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Antibiotic Resistance of Bacteria in Biofilm

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ABSTRACTS

We have learned a great deal over the last ten years regarding the molecular processes behind the start stop of biofilm development in many bactereia species. A complicated, well-organized population of microorganisms that stick to a surface and get immersed in an extracellular polymeric matrix that they manufacture on their own is called a biofilm (EPS). Both living and non-living surfaces are home to these microorganisms, which might include bacteria, fungus, algae, protozoa, and other microbes. About 52% of nosocomial infections are specific to the patients who have indwelling medical devices. Biofilms that contain antibiotic resistance are a major problem in many areas, especially in the medical and healthcare industries. When it comes to antibiotic resistance, biofilms are more advanced than their planktonic (free-floating) cousins. Many elements inherent to the biofilm structure contribute to this resistance to antibiotics such as physical barrier, altered the gene expression and communication as well as metabolic activity. Nevertheless, biofilms are the source of a variety of chronic illnesses and treating them effectively is challenging because of the development of antibiotic resistance in bacteria. The process of biofilm formation includes the adhesion of microorganisms, colonisation, growth of microcolonies, synthesis of extracellular matrix, and maturation of three-dimensional structures. Instead, we concentrate on the current understandings of biofilm development in harsh settings in this review. We also discuss the basic functions of biofilm in shielding microbes from harsh environmental stressors and the regulatory elements that contribute to biofilm formation. Antibiotic resistance and biofilms provide numerous major obstacles to the efficient management and treatment of a variety of illnesses.

Keywords: Antibiotic drugs resistance, Biofilm devices.

INTRODUCTION

The term "biofilm" describes the complex communities of microorganisms that can either form *Staphylococcus aureus*, *Pseudomonas aeruginosa*, and some other bacteria. Due to their increased resistance to antimicrobial treatment, biofilms formed by pathogenic bacteria pose serious problems to human health, such as cystic fibrosis, prostatitis, and periodontitis. In contrast, some commensal bacteria are crucial for nutrient assimilation and beneficial to the human immune systems.[1,2] From natural ecosystems to medical settings, biofilms are found in many different types of situations. They have important ramifications for industry, environmental research, and medicine, among other sectors. In the medical field, biofilms are linked to recurring infections and have a high level of resistance to the immune system and medications. Biofouling and equipment corrosion are potential consequences in industrial environments. The breakdown of organic matter and provision of food for other species are essential functions of biofilms in natural ecosystems. About 52% of nosocomial infections are specific to the patients who have indwelling medical devices, such as cardiac pacemakers, joint prostheses (Artificial body part), contact lenses, dentures, and prosthetic heart valves. Extremophiles are microorganisms that are able to endure under extremely harsh conditions.[3,4], which comprise psychrophiles, thermophiles, alkaliphiles, acidophiles, halophiles, piezophiles, and radiation-resistant extremophiles. Every microbe that survives in these harsh circumstances demonstrates a unique resistance strategy, with biofilm being one of the most important ones.[5,6]

Biofilm Formation

Microorganisms, including bacteria, fungus, and algae, naturally produce biofilms when they attach to surfaces and form an ordered community bound together by an extracellular polymeric matrix. Numerous habitats, such as soil, water systems, and living things, are involved in this process. Cells adhere to a surface in the first stage, assemble to create microcolonies, and then differentiate into a mature structure called a biofilm. Following biofilm growth, both mechanical and active methods are used to disassemble or disperse the film.[7] And the second stage is mature biofilm develops when microcolonies grow and unite. It is made up of many bacterial layers covered with an EPS matrix, which offers protection and a favorable habitat for a variety of microorganisms to flourish. At last, the detachment of biofilm occurs after the maturation process. This process allows bacteria to disperse and potentially colonize new surfaces or environments.

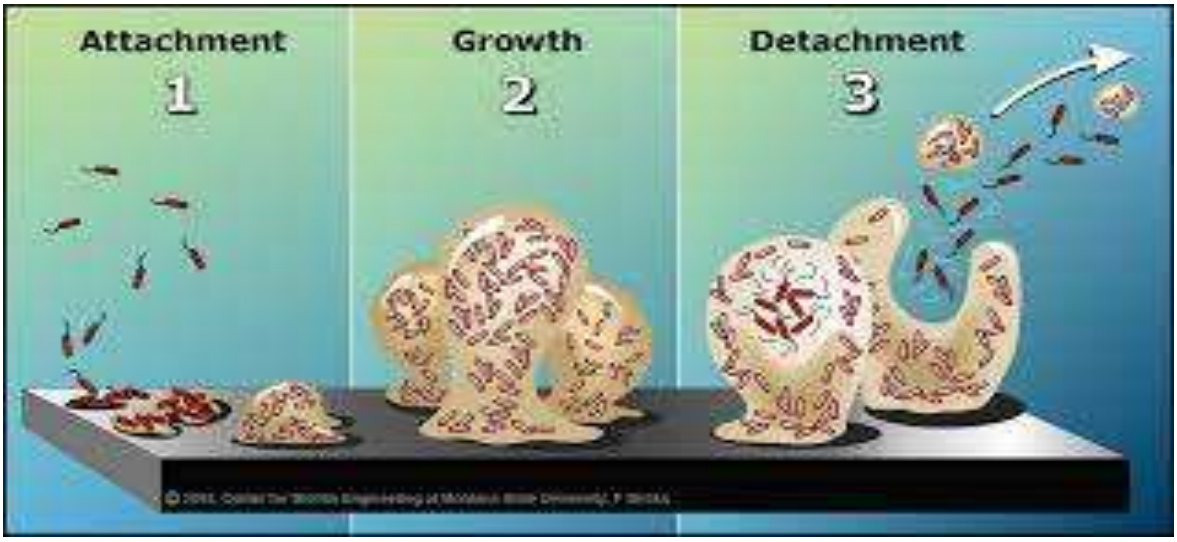

Fig: Biofilm formation

Biomarkers:

The term biomarker stands for biological marker. Biomarkers indicate when and to which extent a physiological condition is taking place. In clinical applications, biomarkers have the potential to predict risk factors, diagnose, assess disease prognosis, or monitor medical conditions.[8-10]

Research Materials and Methods:

- Sources of Strains
- Main Reagents and Equipments
- Antibiotic drugs sensitivity Tests
- PCR amplifications of drug resistance genes and results
- Laboratory induced biofilm Formations
- Real- time fluorescent quantitative PCR Reactions. [11-14]

Factors Influencing Biofilm Susceptibility

Antimicrobial Chemistry: In order to break up biofilms, antimicrobial chemistry must penetrate the protective matrix, target a variety of bacteria populations, prevent quorum sensing, and get past adaptive resistance mechanisms.

Substratum Materials: Substratum materials impact the structure, development, and resilience of biofilms by offering a variety of surfaces that either facilitate or impede bacterial attachment. For example, When biofilms grew on Buna rubber (TF = 70), iodine was useless against the same strain of Listeria, but it proved reasonably successful in killing it on stainless steel (TF = 1.7). [15] It has been demonstrated that buna rubber has separate bacteriostatic properties. Compared to biofilms on stainless steel, those on mild steel, where some metal corrosion was visible, were less vulnerable to monochloramine-induced death. [16]

Cell Density: Higher cell density promotes biofilm formation as increased microbial populations facilitate the production of extracellular polymeric substances (EPS) and enhance quorum sensing, contributing to biofilm stability.

Age: Biofilm cell density and age are often highly associated. Therefore, it is easy to confuse the impacts of these two factors. The susceptibility of biofilms that are two days old and those that are seven days old differs [17] a result of aging or the notable variation in biofilm buildup between these two time periods? Here, I examine a single data set where it is fortunately easy to distinguish between these two factors. Wolcott et al. [18] reported on the challenge of Staphylococcus aureus biofilm with gentamicin.

Summary:

Thus far, research has demonstrated that the quantitative degree of tolerance generated during biofilm development is unaffected by the antimicrobial size, antimicrobial chemistry, substratum material, or microbial species composition. Antimicrobial tolerance is only marginally correlated with areal cell

density and biofilm age. This implies that a physical or physiological event that takes place during biofilm development is necessary for complete biofilm tolerance. The findings of the case study also suggest that physiology and medium composition play a significant part in biofilm tolerance. Another way to put it is that the specifics of the biofilm growth process used for a certain test will probably matter more than the selection of the microbe or antimicrobial agent.

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