

## Strict anaerobes: Masters of life in oxygen's absence.

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### Introduction

In the mesmerizing world of microbiology, there exists a class of microorganisms that defy the conventional rules of life as we know it. These are the strict anaerobes, a group of organisms that thrive in the absence of oxygen, a gas that is considered indispensable for most life forms on Earth. Their existence challenges our perception of habitable environments and highlights the remarkable adaptability of life. In this article, we embark on a journey into the realm of strict anaerobes, exploring their characteristics, habitats, metabolic adaptations, and their significance in various fields of science [1].

### Defining strict anaerobes: Life without oxygen

To understand strict anaerobes, we must first grasp the concept of anaerobic life. Anaerobes are organisms that can live and grow in environments devoid of molecular oxygen (O<sub>2</sub>). While oxygen is essential for the respiration of many living organisms, strict anaerobes have evolved unique adaptations that enable them to thrive where oxygen is scarce or entirely absent.

### Characteristics of strict anaerobes

Strict anaerobes are highly sensitive to oxygen. Even brief exposure to oxygen can be lethal for them. This intolerance is due to their inability to detoxify Reactive Oxygen Species (ROS), which are harmful by-products of oxygen metabolism. Energy generation unlike aerobic organisms that use oxygen as the final electron acceptor in their Electron Transport Chain (ETC) for energy production, strict anaerobes employ alternative electron acceptors, such as nitrate, sulfate, or carbon dioxide, to generate energy through anaerobic respiration or fermentation. Some strict anaerobes are capable of forming resilient spores, allowing them to endure unfavorable conditions, including oxygen exposure, until more hospitable environments arise [1].

### Habitats of strict anaerobes

Soil has many strict anaerobes inhabit soil, where oxygen penetration can be limited, especially in deeper layers. They play crucial roles in nutrient cycling and organic matter decomposition. These environments are often oxygen-poor due to water saturation. Strict anaerobes in wetlands contribute to the production of methane, a potent greenhouse gas. Gastrointestinal tracts the intestines of humans and animals provide a unique anaerobic environment where strict anaerobes

participate in digestion and the fermentation of dietary fibre. Deep ocean sediments in the deep ocean, where oxygen concentrations decrease with depth, strict anaerobes are found in sediments below the seafloor. These microorganisms are crucial for carbon and nutrient cycling in the ocean's depths. Bioreactors and fermentation tanks in industrial settings, strict anaerobes are harnessed in bioreactors and fermentation tanks to create controlled anaerobic conditions for the production of biofuels, chemicals, and enzymes [2].

### Metabolic adaptations of strict anaerobes

To survive and thrive without oxygen, strict anaerobes have evolved various metabolic adaptations. Many strict anaerobes employ fermentation as a means of generating energy. During fermentation, they metabolize organic compounds, such as sugars and organic acids, to produce energy and metabolic byproducts like alcohol, lactic acid, and hydrogen gas. Some strict anaerobes use sulfate (SO<sub>4</sub><sup>2-</sup>) as an electron acceptor in a process called sulfate reduction. This metabolic pathway leads to the production of hydrogen sulfide (H<sub>2</sub>S), a metabolic byproduct often associated with the distinctive smell of swampy environments. Certain strict anaerobes are involved in methanogenesis, a process where they produce methane (CH<sub>4</sub>) by utilizing carbon dioxide (CO<sub>2</sub>) or various organic compounds as electron acceptors. Methanogens are particularly abundant in environments like wetlands and the digestive tracts of animals [3].

### Significance of strict anaerobes

Strict anaerobes hold substantial significance across various fields of science. Strict anaerobes are essential players in biogeochemical cycles, particularly in carbon and nutrient cycling. Their metabolic activities impact global ecosystems and have implications for climate change. Some strict anaerobes are employed in bioremediation processes to clean up contaminated environments. They can degrade a wide range of pollutants, including organic compounds and heavy metals. Strict anaerobes are utilized in industrial biotechnology for various applications, including the production of biofuels (e.g., biogas, butanol) and valuable chemicals [4].

Despite their remarkable adaptability and significance, strict anaerobes present challenges in research and practical applications. Managing and working with strict anaerobes in a laboratory setting can be challenging due to their extreme sensitivity to oxygen. Specialized equipment and techniques are required to maintain anaerobic conditions. Continued

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research into the metabolic pathways and genetic regulation of strict anaerobes holds the potential for optimizing their use in biotechnological applications. Understanding the role of strict anaerobes in environmental processes, such as methane production and bioremediation, is essential for addressing global environmental challenges [5].

## Conclusion

Strict anaerobes, the masters of life in oxygen's absence, continue to intrigue scientists with their remarkable adaptability and ecological significance. These microorganisms have found a niche in diverse environments, from the depths of ocean sediments to the depths of our own digestive tracts. Their metabolic adaptations, including fermentation and alternative electron acceptors, enable them to thrive where oxygen is scarce or entirely absent. As researchers delve deeper into the genetic and metabolic intricacies of strict anaerobes, we can anticipate new breakthroughs that harness their potential for biotechnological applications and environmental solutions. Understanding strict anaerobes is not just about unveiling the diversity of these microorganisms; it's also about unlocking their transformative potential in various domains of science

and industry while navigating the unique challenges they present.

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