ISSN: 2167-7662
Bioenergetics: Open Access

OPEN ACCESS Freely available online

Commentary

Metabolic Maneuvers: *Salmonella typhimurium's* Anaerobic Respiration against Colonization Resistance

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DESCRIPTION

Salmonella enterica serovar typhimurium (Typhimurium) is a bacterial pathogen that can cause gastrointestinal infections in humans and animals. To establish infection and colonization within the host, Typhimurium must overcome various host defenses, including the colonization resistance mediated by the gut microbiota. Recent research has revealed a mechanism employed by Typhimurium to overcome propionate-mediated colonization resistance. This article aims to explore the role of anaerobic respiration in Typhimurium's ability to overcome propionate-induced colonization resistance, analysing on the intricate interactions between pathogens and the gut microbiota.

Colonization resistance and propionate-mediated defense

The gut microbiota plays a crucial role in protecting the host against pathogenic infections. One mechanism by which the gut microbiota provides colonization resistance is through the production of Short-Chain Fatty Acids (SCFAs), including propionate. Propionate acts as a potent antimicrobial agent, inhibiting the growth and colonization of certain pathogens, including Typhimurium.

Propionate is produced by specific members of the gut microbiota, such as bacteroidetes and firmicutes, through the fermentation of dietary fibers. This SCFA inhibits pathogen growth by multiple mechanisms, including disruption of bacterial membrane potential, inhibition of essential metabolic pathways, and alteration of the local gut environment. Thus, propionate-mediated colonization resistance represents an important defense mechanism against enteric pathogens.

Typhimurium's anaerobic respiration as a countermeasure

In response to propionate-induced colonization resistance, Typhimurium has evolved a unique strategy to overcome this host defense mechanism. Recent studies have demonstrated that Typhimurium utilizes anaerobic respiration as a countermeasure against propionate-mediated inhibition.

Anaerobic respiration is a metabolic process that allows bacteria to generate energy in the absence of oxygen. Typhimurium possesses a set of genes encoding enzymes involved in anaerobic respiration, such as nitrate reductases and fumarate reductases. These enzymes enable Typhimurium to utilize alternative electron acceptors, such as nitrate and fumarate, in the absence of oxygen.

By switching to anaerobic respiration, Typhimurium can bypass the inhibitory effects of propionate. This is because propionate-mediated inhibition primarily occurs under aerobic conditions, where propionate inhibits bacterial respiration and energy production. However, under anaerobic conditions, Typhimurium can utilize alternative electron acceptors and maintain its energy metabolism, allowing it to overcome propionate-induced colonization resistance.

The mechanism of anaerobic respiration and propionate resistance

The precise mechanism by which anaerobic respiration enables Typhimurium to overcome propionate-induced inhibition is still being investigated. However, several hypotheses have been proposed based on the current understanding of bacterial physiology and metabolism.

One hypothesis suggests that anaerobic respiration allows Typhimurium to bypass the need for aerobic respiration, thereby preventing the accumulation of propionate-induced metabolic intermediates that inhibit bacterial growth. Another possibility is that the use of alternative electron acceptors in anaerobic respiration alters the intracellular redox balance, preventing the inhibitory effects of propionate.

Furthermore, it is speculated that the switch to anaerobic respiration may induce changes in the expression of specific genes or metabolic pathways, allowing Typhimurium to adapt

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Received: 19-Jun-2023, Manuscript No. BEG-23-22347; **Editor assigned**: 21-Jun-2023, PreQC No. BEG-23-22347 (PQ); **Reviewed:** 06-Jul-2023, QC No. BEG-23-22347; **Revised:** 13-Jul-2023, Manuscript No. BEG-23-22347 (R); **Published:** 21-Jul-2023, DOI: 10.35248/2167-7662.23.11.224

Citation: Laura C (2023) Metabolic Maneuvers: *Salmonella typhimurium's* Anaerobic Respiration against Colonization Resistance. J Bio Energetics. 11:224.

and survive in the presence of propionate. Future research is needed to show the precise molecular mechanisms underlying the interplay between anaerobic respiration and propionate resistance in Typhimurium.

Implications for host-pathogen interactions and therapeutic strategies

The discovery of Typhimurium's utilization of anaerobic respiration to overcome propionate-mediated colonization resistance has important implications for our understanding of host-pathogen interactions and the development of therapeutic strategies.

Firstly, this mechanism highlights the dynamic and adaptive nature of bacterial pathogens in response to host defenses. Pathogens such as Typhimurium have evolved strategies to exploit specific conditions or resources within the host to establish successful colonization and infection.

Secondly, this finding suggests that targeting the metabolic pathways and electron acceptors utilized by Typhimurium during anaerobic respiration may represent a potential therapeutic strategy. By disrupting the ability of Typhimurium to adapt to propionate-induced inhibition, it may be possible to enhance the effectiveness of existing antimicrobial treatments or develop novel therapeutic interventions. Typhimurium's utilization of anaerobic respiration to overcome propionate-mediated colonization resistance provides valuable insights into the complex interplay between pathogens and the gut microbiota. This mechanism highlights the adaptive nature of bacterial pathogens and their ability to overcome host defenses through metabolic strategies.