6.2C: Starvation-Induced Fruiting Bodies

Starvation-induced fruiting bodies can aggregate up to 500 micrometres long and contain approximately 100,000 bacterial cells.

Learning Objectives

• Explain starvation induced fruit bodies

Key Points

• In fruiting bodies, the bacteria perform separate tasks; this type of cooperation is a simple type of multicellular organisation.
• *Myxococcus xanthus* colonies exist as a self-organized, predatory single-species biofilm called a swarm.
• The fruiting process is thought to benefit *myxobacteria* by ensuring that cell growth is resumed with a group (swarm) of *myxobacteria*, rather than as isolated cells.

Key Terms

• **quorum sensing**: A proposed method of communication between bacterial cells by the release and sensing of small diffusible signal molecules.
• **stigmergy**: A mechanism of spontaneous, indirect coordination between agents or actions, where the trace left in the environment by an action stimulates the performance of a subsequent action.
• **saprotrophic**: Extra-cellular digestion involved in the processing of dead or decayed organic matter
Starvation-Induced Fruiting Bodies

When starved of amino acids, myxobacteria, or slime bacteria, detect surrounding cells in a process known as quorum sensing. Migrating towards each other, they aggregate to form fruiting bodies up to 500 micrometers long containing approximately 100,000 bacterial cells. In these fruiting bodies, the bacteria perform separate tasks; this type of cooperation is a simple type of multicellular organisation. About one in 10 cells migrate to the top of these fruiting bodies and differentiate into a specialized dormant state called myxospore, which is more resistant to drying and other adverse environmental conditions than ordinary cells.

The myxobacteria are a group of bacteria that predominantly live in the soil and feed on insoluble organic substances. The myxobacteria have very large genomes, relative to other bacteria e.g., 9–10 million nucleotides. Sorangium cellulosum has the largest known (as of 2008) bacterial genome, at 13.0 million nucleotides.

Myxobacteria are included among the delta group of proteobacteria, a large taxon of Gram-negative forms. They can move actively by gliding and typically travel in swarms (also known as wolf packs), containing many cells kept together by intercellular molecular signals. Individuals benefit from aggregation as it allows accumulation of extracellular enzymes which are used to digest food that increases feeding efficiency.

Myxobacteria produce a number of biomedically and industrially-useful chemicals, such as antibiotics, and export those chemicals outside of the cell. When nutrients are scarce, myxobacterial cells aggregate into fruiting bodies, a process long-thought to be mediated by chemotaxis but now considered to be a function of a form of contact-mediated signaling. These fruiting bodies can take different shapes and colors, depending on the species.

Within the fruiting bodies, cells begin as rod-shaped vegetative cells and develop into rounded myxospores with thick cell walls. These myxospores, analogous to spores in other organisms, are more likely to survive until nutrients are more plentiful. The fruiting process is thought to benefit myxobacteria by ensuring that cell growth is resumed with a group (swarm) of myxobacteria, rather than as isolated cells. At a molecular level, initiation of fruiting body development is regulated by Pxr sRNA.
*Myxococcus xanthus* colonies exist as a self-organized, predatory, saprotrophic, single-species biofilm called a swarm. *Myxococcus xanthus*, which can be found almost ubiquitously in soil, are thin rod-shaped, gram-negative cells that exhibit self-organizing behavior as a response to environmental cues. The swarm modifies its environment through *stigmergy*. This behavior facilitates predatory feeding, as the concentration of extracellular digestive enzymes secreted by the bacteria increases.

*M. xanthus* is a model organism for studying development, the behavior in which starving bacteria self-organize to form fruiting bodies: dome shaped structures of approximately 100,000 cells. These swarms differentiate into metabolically quiescent and environmentally resistant myxospores over the course of several days. During this process of self-organizing, dense ridges of cells move in traveling waves (ripples) that grow and shrink over several hours.