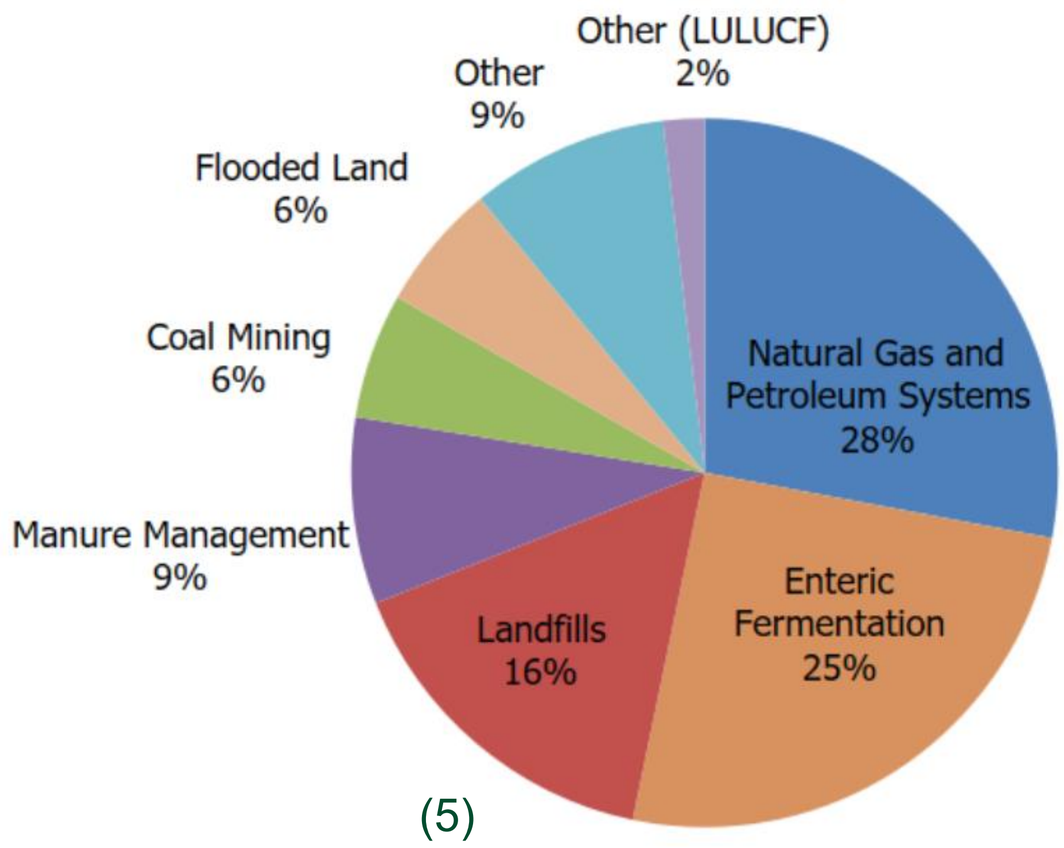

(5)

Enteric fermentation is a natural digestive process in ruminant animals (cattle, sheep, goats) where microbes in the rumen ferment carbohydrates, producing methane as a by-product. This is estimated to be the source of 25% of methane emissions (2025).

Figures
(1) Adobe Stock, (2) wp. (2025, April 4). What Makes a Wetland a Wetland? WSB. https://www.wsbeng.com/what-makes-a-wetland-a-wetland/, (3) P. Rona / OAR/National Undersea Research Program (NURP); NOAA - NOAA Photo Library. Memento (WayBack Machine archive.org), (4) Enteric Methane Reduction | Dairy Conservation Navigator. (2021). Dairy Conservation. https://www.dairyconservation.org/enteric-emissions, (5), Methane Emissions | US EPA. (2025, January 7). US EPA. https://www.epa.gov/ghgemissions/methane-emissions#:~:text=Natural%20gas%20and%20petroleum%20systems,in%20the%20absence%20of%20oxy