Chapter 15
Recent Advancements in Bioremediation of Metal Contaminants

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ABSTRACT

Biofilms are an accumulation of single or various populations of microorganisms that are present on the surfaces through membrane-bound substances due to the gene expression, which differs from free-floating expression and leads to expressed genes regulating biofilm formation and development. In this regard, recent advances in microbial-based heavy metals have propelled bioremediation as a prospective alternative to conventional techniques. Adsorption and biodegradation of organic contaminants and the immobilization, mobilization, and/or transformation of metals are the main remediation processes that can be mediated by the action of several microorganisms surviving in hostile environments with high concentrations of pollutants. The chapter discussed the formation and regulation of biofilms to degrade the metal contaminant, the importance of gene transfer, and applications of biofilm-mediated bioremediation processes.

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INTRODUCTION

Harmful materials are released into the environment as a result of human activities. Different pollution arising from the farming industry, transport and energy use, enter the air, soil, freshwater and the oceans. Pollutions effects can be small scale or global, gradual or dramatic and include threats to wildlife and health problems for the public, pollution is the present environmental issue. Pollutions are entering into the environment in the forms of Gases and smoke from industry and vehicles drift into the air household sewage, agricultural sprays and other liquids are released on to land and into the oceans and rivers. Solids too, such refuse and mining waste are dumped on the ground and into the sea.

The heavy metal consists of metal and metalloid elements that have a rather high density ranging from 3.5 to 7g cm^3 and is toxic or poisonous at low concentrations and includes mercury, cadmium, arsenic, chromium, thallium, zinc, nickel, copper and lead. It was widely documented and frequently applied to the widespread pollutants of soils and water bodies (Duffus, 2002). Refinement of heavy metals from wastewater has been a challenge for a while in that, most of the heavy metal salts are soluble in water very quickly and form aqueous solution and so, cannot easily be separated using ordinary physical means. However, several different conventional treatment processes are commonly employed to remove heavy metals from industrial wastewater before their discharge into the environment (Fomina and Gadd, 2014). Moreover, such treatments produce large amounts of sludge that are not environmentally friendly and need to be treated with great difficulties. Ion exchange membrane technologies and activated carbon adsorption processes are extremely expensive (Eccles, 1999).

In most natural environmental system, microbial like bacteria, fungal and algae are commonly found in close association with surfaces and interfaces in the form of multicellular aggregates glued together with the slime they secrete (Wimpenny, 2000). Biofilms are bacterial species in which cells are fixed in a matrix of extracellular polymeric compounds attached to a surface(Branda, 2005). Living in biofilms helps protect bacteria from toxic conditions and the formation of biofilms appears to be an important factor in the disease cycle of bacterial pathogens in both animals and plants. There is one chance for the increased resistance to environmental stresses observed in biofilm cells appears to be the increase in the outer layer surface of accumulation of persister cells within the biofilm (Davey and Toole, 2000). The molecular mechanisms of the biofilm formation differ from among the varies species, and even slight modification among the varies strains of the same species. Conversely, some features are recognized as general attributes of biofilm formation (Lewis, 2005). In this review, work discussed the recent advancement techniques of control of metal contaminant water using biofilms such as bacterial, fungal, algae and yeast.

Origin of Heavy Metals

Heavy metals are classified as different due to their chemical properties and are used broadly in electronics, machines and the artefacts of everyday life, as well as in high-tech applications. As a result, they can enter into the aquatic and edible systems of human and animals from the differentiation of anthropogenic sources as well as from the natural geochemical weathering of soil and rocks. The main reasons for contamination such as mining wastes, landfill leaches, municipal wastewater, urban reservoirs and industrial wastewaters, particularly from the electroplating, electronic and metal-finishing industries (Fig.1.). With the increasing generation of metals from technologies activities, the problem of waste disposal has become one of paramount importance. Many aquatic environments face metal concentra-