Підсекція «Біотехнологія»

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BIOFILM FORMATION IN ABIOTIC STRESS ENVIRONMENT

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The aim and the task of the study. Biofilms – matrix-enclosed microbial accretions that adhere to biological or non-biological surfaces – represent a significant and incompletely understood mode of growth for bacteria [8]. The success of the biofilm mode of life has been associated with the emergent properties, which arise from aggregated cells, kept together by the biofilm matrix. Emergent properties are novel structures, activities, patterns and properties, which arise during the process, and as a consequence, of self-organization in complex systems [6]. The aim of this study was to describe and summarize survival and propagative mechanisms of biofilm formation in the context of the natural environment. The task was to understand which strategies bacteria use to resist stress environments.

The object and subject of study. The object of study was the phenomena of biofilm formation. The subject of study was the mechanisms of bacterial adaptation under stress environment.

The methods of study. We have used analytical and observative methods to summarize the information from different resources in order to make this overview.

Results. Biofilm formation represents a protected mode of growth that allows cells to survive in different environments and also disperse to colonize new niches. Bacterial cells living in biofilms have increased resistance to various antimicrobial agents and are better adapted to survive periods of environmental stress [4, 9]. These phenotypes of bacteria living in biofilms have led to problems of biofouling in various industrial and medical situations [5, 10]. The fact that bacteria are better able to survive environmental insults when growing in biofilms highlights the advantage of cooperation and a multicellular lifestyle. Biofilms are group or micro-organisms in which microbes produced an extracellular polymeric substances (EPS) such as proteins (< 1-2 %) including enzymes), DNA (< 1 %), polysaccharides (1-2 %) and RNA (< 1%), and in addition to these components, water (up to 97 %) is the major part of biofilm which is responsible for the flow of nutrients inside biofilm matrix. The architecture of biofilm consists of two main components i.e. water channel for nutrients transport and a region of densely packed cells having no prominent pores in it [7]. Biofilm forming bacteria switch on some genes that activate the expression of stress genes which in turn switch to resistant phenotypes due certain changes e.g. cell density, nutritional or temperature, cell density, pH and osmolarity [12].

The first bacterial colonists to adhere to a surface initially do so by inducing weak van der Waals forces. If the colonists are not immediately separated from the surface, they can anchor themselves more permanently using cell adhesion molecules, proteins on their surfaces that bind other cells in a process called cell adhesion [6]. After micro-colony formation stage of biofilm, expression of certain biofilm related genes take place. These gene products are needed for the EPS which is the main structure material of biofilm. It is reported that bacterial attachment by itself can trigger formation of extracellular matrix. Matrix formation is followed by water-filled channels formation for transport of nutrients within the biofilm.

The formation of the extracellular polymeric substance (EPS) matrix leads to the establishment of stable gradients that provide different localized habitats at a small scale. In an aerobic copiotrophic biofilm, organisms are stratified according to oxygen availability, which becomes depleted in the lower layers of the biofilm, as the consumption of oxygen by aerobic organisms in the higher layers of the biofilm is faster than the rate of diffusion. Similarly, in aerobic oligotrophic biofilms, nutrient consumption by organisms in the upper layers results in the

starvation of organisms in the lower layers, which may lead to the adoption of slow growth states, such as those found in dormant cells, or even in cell death. Other gradients that are present in biofilms include pH gradients, which are produced by heterotrophic metabolism, and gradients of signalling molecules, in which the concentration of these molecules varies according to the distance from producing cells [2].

After biofilm formation, bacteria leave the biofilms itself on regular basis. By doing this the bacteria can undergo rapid multiplication and dispersal. Detachment of planktonic bacterial cells from the biofilm is a programmed detachment, having a natural pattern. Sometime occasionally due to some mechanical stress bacteria are detached from the colony into the surrounding. But in most cases some bacteria stop EPS production and are detached into environment. In biofilm cells are removed due to an enzyme action that causes alginate digestion [6].

Phenotypic characters of organisms are apparently affected by the mode of biofilm dispersion. Dispersed cells from the biofilm have the ability to retain certain properties of biofilm, such as antibiotic in-sensitivity. The cells which are dispersed form biofilm as result of growth may return quickly to their normal planktonic phenotype. Bacteria expand its boundaries to provide more space and nutrients. For such expansion bacteria have their own strategies. Its include streaming, rippling, rolling and, of course, detachment in single cells and clumps is the way to further colonization of the surface [11]. In addition to releasing bacteria to colonize new sites, dispersal is associated with the formation of genetic variants that may be altered in traits which are important for colonization of and competition in new habitats [3].

Conclusions. The ability of bacterial cells to adopt different biofilm structures in response to environmental conditions – owing to genetic regulation, selection, or both, or to localized growth patterns – gives them the flexibility to rapidly adapt to an extent that is not possible in multicellular eukaryotic organisms. The proclivity of bacteria to adhere to surfaces and form biofilms in so many environments is undoubtedly related to the selective advantage that surface association offers.

Key words: **biofilm formation, strategies, environment, stress**

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