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Role of Geomicrobiology and Biogeochemistry for Bioremediation to Clean the Environment

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Abstract

The present review is based on book entitled "Geomicrobiology and Biogeochemistry" which is an interdisciplinary research based compilation of two or more discipline such as Geology, Microbiology, Biology and Chemistry. Microorganisms have played a role for shaping the earth and making it more fit for habitation of higher forms of life. The metabolic diversity and capability of microbes have found to harvest energy from oxidation and reduction process. The exploration on microbiological processes has led to the newly evolving fields of geomicrobiology and biogeochemistry, linking the geosphere and the biosphere. This book has covered broader research and multidisciplinary aspects such as bioremediation of contaminated environments, biomining, biotechnological applications of extremophiles, subsurface petroleum microbiology, enhanced oil recovery using microbes and their products, metal extraction from soil, soil elemental cycling and plant nutrition. It is a comprehensive book that describes current knowledge of how microbial activities have influenced the biogeochemical processes & how these biogeochemical processes can be helpful in improvement environmental management for sustaining life.

Keywords: Geomicrobiology; Biogeochemistry; Extremophiles; Bioremediation; Environmental management

Introduction

The book "Geomicrobiology and Biogeochemistry" edited by Nagain P & Singh A [1] covers a holistic approach of geomicrobiology and biogeochemistry related to important topics of biomining, bioremediation, biotechnological applications of extremophiles, subsurface petroleum microbiology, metal extraction and soil nutrient cycling .

In general research, microbes show an important geoactive role in the environment. Microorganism intermingle with metals and minerals in the natural and artificial environment, changing their physical and chemical state, and also these metals has ability to affect the growth activity and behavior of soil flora and fauna [2]. Various types of microbes e.g., prokaryotes, eukaryotes and higher organisms have special mechanisms for biotransformation though the biogeochemical cycle of different element like sulphur, iron, phosphorus, potassium, aluminium, metalloids, actinides and metal radionuclides. These elemental transformations can have ability for beneficial or harmful values in the context of human beings. Some bacteria and fungi having most important properties for bioremediation of organic and inorganic pollutant from contaminated environments [3]. Others, microbes have properties to decay, natural and synthetic materials, rock and mineral-based building materials, acid mine drainage and containment, all with immense social and economic consequences. The benefits of microorganisms in the biosphere categorized as geomicrobiology one of the most important concepts within microbiology for requiring an interdisciplinary approach to delineate ecological conservation and applied significance in biotechnology [4]. Geomicrobiology branch only defines as the roles of microbes in geological processes [5,6].

The present book review also highlighting like geomicrobiology and biogeochemistry, biomining, bioremediation, biotechnological applications of extremophiles, subsurface petroleum microbiology in details about practical application in biosphere i.e. extremophile, their economic relevance and wide applications for societal benefits [7]. The aim of this book is also to develop biotechnology oriented approaches that focus on the geological significance of microbial activity which will definitely help to integrate the biological and geological process for better understanding of biogeochemical process. The editors discuss the book into three sections with fourteen chapters, each of them dealing with different domain of geomicrobiology and its application for mankind in a sustainable manner.

The first section covers an overview of exploration of new strains of microbe from extreme environment with the help of advance molecular tools. Discovery of microbes with distinctive

characteristics are described within these chapters which could be utilized for industrial application such as enzymes and chemical production, waste treatment and recycling, bioremediation of industrial pollutants in soil and aquifers, enhanced petroleum oil recovery, bio-mining and soil fertility [8]. The application of molecular techniques are the study of microbial diversity and community structure in terms of function, phylogeny, and community composition within natural environments [9].

A second section of the book deals with the harnessing of different type's extremophilic bacteria, such as haloalkaliphile, its diversity and application to improvement of biotechnology tools for mankind's. Extremophiles like *Thioalkalivibrio* spp. *Desulfonatronum* spp. and *Halomonas* spp. are able to grow in extreme environment. These type microbes show dual activities in extreme environment, this make a model for fundamental research and exploration of biotechnology potential [10]. Furthermore, the unique metabolic pathways of haloalkaliphiles can be applied in the biodegradation and (or) biotransformation of a broad range of toxic industrial pollutants (pesticide) and heavy metals, in wastewater treatment, and in the biofuel industry [11].

Third section deals with the application of extremophile microbes in the innovation of biotechnology tools like biomining, bioremediation and phytoremediation, petroleum recovery and nutrient cycle for societal development. This section offers to the solution of all challenges regarding the role of microbes that play in the geological process in adverse environment and to improve the biotechnological tools and techniques for human being. The current challenge is to recovery petroleum from deep subsurface of petroleum reservoir e.g. biodegradation of hydrocarbon, microbial interaction with metals and metalloids. The indigenous microorganism helps in reducing chemical fertilizer and improving essential macro and micronutrients in soils for enhancing crop yields under sustainable development [12].

This book highlights the role of microbes in biogeochemical cycling of nutrients of all natural ecosystems. Genetic Engineering has become an important tool for manipulating for enhancing the utilization of microbes and plants in various industries including petroleum, food, feed, pharmaceutical, detergent, and pulp and paper. Novel microbial strains are unremittingly being discovered and genetic or enzymatic functions are often reconstructed through DNA and protein engineering techniques to increase the gene expression and metabolic productivity of industrially important organisms. Genetically modified microbes have very unique characters which are broadly exploited for industrial applications such as enzymes and chemical production, waste treatment and recycling, bioremediation of industrial pollutants in soils and aquifers, enhanced petroleum oil recovery, biomining, and soil fertility. The editors also describe about role of soil microbes for enhancing crop productivities by plant growth promoting activities and nutrient availability like potassium and phosphorus.

The editors should include one chapter for comparative studies between extremophilic and non extremophilic microbes in the context of their commercial application for ecological and societal benefits for human being. The editors should include some case studies related to biomining, oil recovery and effective application of genetically modified microbes for cost effective technology in industries and natural fields while in the literature of research paper conducted real experiment in control and field condition then give and transfer technology for commercialization and their application in the fields. After few minor drawbacks of this book, it was really very useful and beneficial book which includes about the aspect of microbial isolation, molecular characterization and their application for bioremediation, bio-mining, biotransfering of soil nutrient, biomineralization, oil recovery, metal extraction, potassium and phosphate solubilisation [13], plant growth promotion [12]. The final conclusion of this book offers the solution of fundamental questions in interdisciplinary sciences e.g., gemicrobiology, bioremediation and biotechnology with multiple application for societal development. Various experts and scientist related to the area of geomicrobiology, bioremediation, ecological sciences and environmental sciences of diverse institutions have been contributed their experiences and knowledge in different chapters of the book, which is useful and beneficial for students, teachers, researchers, scientist, farmers and policy makers in the disciplines of soil and geological sciences, microbiology, plant physiology, environmental engineering and biotechnology.

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