16.4C: Syntrophy and Methanogenesis

Bacteria that perform anaerobic fermentation often partner with methanogenic archea bacteria to provide necessary products such as hydrogen.

Learning Objectives

• Assess syntrophy methanogenesis

Key Points

• Methanogenic bacteria are only found in the domain Archea, which are bacteria with no nucleus or other organelles.
• Methanogenesis is a form of respiration in which carbon rather than oxygen is used as an electron acceptor.
• Bacteria that perform anaerobic fermentation often partner with methanogenic bacteria. During anaerobic fermentation, large organic molecules are broken down into hydrogen and acetic acid, which can be used in methanogenic respiration.
• There are other examples of syntrophic relationships between methanogenic bacteria and microorganisms: protozoans in the guts of termites break down cellulose and produce hydrogen which can be used in methanogenesis.

Key Terms

• Archea: A domain of single-celled microorganisms. These microbes have no cell nucleus or any other membrane-bound organelles within their cells.
• syntrophy: A phenomenon where one species lives off the products of another species.
• **methanogenesis**: The generation of methane by anaerobic bacteria.

Syntrophy or cross feeding is when one species lives off the products of another species. A frequently cited example of syntrophy are methanogenic archaea bacteria and their partner bacteria that perform anaerobic fermentation.

![Methanogenic Bacteria in Termites](https://bio.libretexts.org/Bookshelves/Microbiology/Book%3A_Microbiology_(Boundless)/16%3A_Microbial_Ecology/16.4%3A...)

**Figure: Methanogenic Bacteria in Termites**: Methanogenic bacteria have a syntrophic relationship with protozoans living in the guts of termites. The protozoans break down cellulose, releasing H2 which is then used in methanogenesis.

Methanogenesis in microbes is a form of anaerobic respiration, performed by bacteria in the domain Archaea. Unlike other microorganisms, methanogens do not use oxygen to respire; but rather oxygen inhibits the growth of methanogens. In methanogenesis, carbon is used as the terminal electron receptor instead of oxygen. Although there are a variety of potential carbon based compounds that are used as electron receptors, the two best described pathways involve the use of carbon dioxide and acetic acid as terminal electron acceptors.

**Acetic Acid**: $\text{CO}_2 + 4\text{H}_2 \rightarrow \text{CH}_4 + 2\text{H}_2\text{O}$

**Carbon Dioxide**: $\text{CH}_3\text{COOH} \rightarrow \text{CH}_4 + \text{CO}_2$

Many methanogenic bacteria that live in close association with bacteria produce fermentation products such as fatty acids longer than two carbon atoms, alcohols longer than one carbon atom, and branched chain and aromatic fatty acids. These products cannot be used in methanogenesis. Partner bacteria of the methanogenic archea therefore process these products. By oxidizing them to acetate, they allow them to be used in methanogenesis.
Methanogenic bacteria are important in the decomposition of biomass in most ecosystems. Only methanogenesis and fermentation can occur in the absence of electron acceptors other than carbon. Fermentation only allows the breakdown of larger organic compounds, and produces small organic compounds that can be used in methanogenesis. The semi-final products of decay (hydrogen, small organics, and carbon dioxide) are then removed by methanogenesis. Without methanogenesis, a great deal of carbon (in the form of fermentation products) would accumulate in anaerobic environments.

Methanogenic archea bacteria can also form associations with other organisms. For example, they may also associate with protozoans living in the guts of termites. The protozoans break down the cellulose consumed by termites, and release hydrogen, which is then used in methanogenesis.