The Life Cycle and Social Networks of Myxococcus Xanthus

Introduction

Bacterial distribution varies in different ecological niches including soil. Micrococci bacteria majorly live in the topsoil layer of the earth. They are responsible for natural soil fertility. These microbes are both predatory and saprophytic. Myxococcus xanthus is one of the species belonging to this group of bacteria with unique traits. Scientific research of Myxococcus xanthus seeks to understand the factors regulating their unusual life cycle as well as their nature of forming bridging networks in biofilms.

Literature Review

Myxococcus xanthus is a gram-negative bacterium that is rod-shaped and belongs to the myxobacteria species. The bacterium grows commonly in soils rich in organic matter and a pH range of between 5-10. However, the bacterium can also grow in natural environments with high organic components such as cow dung [4]. The bacterium utilizes macromolecules such as lipids and peptides as a source of nutrition. In addition. the bacterium also groups together to form multicellular communities that feed on other microorganisms such as E.coli [4]. The colony utilizes extracellular antibiotics and enzymes that are derivative to immobilize and consume their prey [2]. This is facilitated by the process of stigmergy that allows the swarm to increase the concentration of digestive extracellular enzymes.

The gram-negative bacterium moves by gliding motility. The term motility refers to movement along the long axis of a cell on a surface without the use of flagella [3]. In M. xanthus the motilities are divided into A and S motility. S-motility refers to the movement of the cells in groups while A-motility refers to the individual movement of single cells. S-motility requires fibrils, type four pili and lipopolysaccharide (LPS) and O- antigen. The type four pilus cells adhere to the surface of neighboring surface the cells then retract resulting in movement [3]. In A-motility movement combines multiple motor elements that are localized on periplasmic space and bound on the peptidoglycan layer. The motorS generate the movement assisted by extracellular polysaccharide slime

During periods of nutritional stress or starvation when the bacterium cannot attain enough nutrients they come together to form fruiting bodies and spores in the interior of the body. The spores can go long periods without feeding due to their cells being metabolically neutral [1). The cells can withstand desiccation, higher temperatures within their habitat. The process involves rounding up of the cells and restructuring of cell walls. The cells transform from their rod shape to spherical shapes that are heat resistant myxospores [2]. The peripheral cells retain their rod shapes. As soon as the environment becomes conducive again, the spores germinate to produce other rod-ronized process enables germination of many cells [1. These shaped vegetati myxospores to facilitate swarming.

Unique Characteristics

Previous research indicates the presence of intercellular communication that facilitates swarming. fruiting and sporulation. The M. xanthus swarm has been associated with eavesdropping on prey. As such, the bacterium detects extracellular signals produced by prey thus able to change swarming behavior to become a better predator [ó).

Discussion

The life cycle of Myxococcus xanthus

When nutrients are scarce, M. xanthus microbes are triggered to initiate a life cycle. That is, starvation causes the swarms to aggregate [91. The aggregated cells transform into a mold. In these stages, some of the cells remain free fioating as monolayers of rod cells in the surrounding environment [9]. Although little is known about this undifferentiated monolayer of cells, it is believed that their purpose is to survey the environment and detect the presence of nutrients since the aggregated cells are inactive. If starvation persists, the molds are differentiated into fruiting bodies. Persistent deficiency of nutrients triggers morphogenesis of the fruiting bodies into spores known as Myxospores l6]. Spores are inactive during starvation and are activated by the presence of nutrients [6]. When nutrients are detected in the environment, myxospores germinate into a vegetative form and initiate formation of biofilms and swarms. Availability of nutrients before the cells form spores triggers the vegetative stage in the undifferentiated cells [71. This cycle is summarized in figure 1. Such a highly regulated cycle is genetically programmed [6].

The social network of M. xanthus

Although earlier debates have disputed the existence of connections between cels in a biofilm, a study by Remis and others [5], revealed that the connecting vesicles are not artifacts from the sample. Their analysis demonstrated the existence of a consistent network that cannot occur randomly from sample artifacts [5]. In their study, they asserted that these bridges had a fundamental role in the nutrition or communication of signals within the biofilm apart from binding the cells [5]. Moreover, they might be useful in the movement of swarms during predation, as well as the formation of aggregates in the life cycles. Their 3-D imaging technique revealed that the connections existed between all the cells of the biofilm suggesting the existence of a bacterial social network 15].

An analysis of the bridges between these cells reveals that they are fluid bridges that can allow the exchange of substances such as proteins and hydrophobic molecules [5]. Also, sugar-like groups similar to those found in eukaryotic cells were evident in these bridges l5]. Thus, the bridges might possess characteristics of communication channels between the cells in the network [5]. Moreover, the vesicles are filled with spaces and therefore possess traits of selective permeability found in cells. Consequently, the vesicles might be elongations of the cells to increase the surface area of nutrient absorption [5]. On the other hand, Cg1B and Tgl vesicles have been identiffed in bridges connecting the biofilms. These vesicles are usually used to transport motility proteins in cells [5]. Their presence in the network bridges suggests that these connections are involved in aiding motility of the clusters [5]. As such, the cells transfer mobility proteins to the mobile strains of the cluster to enable their propulsion.

Conclusion

Xanthus is a predatory bacterial strain that commonly exists in swarms of clustered biofilms. They are soil microbes with a unique life cycle that has a vegetative and an inactive stage regulated by the presence of nutrients. The bacteria predate on other cells using lytic, enzymatic, and antibiotic secretions to digest the cells. Their movement occurs by gliding. but it is their clustering that fascinates researchers. Evidence reveals that connecting bridges exist between the cells resulting in many hypotheses about their functions. Thus, further investigation is needed to understand the role of this network.