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Commentary

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Biofilm Environmentome: A Survival Experiment

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Abstract

Microbial biofilms are communities of constant symbiosis and interaction in adaptation with their environment. This signaling network determines the chemistry as well as the physiology of the biofilm, it also confers protection to the microorganisms embedded in this formation, which improves the chances of survival in the face of external aggression. This mechanism known as Quorum Sensing (QS) responds to both intracellular and extracellular signals and modulates the response of the biofilm to the immune system. This chemical response to the environmental factors involved, together with the genetic factors of the genome in the development of an individual constitute the environmentome, it which represents a new source of promising therapeutic targets for the development of new treatments that prevent the emergence of antimicrobial resistance (AMR). The aim of this comment paper is briefly to explore the initial elements of an approach that can be applied in the development of new tools for clinical diagnosis and treatment, as well as in other areas such as ecology.

Keywords

Biofilm; Environmentome; Microbial pathogenesis; Biosensors

Introduction

Biofilms are an organized spatial structure, made up of several groups of microorganisms in exchange, these symbiotic relationships constitute a sociomicrobiological network that allow the evolution and survival of the organisms that persist inside [1]. In this order of ideas, biofilms contain a large number of microbial cells in different physiological states with a variety of information and expression, both genotypic and phenotypic, that modulates various metabolic pathways involved in adaptive mutation and selection responses to environmental agents [2]. In fact, it have been demonstrated that this formation helps cells to survive during exposure to toxic compounds as metals [3], it has also been described that the production of substances such as taurine, ectoine, and hydroxyectoine give protection against osmotic stress in the biofilms [4]. As a consequence, this resistance and tolerance that characterizes this microbial association is defined by the development of metabolic shifts as the primary response [5]. Likewise, as the biofilm interacts with the external environment, it is able to modulate the environment inside the structure in order to increase the persistence, in this way present two different internal domains, namely: an internal region with a low amount of oxygen that has dormant cells and an outer layer with cells in active metabolic state and greater amount of oxygen, the presence of these two populations should always be taken into account for the design of any study and approach, because it represents the biofilm in a mature state [6]. Equally the production of microbial metabolites inside the biofilm microenvironments can alter the surrounding acidity by altering the microbiome and favoring tissue invasion [7], so this process can be considered as an adaptive phenomenon of microorganisms aimed at aggregation as a factor of survival and persistence [8].

Quorum sensing and environmentome

In this way, bacteria produce various compounds that modify their environment to increase their resilience, such is the case of *Pseudomonas aeruginosa* quorum sensing (PQS) system that use 2-alkyl-4(1H)-quinolone molecular family that modulates the production of toxins and the biofilm conformation [9]. These environmental changes modulated by QS are essential for survival and adaptation [10] and control various microbial processes as are: motility, biofilm structure, immune evasion, iron scavenging, cytotoxicity and antibiotic resistance [11].

Microbial glycomics

On the other hand microbial surface adhesion is an important pathogenic factor that favors cell invasion and lysis [12]. Adhesion is considered an important step in the establishment of biofilm and a need for microbial cells, which makes it an important factor of interaction with the environment for obtaining nutrients [13]. In addition, adhesion is determined by specific carbohydrate ligands lectin type with the ability to bind to glycans on human glycoproteins [14]. In this way the final attachment induced by microbial adhesins determines the production of the exopolysaccharide matrix that consolidates irreversible adhesion towards a mature formation that protects against external antimicrobial agents [15].

Ironfilm

There is evidence that the biofilm is not only a process of adaptation to the environment but a way of using environmental resources in favor of persistence, an example of this case is the iron, it have been observed that iron supplementation increase AMR to antimicrobial drugs tigecycline and tobramycin, also it has been shown that the absence of iron blocks the formation of the biofilm, these data suggest that the inhibition of iron metabolism may be an important therapeutic target for the development of new antibiotic drugs that prevent the development of AMR [16]. In this order of ideas two siderophores have been detected in *P. aeruginosa* (pyoverdine and pyochelin) which are determined by PQS [9].

Microbial fuels cell-based biosensor

This remarkable ability of biofilms to modulate the environment through a network of sociomicrobiological interactions can be applied as a powerful environmental monitoring tool that allows the detection of multiple pollutants, as the case of devices that include microbial fuel cell (MFC)-based biosensors with great advantages in selectivity and stability [17]. This technology have promising applications as are: bioremediation, biosensors, wastewater treatment and energy production [18]. Equally, MFC-sensors hace several advantages between them: simplicity, results in a short period of time, wide range

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of measurements and the possibility of conducting studies in the field; but the materials for its manufacture are expensive [19].

In this way the study of biofilm environmentome is an exciting research field where is possible to integrate multiple disciplines to obtain applicable knowledge that leads to innovation and sustainable development.

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