



Short Communication

Approach to Quorum Sensing and Functions of Signal Molecules in Biofilms

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ABSTRACT

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Quorum sensing (QS) permits bacteria to assess their local population density and physical confinement via the secretion and detection of small, diffusible signal molecules. Bacteria physically interact with surfaces to develop complex multicellular and often multispecies assemblies, together with biofilms and smaller aggregates. The potential of bacteria to communicate and act as a group for social interactions like a multi-cellular organism has provided remarkable benefits to bacteria in host colonization, formation of biofilms, defense against competitors, and adaptation to changing environments. Signal molecules functions and biofilm development often requires cell-cell communication between colonizing bacteria. Significantly, many quorum sensing-controlled activities have been entangled in the virulence and pathogenic potential of bacteria. Accordingly, knowing the molecular details of quorum sensing mechanisms and functioning of signal molecules in biofilms may results in controlling bacterial infections.

Keywords: Quorum sensing, Biofilms, AHL (acyl-homoserine lactone) molecules, Furanones, Quorum sensing inhibitors.

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1. INTRODUCTION

Many bacteria have been found to regulate diverse physiological processes and group activities through a mechanism called quorum sensing. Quorum sensing describes a bacterial communication phenomenon that allows bacteria to communicate using secreted signal molecules to access their population density [1]. QS mechanisms have been studied in the context of planktonic cultures. Pure-culture planktonic growth of bacteria rarely exists in natural environments. In fact, bacteria in Nature

largely reside in a complex and dynamic surface-associated community called a biofilm [2]. Microbiologists have discovered an unexpectedly high degree of coordinated multi-cellular behaviours that have led to the perception of biofilms as “cities” of microorganisms [3]. It has long been known that in infectious diseases the invading bacteria need to reach certain critical cell density before they express virulence and overwhelm the host defence mechanisms before they initiate an infectious disease [4]. A growing body of excellent reviews has highlighted quorum sensing and its roles in bacterial social activities, biofilm formation and infectious diseases over the last few decades [5]. This review gives an idea about the quorum sensing mechanisms and also enlightens signal molecules function in Biofilms. Earlier the QS mechanisms were studied on the basis of bacterial ecology, evolution and its social interactions in a biofilm which enhanced the pre requisite knowledge for biofilm formation. The critical cell density before express its virulence, gives an exotic gateway to cure infectious disease in coming years. Presently, the researchers are more concerned on QS and signal molecules and its function in biofilms.

How will Quorum Sensing Signal Molecules Function in Biofilms?

In liquid cultures, all bacteria are presumed to be physiologically similar and are producing signal molecules at the same rate [6]. However, quorum sensing and signal transduction in biofilms might be much more troublesome because of a range of physical, chemical and nutritional factors which may influence signal production, stability, distribution and efficiency that interact with their cognate receptors in a biofilm. Bacterial biofilms normally have bacterial cells and an extracellular matrix, including a mixture of secreted proteins, polysaccharides, nucleic acids and dead cells [7]. AHL (acyl-homoserine lactone) molecules are known to diffuse freely across the cell membrane, so that they are assumed to have little trouble to reach their target receptors via free diffusion in the biofilm matrix [8]. However, signaling peptides produced from Gram-positive bacteria are likely influenced by physical, chemical and biological factors within a biofilm because of the highlight that small peptides likely interact with charged molecules [9]. Presently, little bit is known about whether signal peptides can be affected by diffusion limitation or by non-specific binding to polysaccharides, proteins, DNA and even cell wall components within the biofilm [10]. Keller and Surette have estimated that the production of a signal peptide in *S. aureus* costs 184 ATP but only 8 ATP for an AHL (acyl-homoserine lactone) in *P. aeruginosa* [11]. Clearly, the cost for production of a signal peptide is much more expensive in Gram-positive bacteria. It is therefore fair to assume that nutrient or energy source will be vital factors to influence signal peptide-mediated quorum sensing and activities in Gram-positive biofilms [12]. Quorum sensing postulates that bacteria sense their density to permit them to

go in for social behavior; accordingly, quorum sensing assumes that sensing evolved because of the group benefits [13].

2. QUORUM SENSING AS NOVEL TARGET FOR ANTI-VIRULENCE THERAPIES

A proof has collected that such quorum sensing interference can be developed as promising approaches to control biofilm formation and microbial infections [14]. Interestingly, anti-quorum sensing compounds exist in nature. As both plants and algae produce compounds that mimic quorum-sensing signals of many bacteria, so that they restrict bacterial quorum sensing and its controlled activities [15]. For example, the red seaweed called *Delisea pulchra* (Greville) that grows under the sea around Australia, produces a range of biologically active furanones [16]. Furanones inhibit bacterial colonization and biofilm formation through interference with acyl-HSL (acyl-homoserine lactone) quorum-sensing pathway in Gram-negative bacteria. They also interfere with AI-2 (autoinducer-2) signaling systems in both Gram-negative and -positive bacteria. Quorum sensing inhibitors (QSI) bring into being rise in the vulnerability of bacterial biofilms to subsisting antibiotics both *in vitro* and *in vivo*, therefore, the success is growing in terms of antibiotic treatment of biofilm infections [17]. Compounds that can inhibit signals of quorum sensing systems can be developed into vigorous contender against infectious bacteria, although there may be a risk for inactivation of antagonists [18]. These novel drugs that specifically target quorum sensing systems are capable of attenuating bacterial infections in a manner that is less likely to result in the development of resistant mutants [19]. Different studies have presently mentioned the application of AHL analogs or signal peptide analogs to achieve inhibition of quorum-sensing circuits in some bacteria [20].

3. CONCLUSIONS

Quorum sensing is emerging as an integral component of bacterial global gene regulatory networks responsible for bacterial adaptation in biofilms. Research on how bacterial quorum sensing works mechanistically in biofilms remains in their infancy. There is a growing interest in blocking bacterial cell-cell communication as a means to control infections. A clear challenge facing the field is to determine what factors of a biofilm influence the onset of quorum sensing and subsequent gene expression. Another vital challenge is to determine functional consequences of quorum sensing in multi-species biofilms. The answer to these questions will undoubtedly provide new insights and surprises.

4. REFERENCES

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