Soravana H., Edirisinghe S.

QUORUM SENSING. MOLECULAR COMMUNICATION IN BACTERIA

Tutor: senior lecturer Chakhovich N.I.
Department of Microbiology, Virology, Immunology
Belarusian State Medical University, Minsk

Quorum sensing is the control of gene expression in response to changes in cell population density in bacteria. This allows them to sense the number of bacteria around and decide when to act together.

This occurs by releasing signaling molecules called autoinducers (AIs). As bacteria multiply, more autoinducers build up in the environment. When the signal reaches a threshold, a population wide behavioral change takes place by gene alteration. Different bacteria use different autoinducers. Gram negative bacteria, like *Vibrio fischeri* use acyl homoserine lactones (AHLs) and Gram positive bacteria, like *Staphylococcus aureus* use oligopeptides. Gram positive and Gram negative bacteria use quorum sensing to control activities such as the production of virulence factors and formation of biofilms. The use of autoinducers, which at higher concentrations can activate or repress specific genes helps certain bacteria become pathogenically infectious. The first solid proof of quorum sensing was done by the study of bioluminescence in a Gram negative marine bacterial system of *Vibrio fischeri*. It was found living symbiotically on Hawaiian squid for luminescence at night. The light emission was explained at molecular level due to the luciferase operon with *LuxI/R* gene system.

The *LuxI/R* gene system is a communication system where *LuxI* gene codes for a synthase which produces AHLs, which, at high population densities, bind to form a complex with *LuxR* transcription regulator protein which activates transcription of *LuxI* gene so even more AHLs can be produced. The *LuxS* gene produces autoinducer-2 (AI-2) for communication between different bacterial species, unlike the *LuxI/LuxR* system. The *LuxS* gene system is responsible for the expression of the virulence cascade (For an infectious state to be established a threshold of cell density must be achieved before the virulence and its symptoms are observed). Few of such observations include the expression and regulation of virulence and pathogenicity in the human pathogen *Pseudomonas aeruginosa*, and the expression and regulation of a range of enzymes to attack the plant host and the production of antibiotics by a phytopathogen *Erwinia carotovora*. Another example is the phytopathogen *Agrobacterium tumeficiens* was observed to have a *LuxR/I* gene system. The QS circuit system in its plasmid helps in the conjugal transfer of the plasmid into wounded dicot plants and to establish a diseased condition.

Quorum sensing is used in many clinical applications today. Vaccine Development involves making anti-signal vaccines to immunize the host against QS molecules, or as diagnostic biosensors where specific autoinducers are detected to indicate specific pathogen presence. Another clinical application widely used is the enhancement of antibiotics where susceptibility is restored in resistant strains.

The future of quorum sensing is an interesting topic. Scientists see uses in the green industry to optimize bioleaching and in wastewater treatment. In synthetic biology, standardized QS systems can act as genetic switches to control bacterial behaviour. Anti-virulence drugs containing QS inhibitors can be used to disarm pathogens without killing them, reducing resistance risk.

In conclusion, quorum sensing bestows upon bacteria some of the qualities of higher organisms. The evolution of quorum sensing systems in bacteria could have been one of the early steps in the development of multicellularity.