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Quorum Sensing

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Introduction

Bacteria can communicate by producing and responding to small diffusible molecules that act as signals. These molecules have been termed autoinducers (AIs). AIs are produced at basal levels and their concentration increases with growth. Upon reaching a critical concentration, the signal molecules can bind to and activate receptors inside bacterial cells. These receptors can then alter gene expression to activate behaviours that are beneficial under the particular condition encountered. As this phenomenon occurs in a cell-density-dependent manner, it has been termed quorum sensing.

Classes of AIs Molecules

- N-acylhomoserine lactones (AHLs) of Gram-negative bacteria, the peptides of Gram-positive bacteria
- A class of AIs termed AI-2
- AHLs detected -cytoplasmic receptor proteins

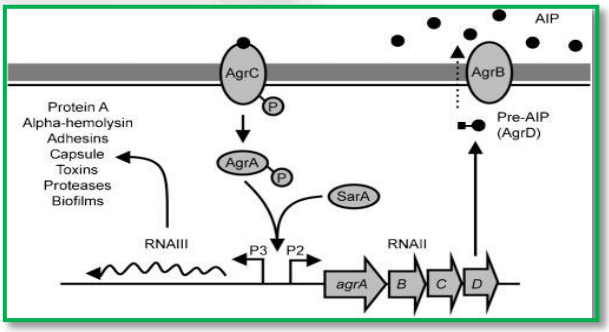
Quorum sensing was originally described in the marine luminescent bacterium *Vibrio fischeri*, where it functions as the control mechanism of light production and numerous other traits. But it is now widely recognized that many bacterial species utilize quorum sensing as part of their regulatory machinery.

Quorum sensing in *Staphylococcus aureus* virulence

- Many Gram-positive bacteria utilize peptide quorum sensing systems to control gene expression and *S. aureus* has served as a model to study bacterial peptide signaling.
- One of the factors which contribute to *S. aureus* virulence is its peptide-based quorum sensing system, encoded by the accessory gene regulator (agr) locus.

Quorum sensing in *Escherichia coli* virulence

- Another bacterial species that uses quorum sensing to control virulence gene expression is *E. coli*.
- This organism produces a signal molecule termed AI-2. AI-2 was originally identified as one of the AIs controlling light production by the marine bacterium *Vibrio harveyi*.
- Subsequently, the gene responsible for AI-2 production was identified and named luxS. Genetic studies in enterohaemorrhagic *E. coli* (EHEC) and enteropathogenic *E. coli* revealed that LuxS controls the expression of the type-3 secretion system encoded by the locus of enterocyte effacement (LEE) pathogenicity.



Quorum sensing controlled processes

- Bioluminescence
- Biofilm formation
- Virulence gene expression
- Sporulation
- Competence

Hrp Genes: One of the Elicitors of Plant Defense Responses

- Hrp genes were first reported by Lindgren *et al*., in 1986
- The ability of plant pathogenic bacteria to deliver death triggering proteins to the interior of plant cells was revealed in 1996
- Plant pathogenic bacteria in the genera *Erwinia, Pseudomonas, Xanthomonas and Ralstonia* they possess *hrp genes*

hrp genes have been extensively characterized in four representative gram-negative plant pathogens:

- *P. syringae pv. syringae (*brown spot of bean*),*
- *Erwinia amylovora* (fire blight of apple and pear),
- *Ralstonia solanacearum (*bacterial wilt of tomato*),*
- Most of the known *hrp genes in these strains are contained* in chromosomal clusters of about 25 kb

Characteristics of *Hrp* Genes

- The *hrp (hypersensitive response and pathogenicity)* genes, found only in gram-negative bacteria
- Are additional bacterial genes that seem to be essential for some bacteria to be able to cause visible disease on a host plant
- *hrp* genes encode proteins called harpins or pilins and are used to make a type III protein secretion system that is used to deliver Avr proteins across the walls and plasma membrane of living plant cells
- enable bacteria to multiply and reach high numbers in a susceptible host
- Most bacterial species have two distinct clusters of *hrp* genes. The larger *hrp* gene cluster consists of six to nine transcription units, with each transcription unit coding for several (1 to 12) proteins.
- The transcription of *hrp* genes is controlled *by* the presence of certain nutrients, by other bacterial regulatory genes, and by signal molecules of plant origin
- Some *hrp genes* also code for an ATPase enzyme that may play a role in energizing the secretory apparatus
- Hrp genes were located both on chromosome and plasmid

Functions of Hrp and Hrc proteins in type III protein secretion

- The formation of secretory apparatus requires the presence of all the hrp and hrc genes
- Hrp genes in pathogenesis
- Hrp genes induce the defence mechanism
- Hrc genes helps in flagellum biogenesis in G –ve bacteria

Effector proteins

Based on their localization in plants, type III effector proteins of *P. syringae* can be grouped into two classes*:*

1.Extracellular type III effectors
2. Intracellular type III effectors

The extracellular type III effectors

- Mainly HrpZ and HrpW,
- Are glycine-rich, cysteine-lacking,
- Heat-stable proteins (called harpins)
- Can elicit an HR-like response when injected into the intercellular space of plant leaves

The intracellular effectors

- Are those directly transported from the bacteria cell into the plant cytosol, including Avr proteins, which function within the plant host cell.