ALUMINIUM (III) BIOSORPTION MAGNETOTACTIC *ALCALIGENES* SP. SUM 123 ISOLATED FROM SKUDAI RIVER JOHOR

LAILA MUFTAH ALI ZARGOUN

UNIVERSITI TEKNOLOGI MALAYSIA

ALUMINIUM (III) BIOSORPTION MAGNETOTACTIC *ALCALIGENES* SP. SUM 123 ISOLATED FROM SKUDAI RIVER JOHOR

LAILA MUFTAH ALI ZARGOUN

A thesis submitted in fulfilment of the
requirements for the award of the degree of
Doctor of Philosophy (Bioscience)

Faculty of Biosciences and Medical Engineering
Universiti Teknologi Malaysia

JUNE 2017

This thesis work is dedicated to my husband, Abdelhafid, who has been a constant source of support and encouragement during the challenges of graduate school and life. I am truly thankful for having you in my life. This work is also dedicated to my parents, Muftah and Fatima, who have always loved me unconditionally and whose good examples have taught me to work hard for the things that I aspire to achieve.

ACKNOWLEDGEMENT

First and foremost, all praise be to Allah the Almighty, thanks to Him for giving me the opportunity and will to finish this research and to complete this dissertation. I would like to express my sincere appreciation and gratitude to my research supervisor, Dr. Nor Azimah Mohd Zain and co-supervisor Dr. Shafinaz Shahir for her knowledge, guidance, supervision, critics, evaluation, encouragement, and for supporting me throughout the undertaking of this dissertation.

This thesis is the culmination of my journey of Ph.D which was just like climbing a high peak step by step accompanied with encouragement, hardship, trust, and frustration. When I found myself at top experiencing the feeling of fulfillment, I realized though only my name appears on the cover of this dissertation, a great many people including my family members, well-wishers, my friends, colleagues and various institutions have contributed to accomplish this huge task. A thousand thanks also to all of the staff at faculty of Biosciences and Medical Engineering for helping me during this research, particularly, the lab assistants.

I owe thanks to a very special person, my husband, Abdelhafid for his continued and unfailing love, support and understanding during my pursuit of Ph.D degree that made the completion of thesis possible. You were always around at times I thought that it is impossible to continue, you helped me to keep things in perspective. I greatly value his contribution and deeply appreciate his belief in me. I appreciate my sons, for abiding my ignorance and the patience they showed during my thesis working. Words would never say how grateful I am to you. I consider myself the luckiest in the world to have such a lovely and caring family, standing beside me with their love and unconditional support. My heartfelt regard goes to my father, mother, and mother in-law, sister, and brothers for their love and moral support.

ABSTRACT

The increasing application of aluminium metals in various industrial processes have raised significant concerns and health risks for humans and its environments. In its ionic form, aluminium poses higher threats to human health due to its ability to cause cellular impairment. As a remediation tool, biosorption by magnetotactic bacteria (MTB) is considered in this study for the removal of this metallic pollutant due to its ability to adsorb heavy metals. The isolation of iron oxide-producing *Alcaligenes* sp. strain SUM 123 for aluminium(III) biosorption was conducted from samples collected from Skudai River. Biochemical tests and 16S rRNA chararacterization was employed for the identification of the isolated magnetotactic bacterium (MTB). The characterization of this MTB was determined using a High Resolution Transmission Electron Microscope (HRTEM), X-Ray Diffraction (XRD), Scanning Transmission Electron Microscope and Energy Dispersive x-ray Spectroscopy (STEM-EDX) and the Fourier Transform Infrared Spectroscopy (FTIR). Observation by HRTEM shows the lattice spacing of iron oxide at 0.24 nm and 0.31 nm while the XRD analysis depicts the presence of crystalline planes of iron oxide at (311) and (220). The magnetosomes observed via STEM-EDX analysis confirms the presence of iron oxide and the composition of P-granules containing different heavy metals in the isolated *Alcaligenes* sp. strain SUM 123. The appearance of Fe-O groups of magnetosomes were observed via FTIR analysis. In addition, the decomposition of these iron oxide components was at 270-500 ºC according to thermogravimetric analysis (TGA). The MTB growth and magnetosomes formation were studied at different pH (5-8), temperature (20-40 ºC), and ferric quinate concentration (20-120 µM). It was observed that magnetosomes formation is significantly influenced by pH change and relatively unaffected by variations in temperature and ferric quinate concentrations. Aluminium(III) adsorption by the isolated *Alcaligenes* sp. strain SUM 123 was examined at pH 2-9, temperature 10-40 ºC, initial Al(III) concentration 80-500 $mg.L^{-1}$, contact time 10-60 mins and adsorbent dosage 2-12 $g.L^{-1}$. The optimal adsorption of Al(III) by SUM 123 was observed at pH 5, temperature 25 ºC, 80 $mg.L^{-1}$ initial Al(III) concentration, 60 mins contact time and an adsorbent dosage of 10 $g.L^{-1}$. The biosorption process of Al(III) by SUM 123 was best fitted to the Langmuir isotherm model, while the pseudo-second order was found to be the best describe the experimental data. According to FTIR analysis, it was found that the hydroxyl, amide, and amine groups of the magnetosomes were involved in the biosorption process. It is therefore established from this study that the iron oxide-producing *Alcaligenes* sp. strain SUM 123 is a potentially effective and economical remediation tool for aluminium(III) removal in industrial applications.

ABSTRAK

Penggunaan logam aluminium dalam pelbagai industri telah menimbulkan kebimbangan dan risiko kesihatan yang tinggi terhadap manusia dan persekitarannya. Logam aluminium dalam bentuk ion membawa ancaman yang lebih besar kepada kesihatan manusia kerana keupayaannya untuk menyebabkan kemerosotan sel. Sebagai alat rawatan, bioerapan menggunakan bakteria magnetotaktik (MTB) digunakan dalam kajian ini untuk penghapusan pencemar metalik disebabkan oleh kebolehan penjerapan logam beratnya. Pengasingan ferum oksida yang menghasilkan *Alcaligenes* sp. strain SUM 123 bagi bioerapan aluminium(III) dijalankan melalui sampel yang dikutip daripada Sungai Skudai. Ujian biokimia dan protokol analisis gen 16S rRNA digunakan untuk mengenal pasti bakteria magnetotaktik terpencil (MTB). Pencirian MTB ditentukan dengan menggunakan Mikroskop Pancaran Elektron Beresolusi Tinggi (HRTEM), Pembelauan Sinar-X (XRD), Mikroskop Pengimbas Transmisi Elektron dan Spektroskopi Sinar-X Tenaga Serakan (STEM-EDX) dan Spektroskopi Inframerah Transformasi Fourier (FTIR). Kajian HRTEM menunjukkan ruang kekisi ferum oksida pada 0.24 nm dan 0.31 nm manakala analisis XRD menggambarkan kehadiran satah berhablur ferum oksidapada (311) dan (220). Tinjauan ke atas magnetosom melalui analisis STEM-EDX mengesahkan kehadiran ferum oksida dan komposisi granul-P yang mengandungi pelbagai jenis logam berat dalam *Alcaligenes* sp strain SUM 123. Kemunculan kumpulan magnetosom Fe-O dicerap melalui analisis FTIR. Berdasarkan Analisis Termogravimetrik (TGA) penguraian ferum oksida adalah pada 270-500 ºC. Pertumbuhan MTB dan pembentukan magnetosom telah dikaji pada pelbagai julat pH (5-8), suhu (20-40 ºC), dan kepekatan ferik quinate (20-120 µM). Hasil tinjauan menunjukkan bahawa pembentukan magnetosom dipengaruhi oleh perubahan pH dan secara relatifnya tidak terjejas oleh perubahan suhu dan kepekatan ferik quinate. Penjerapan aluminium(III) oleh *Alcaligenes* sp. strain SUM 123 dikaji pada pH 2-9, suhu 10-40 °C, kepekatan awal Al(III) 80-500 mg.L^{-1}, masa sentuhan 10-60 minit dan dan dos penjerap 2-12 g.L^{-1}. Penjerapan optimum Al(III) oleh SUM 123 yang ditinjau adalah pada pH 5, suhu 25 °C, kepekatan awal Al(III) 80 mg.L^{-1}, masa sentuhan 60 minit dan dos penjerap 10 g.L^{-1}. Proses bioerapan Al(III) dengan SUM 123 paling menepati model isoterma Langmuir, manakala model aturan pseudo-kedua didapati paling baik menggambarkan data eksperimen. Analisis FTIR menunjukkan penglibatan kumpulan hidroksil, amida dan amina daripada magnetosom dalam proses bioerapan. Hasil daripada kajian ini menunjukkan *Alcaligenes* sp. strain SUM 123 yang menghasilkan ferum oksida merupakan alat rawatan yang berkesan dan ekonomikal untuk penyingkiran aluminium(III) dalam aplikasi industri.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

µM	-	Micromolar
µm	-	Micrometer
AAS	-	Atomic Absorption Spectroscopy
BCM	-	Biological-Controlled Mineralization
CRM	-	Capillary method
CSD	-	Crystal Size Distribution
DDW	-	Distilled deionized water
DIC	-	Differential Interference Contrast
DNA	-	Deoxyribonucleic acid
DOE	-	Department of Environment
E. coli	-	*Escherichia coli*
EDX	-	Energy X-ray diffraction
EMA	-	European Medicines Agency
FDA	-	Food and Drug and Administration
FESEM-EDX	-	Field Emission Scanning Electron Microscopy-Energy X-ray Diffraction
FTIR	-	Fourier Transform Infrared Spectroscopy
GM	-	Growth medium
HRTEM	-	High Resolution Transmission Electron Microscope
IM	-	Isolation medium
LM	-	Light microscopy
M	-	Molar
mbar	-	millibar
MMP	-	Multicelled magnetic prokaryote
MSs	-	Magnetosomes
MTB	-	Magnetotactic bacteria

NCBI	-	National Center of Biotechnology Information
nm	-	nanometer
nmol	-	Nanomole
NS	-	North Seeking
OD	-	Optical Density
OTAZ	-	Oxic-anoxic transition zones
ppm	-	part per million
RLS	-	rate limiting step
rpm	-	Revolutions per minute
SD	-	Single-magnetic Domain
SP	-	Superparamagnetic
SS	-	South Seeking
STEM	-	Scanning Transmission Electron Microscope
TEM	-	Transmission electron microscopy
TGA	-	Thermogravimetric Analysis
USA	-	United States of America
XRD	-	X-ray Diffraction

LIST OF SYMBOLS

$AlCl_3.6H_2O$	-	Aluminium chloride
C_e	-	Equilibruim aluminium concentration (ppm)
C_o	-	Initial aluminium concentration (ppm)
Fe_3O_4	-	magnetite
Fe_3S_4	-	greigite
FeS	-	Mackinawite
K_1	-	Equilibruim rate constant of pseudo-first order kinetic model (1/min)
K_2	-	Equilibruim rate constant of pseudo-second order kinetic model (g/mg.min)
K_D	-	Dissociation constant
K_F	-	Freundlich constant (dm3/mg)
n	-	Intensity of adsorption
q_e	-	Amount adsorbed at efficiency condition(mg/g)
q_t	-	Adsoption capacity at time t (mg/g)
R^2	-	Correlation coefficient
RL	-	Langmuir parameter

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Introduction

There are many occasions when there is a direct overlap between geology and biology. Perhaps one of the best examples of this is magnetotactic bacteria (MTBs). They appear to be a distinctive Gram-negative prokaryote that have the ability to synthesize small crystals of magnetite inside their cells. They do this by transporting iron from the surrounding environment into their body. They use a number of proteins to biomineralize the iron into nano-sized magnets of magnetite (Fe_3O_4), greigite (Fe_3S_4) or combination of both (Bazylinski *et al.*, 1993a, 1995; Lower and Bazylinski, 2013). These aquatic microorganisms use the magnets to allow them to orient themselves in the Earth's magnetic field. They use flagella as a source of motility and they are sensitive to the changes in oxygen concentration (Bazylinski and Frankel, 2004).

MTB vary in many aspects but they are united by the presence of magnetosomes. Most discovered MTB are affiliated with *alphaproteobacteria*, but MTB belonging to the *Gammaproteobacteria*, the Deltaproteobacteria, and *Nitrospirae* have also been described (Amann *et al.*, 2007; Lefèvre and Bazylinski, 2013). The variations in cell morphology are represented by coccoid, rod-shaped, spirilla, vibrio and multicellular microorganisms (Keim *et al.*, 2004; Schuler, 2002).

MTBs can befound worldwide in the sediment from various aquatic environments including brackish and fresh water, rivers, lakes, and hot springs (Blackmore, 1975; Moench and Konetzka, 1978; Spring *et al*., 1994; Rulík and Chaudhary, 2014; Ghazvini *et al*., 2014; Lin *et al*., 2009; Oestreicher *et al*., 2012; Lefévre *et al*., 2010b). Bacterial magnetite contributes to the magnetic signal of the sediments and is widely distributed mainly in natural habitats (Oestreicher *et al.*, 2012) such as marine region (Zhu *et al*., 2010), pond ecosystem (Simmons and Edwards, 2007; Lin *et al*., 2013), iron ore soil (Liu *et al*., 2006) and estuarine region (Hergt *et al*., 2005).

The magnetosome is the defining feature of magnetotactic bacteria. It is denoted as an intracellular, lipid membrane-bound, magnetic iron-containing inorganic crystal (Frankel and Bazylinski, 2006; Lefèvre and Bazylinski, 2013). Two types of iron-containing crystals are known to be produced by magnetotactic bacteria: an iron oxide, magnetite (Fe_3O_4), and an iron sulfide, greigite (Fe_3S_4). Only a unique collection of marine magnetotactic multicellular prokaryotes (MMP), of the *Deltaproteobacteria* class, are reported to biomineralize both types of minerals (Lefèvre *et al*., 2011). The crystal morphologies of magnetosomes in MTB include cuboidal (cubo-octahedral), elongated prismatic (quasi-rectangular), arrowhead-shaped (bullet-shaped) and unusually large elongated prismatic crystals (Bazylinski and Frankel, 2003; Lins *et al*., 2005; Yan *et al*., 2012). It is shown that each MTB species have their own crystal habits that are different from a biotically produced magnetite particles. The morphology of biologically synthesized magnetic particles is strain specific. The size is almost equal within one strain; however, sizes can range from 35 to 120 nm for different MTB (Bazylinski and Frankel, 2004).

Magnetosomes (MSs) of MTB composed of various sizes and types of amorphous minerals granules such as calcium, oxygen, and phosphorus and to a lesser extent aluminium, iron, and zinc (Balkwill *et al*., 1980; Ulysses and Marcos, 1999). Some granules containing polyphosphates represent a new category of MSs (Ulysses and Marcos, 1999). Because of their involvement with various metals ions, MTB probably play a significant role in geochemical cycling (Simmons *et al*., 2007). It is common for MTB to contain internal granules, especially phosphorus (Lins and Farina, 1999), and sulphur (Keim and Farina, 2005).

Researchers revealed that MTB can be used to recover precious metals, which is apparently a major solution for industrial processing concerns (Gao *et al*., 2007). MTB can adsorb heavy metal ions more than other bacteria and it can easily be extracted from an aqueous medium after biosorption (Qu *et al*., 2014). The presence of magnetosomes helps to separate MTB from their environment using permanent magnet or electromagnetic field.

Globally, toxic metal ions mediated pollution is continuously growing. Industries such as mining, smelting, and metal plating cause heavy metals contamination in water (Vijayaraghavan and Yun, 2008). Heavy metals accumulation in the food chain cause tremendous ecological imbalances and is detrimental unless inhibited. Thus, there is a need to explore the cheap and environmental friendly process which can act as a shield to these threats to increase the standard of living and to make world a better place to live (Magdalena and Małgorzata, 2014). Countries having strong environmental laws to limit the use of contaminant being wasted in the environment (without being treated under consideration) are urged to developed on site or in plant facilities to treat the effluents to make the pollutants under the acceptable concentration (Banat *et al*., 1996; Vijayaraghavan and Yun, 2008).

Aluminium (Al) is a type of toxic heavy metal. Its exposure to human results in the increase rates of neurological disorder including Alzheimer, Parkinson, and Skeletal diseases (osteomalacia) (Akesson *et al*., 2014; Stephen, 2010). Often, several industries such as food (canning, and packing), kitchen utensils (Tuzen and Soylak, 2008; Yokel, 2016), transportation (Tuzen and Soylak, 2008) and chemicals (catalyst, pigment, tanning agent and as a mordant) predominantly use this heavy metal. It is also used to make abrasives, cement, explosives, and ink (Tuzen and Soylak, 2008). Despite its toxicity, it is used in pharmaceutical industry to create antacids and anti-diarrhoea medicines. This predominant usage of Aluminium in industries makes it abundant in the natural environment. Therefore, Scientists and engineers are using several methods to reduce the concentration of metals in the industrial wastewater; it includes agglomeration, neutralization, complexation, ion-exchange resin, separation and elution (Meshram *et al*., 2014).

Therefore, the development in reducing the metals in environment finds a new method, which is called biosorption. This method has received agreat attention in the recent years due to its low cost and high capacities. The mechanism of adsorption by biomass can be described as a passive immobilization of metal ions. It is essentially based on physicochemical interaction between functional groups of the cell wall and metal. Likewise, the cell wall of bacteria generally consists of proteins, lipids and polysaccharides which contain functional groups, such as amino groups, phosphate, hydroxyl and carboxylate so these functional groups offer binding sites for metals (Won *et al*., 2013).

In this study, a new variant of MTB (*Alcaligenes sp* SUM 123) was isolated from Skudai River water as potential resource to remove Al (III) from aqueous solution. The influence of several external factors such as temperature, pH, Al (III) concentration, and biomass dosage on Aluminium ion biosorption efficacy of such MTB was scrutinized. Earlier studies are mainly focused on the isolation as well as cultivation of MTB and MSs (Schüler and Heyen, 2003; Ghazvini *et al*., 2014). However their biosorption effectiveness towards heavy metals ions is seldom reported (Wu *et al*., 2008).

1.2 Problem Statement

Currently, the chemical explosion from rapid industrialization and expansion of modern agriculture area is the main concern of the environment and human health. Toxic Aluminium metal accumulated and degenerations the environment (Denizli *et al*., 2003). Methods such as chemical precipitation, chemical oxidation or reduction, membrane and evaporation technology, electrochemical treatment, and filtration which are introduced to remove the accumulation of heavy metals are expensive, inaccurate and inefficient (Gunatilake, 2015). To overcome such limitations, an appropriate biological method need to be developed.

Magnetotactic bacteria (MTBs) are ubiquitous in diverse terrestrial and aquatic ecosystem. Malaysia is a tropical country surrounded by oceans, rivers, and lakes and can be a great source of MTB. Thus, it is worth to explore the sediment of Skudai River in Johor, Malaysia as potential resource for MTB isolation. The isolated MTB can be a usefull tools in different area of study such as heavy metals biosorption.

Although much attention has been focused on the mechanisms of biomineralization in MTB (Bazylinski *et al*., 1995; Taylor and Barry, 2004; Rahn-Lee and Komeili, 2013), lack information available on MTB growth and magnetosomes formation under different environmental conditions such as pH, temperature, and iron concentration, since these conditions will affect the magnetosome formation and the performance of the MTB in any area of study. Thus, determining the survival and growth conditions of these MTB together with the formation of MSs in a broad range of environmental parameters is a challenging task.

Pervious studies used MTB to remove different types of metals such as Cr (V) ion from wastewater (Qu *et al*., 2014). In addition, Au (III), Cu (III) ions adsorbed from aqueous solution using MTB (Song *et al*., 2007). Therefore, the present thesis exploits a new variant of MTB (*Alcaligenes sp* SUM 123) isolated from Skudai River as potential resource to remove Al (III) ions metal from aqueous solution with various range of factors such as temperature, pH, Al (III) concentration, and biomass dosages The magnetotactic bacteria have the ability to adsorb high concentration of heavy metals from aqueous solution in a short time compared to other microorganisms. Besides, The presences of magnetosomes in MTBs will help in extracting them from the treatment system just by using a magnet after the biosorption processes.

1.3 Research Objectives

Based on the problem statement the following objectives are set:

i. To isolate MTB from Skudai River sediment (Johor Bahru, Malaysia) and identify them using 16S rRNA sequencing analysis and biochemical method.

ii. To characterize the structure and properties of MTB and magnetosomes.

iii. To determine the influence of temperature, pH, ferric quinate concentration as iron source on the growth of MTB and magnetosomes formation.

iv. To evaluate the Al (III) ions biosorption efficiency of newly isolated MTB from aqueous solution under varying temperature, pH, biomass concentration and Al concentration.

v. To assess biosorption potency via isotherm (Langmuir and Freundlich model) and kinetics study.

1.4 Scope of the Study

Based on the objectives the research scopes are limited to the following aspects:

i. The MTB was isolated from Skudai River water sediment and was identified using 16S rRNA gene analysis and biochemical methods such as catalase, nitrate, indole, motility, MacConkey, starch, lipase, ureas, and citrate tests.

ii. Characterization of the isolated bacterium as magnetotactic bacteria was conducted using Scanning Transmission Electron Microscope-Energy x-ray diffraction (STEM-EDX) that showed the appearance of magnetosomes inside bacterium and P-granlues which is a common trait of MTB. While, X-Ray Diffraction (XRD) detected the crystalline structure of magnetite (Fe_3O_4) in MTB, and High Resolution Transmission Electron Microscope (HRTEM) also confirmed the lattic space of magnetite. Infrared Fourier Transform Spectroscopy (FTIR) revealed the band of Fe-O at 585 cm^{-1} wavenumber. In addition, the domain structure by magnetotactic bacterium detected the magnetism of magnetite as trait for magnetotactic bacterium.

iii. The effects of pH at (5, 6, 7, 8), temperature at (25, 30, 35, 40 ºC) , and ferric quinate as iron source (20- 120 µM) on the MTB growth and magnetosomes formation was determined.

iv. The biosorption of Al (III) from aqeuous solution by isolated MTB was studied under varying parameters such as pH (2-9), contact time (5-70 minutes), temperature (10- 40 ºC), biosorbent dosage (2- 12 g/L), and initial Al concentration (100-500 mg/L).

v. The behaivor and mechanism of biosorption study conducted via isotherm (Langmuir and Freundlich model), kinetics models (Pseudo-first order and Pseudo-second order), and thermodynamic equations.

1.5 Significance of the Study

The isolation of these MTB is expected to bring new knowledge in terms of their growth, morphology, formation of MSs under various external conditions. Upon understanding their structures, growth mechanisms, and magnetic properties it would be possible to implement them for various potential applications in medicine, biotechnology, and bioremediation. For the first time, this work would attempt to isolate new MTB species from Skudai River mud (Malaysia) as new biological source useful for Al (III) biosorption. Thus, major environmental concern regarding the pollution of water by toxic heavy metals and its consequences in ecological imbalances would be mitigated. The isolation of MTB from polluted soil will aid in the use such MTB for removing heavy metals from wastewater and soil. The use of biomass has received a lot attention nowadays due to it has low cost and high adsorption capacity. Furthermore, the MTB used in this study has been screened for its ability to resist high concentration of Al (III). Thus, it can be an economical adsorbent after we got the motivation to remove high concentration of Aluminum. The outcome of the research can be used to prove the existence of specific microorganism can survives in a polluted environment.

REFERENCES

Abbas, M., Parveen, Z., Iqbal, M., Iqbal, S., Ahmed, M. & Bhutto, R. (2010). Monitoring of Toxic Metals (Cadmium, Lead, Arsenic and Mercury) in Vegetables of Sindh, Pakistan, *Journal of Engineering Science and Technology*. 6, pp. 60-65.

Abdel Ghani, N. & Elchaghaby, G. A., (2007). Influence of Operating Conditions on the Removal of Cu, Zn, Cd and Pb Ions from Wastewater by Adsorption. *International Journal of Environmental Science and Technology*. 4(4): 451-456.

Abreu, F., Morillo, V., Nascimento, F. F., Werneck, C.; Cantão, M. E.; Ciapina, L. P., de Almeida, L. G. P., Lefèvre, C. T., Bazylinski, D. A., de Vasconcelos, A.T.R. (2014). Deciphering Unusual Uncultured Magnetotactic Multicellular Prokaryotes through Genomics. *ISME Journal*. 8: 1055-1068.

Adamkiewicz, V. M., Authier, A., Dumont, S., Garzon, S., Leduc, S. (1991). A Simple Procedure for Enriching and cultivating magnetic bacteria in Low Agar-Mud Medium. *Journal of Microbiology Methods*. 13: 255-258.

Åkesson, A., Barregard, L., Bergdahl, I. A., Nordberg, G. F., Nordberg, M. & Skerfving, S. (2014). Non-renal Effects and the Risk Assessment of Environmental Cadmium Exposure. *Environmental Health Perspectives*. 122(5), 431.

Alphandéry, E. (2014). Applications of Magnetosomes Synthesized by Magnetotactic Bacteria in Medicine. *Front Bioeng Biotechnol*. 2: 1-6.

Alphandéry, E., Chebbi, I., Guyot, F. & Durand-Dubief, M. (2013). Use of Bacterial Magnetosomes in the Magnetic Hyperthermia Treatment of Tumours: A Review. *International Journal of Hyperthermia*. 29: 801-809.

Ali, Syed. Shahid., Habib, Iffat., Riaz, Tanzeela. (2009). Screening and characterization of *Alkaliphilic* bacteria from industrial effluents. Punjab University Journal of Zoology 24 (1-2), 49-60.

Alphandéry, E., Faure, S., Raison, L., Duguet, E., Howse, P. A. & Bazylinski, D. A. (2011a). Heat Production by Bacterial Magnetosomes Exposed to an Oscillating Magnetic Field. *Journal of Physical Chemistry C*. 115, 18-22.

Alphandéry, E., Faure, S., Seksek, O., Guyot, F. & Chebbi, I. (2011b). *Chains of Magnetosomes Extracted from AMB-1 Magnetotactic Bacteria for Application in Alternative Magnetic Field Cancer Therapy*. ACS Nano 5, 6279-6296.

Amann, R., Peplies, J. & Schüler D. (2006). Diversity and Taxonomy of Magnetotactic Bacteria. *Micro Monogr*. 3(8):25-36.

Amann, R., Peplies, J., Schüler, D. (2007). Controlled “Diversity and Taxonomy of Magnetotactic Bacteria,” in *Magnetoreception and Magnetosomes in Bacteria*, ed Schüler D., editor. (New York, NY; Berlin; Heidelberg: Springer-Verlag), 25-36

Amemiya, Y., Tanaka, T., Yoza, B., Matsunaga, T. (2005). Novel Detection System for Biomolecules Using Nano-Sized Bacterial Magnetic Particles and Magnetic Force Microscopy. *Journal. Biotechnology*. 120: 308-314.

Anne Postec, Nicolas Tapia, Alain Bernadac, Manon Joseph, Sylvain Davidson, Long-Fei Wu, Bernard Ollivier & Nathalie Pradel. (2011). Magnetotactic Bacteria in Microcosms Originating from the French Mediterranean Coast Subjected to Oil Industry Activities. *Microbial Ecology*. 63:1-11.

Arakaki, A., Nakazawa, H., Nemoto, M., Mori, T., Matsunaga, T. (2008). Formation of Magnetite by Bacteria and its Application. *Journal of The Royal Society Interface.* 5(26):977-99.

Arakaki, A., Takeyama, H., Tanaka, T., Matsunaga, T. (2002). Cadmium Recovery by a Sulfate-Reducing Magnetotactic Bacterium, Desulfovibrio Magneticus RS-1,using Magnetic Separation. *Applied Biochemistry and Biotechnology*. 98-100, 833-40.

Arató, B., Szányi, Z., Flies, C., Schüler, D., Frankel, R. B., Buseck, P. R. & Pósfai M. (2005). Crystal-Size and Shape Distributions of Magnetite from Uncultured Magnetotactic Bacteria as a Potential Biomarker. *American*

Mineralogist. 90, 1233-1241, Available from: http://www.usp.org/pdf/EN/meetings/asMeetingIndia/2008Session4track.pdf.

Azuma Taoka, Junya Kondo, Zachery Oestreicher and Yoshihiro Fukumori. (2014). Characterization of Uncultured Giant rod-shaped magnetotactic *Gammaproteobacteria* from a Freshwater Pond in Kanazawa, Japan. *Microbiology*. 160, 2226-2234.

Baek, S. H., Yin, C. R. & Lee, S. T. (2001). Aerobic Nitrate Respiration by a Newly Isolated Phenol-Degrading Bacterium, Alcaligenes Strain P5. *Biotechnology Letter*. 23: 627-630.

Bagul, V. R., Shinde, D. N., Chavan, R. P., Patil, C. L. & Pawar R. K. (2015). New Perspective on Heavy Metal Pollution of Water. *Journal of Chemical and Pharmaceutical Research*. 7(12):700-705.

Balaria, A. & Schiewer, S. (2008). Assessment of Biosorption Mechanisms for Pb Binding by Citrus Pectin. *Separation and Purification Technology*. 63: 577-581.

Balkwill, D. L., Maratea, D., Blakemore, R. P. (1980). Ultrastructure of *Amagnetotactic Spirillum. J Bacteriol*. 141(3):1399-1408.

Banat, I. M., Nigam, P., Singh, D. & Marchant, R. (1996). Microbial Decolourization of Textile-Dye Containing Effluents: A Review. *Bioresour Technol*ogy 58: 217-227.

Barabasz, W., Albinska, D., Jaskowska, M., Lipiec, J. (2002). Ecotoxicology of Aluminium. *Polish Journal of Environmental Studies*. 11(3):199-203.

Bartholomew, J. W. (1962). Variables Influencing Results and the Precise Definition of Steps in Gram Staining as a Means of Standardizing the Results Obtained. *Stain Technology*. 37: 139-1 55.

Bazylinski D. A. & Frankel R. B. (2004). Magnetosome Formation in Prokaryotes. *Nature Reviews Microbiology*. 2:217-230.

Bazylinski, D. A. & Frankel, R. B. (2003*)*. Biologically Controlled Mineralization in Prokaryotes, p 217–247. In Dove PM, DeYoreo JJ, Weiner S (ed), Biomineralization. Mineralogical Society of America, Washington, DC.

Bazylinski, D. A. & Frankel, R. B. (2004). Magnetosome Formation in Prokaryotes. *Nature Reviews Microbiology*. 2(3):217-30.

Bazylinski, D. A. & Lefèvre, C. T. (2013). Magnetotactic Bacteria from Extreme Environments. *Life*. 3:295-307.

Bazylinski, D. A. & Schübbe, S. (2007). Controlled Biomineralization by and Applications of Magnetotactic Bacteria. *Adv. Appl. Microbiol*. 62, 21-62.

Bazylinski, D. A. (1995). Structure and Function of the Bacterial Magnetosome, *ASM News*. 61, 337-343.

Bazylinski, D. A., Blakemore, R. P. (1983). Denitrification and Assimilatory Nitrate Reduction in Aquaspirillum Magnetotacticum. *Applied Environmental Microbiol*ogy. 46: 1118-1124.

Bazylinski, D. A., Frankel, R. B., and Jannasch, H. W. (1988). Anaerobic Magnetite Production by a Marine, Magnetotactic Bacterium. Nature. 334: 518-519.

Bazylinski, D. A., Frankel, R. B., Heywood, B. R., Mann, S., King, J. W., Donaghay, P. L. & Hanson, A. K. (1995). Controlled Biomineralization of Magnetite (Fe3O4) and Greigite (Fe3S4) in a Magnetotactic Bacterium. *Applied. Environmental. Microbiology*. 61: 3232-3239.

Bazylinski, D. A., Garratt-Reed, A. J., Abedi, A. & Frankel, R. B. (1993a). Copper Associated with Iron Sulfide Magnetosomes in a Magnetotactic Bactrium. *archives microbiology*. 160, 35-42.

Bazylinski, D. A., Garratt-Reed, A. J., Frankel, R. B. (1994). Electron Microscopic Studies of Magnetosomes in Magnetotactic Bacteria. *Microscopy Research and Technique*. 27(5): 389-401.

Bazylinski, D. A., Heywood, B. R., Mann, S. & Frankel, R. B. (1993b). Fe_3O_4 and Fe_3S_4 in a Bacterium. *Nature.* 366, 218.

Bazylinski, D., Williams, T. (2007). Ecophysiology of Magnetotactic Bacteria. *Micro Monogr*. 3 (9). 37-75.

Benoit, M., Mayer, D., Barak, Y., Chen, I. Y., Hu, W., Cheng, Z. (2009). Visualizing Implanted Tumors in Mice with Magnetic Resonance Imaging using Magnetotactic Bacteria. *Clinical Cancer Research*. 15: 5170-5177.

Bhuiyan, M. A. H., Suruvi, N. I., Dampare, S. B., Islam, M. A., Quraishi, S. B., Ganyaglo, S., Suzuki, S. (2011). Investigation of the Possible Sources of Heavy Metal Contamination in Lagoon and Canal Water in the Tannery Industrial Area in Dhaka, Bangladesh. *Environmental Monitoring and Assessment*. 175, 633-649.

Binupriya, A. R., Sathishkumar, M., Kavitha, D., Swaminathan, K., Yun, S.E. & Mun, S. P. (2007). Experimental and Isothermal Studies on Sorption of

Congo Red by Modified Mycelial Biomass of Wood-Rotting Fungus. *Clean–Soil, Air, Water*. 35(2): 143-150.

Blakemore, R. (1975). Magnetotactic Bacteria. *Science*. 190:377-379.

Blakemore, R. P. (1982). Magnetotactic Bacteria. *Annual Review of Microbiology*. 36, 217-238.

Blakemore, R. P. (1983). Magnetic Bacteria and Products Derived Therefrom. US Patent 4385119

Blakemore, R. P., Frankel, R. B. & Kalmijn, A. J., (1980), South-seeking Magnetotactic Bacteria in the Southern Hemisphere. *Nature*. 286:384.

Blakemore, R. P., Maratea, D. & Wolfe, R. S. (1979). Isolation and Pure Culture of a Freshwater Magnetic Spirillum in Chemically Defined Medium. *Journal of Bacteriology*. 140: 720-729.

Boughriet, A., Ouddane, B., Fischer, J. C., Wartel, M. & Leman, G. (1992). Variability of dissolved Mn and Zn in the Seine Estuary and Chemical Speciation of these Metals in Suspended Matter. *Water Research*. 26(10): 1359-1378.

Cai, F., Li, J., Sun, J. & Ji, Y. (2011). Biosynthesis of Gold Nanoparticles by Biosorption using Magnetospirillum Gryphiswaldense MSR-1. *Chemical Engineering Science*. 175. 70-75.

Cai, W. & Wan, J. (2007). Facile Synthesis of Superparamagnetic Magnetite Nanoparticles in Liquid Polyols. *Journal of Colloid and Interface Science*. 305 (2):366-70.

Carini, P.; Steindler, L.; Beszteri, S.; Giovannoni, S.J. (2013). Nutrient Requirements for Growth of the Extreme Oligotroph “Candidatus Pelagibacter ubique” HTCC1062 on a defined medium. *ISME Journal*. 7: 592-602.

Cayllahua Javier Enrique Basurco, Torem Maurício Leonardo , (2010). Biosorption of Aluminum Ions onto Rhodococcus Opacus from Wastewaters. *Chemical Engineering Journal*. 161 (1–2): 1-8.

Cedeno-Mattei Y., Perales-Perez, O., Tomar, M. S., Roman, F., Voyles, P. M. & Stratton, W. G. (2008). Tuning of Magnetic Properties in Cobalt Ferrite Nanocrystals. Tampa, Florida (USA).

Chang, S. B. R. & Kirschvink, J. L. (1989). Magnetofossils, the Magnetization of Sediments and the Evolution of Magnetite Biomineralization. *Annual Review* *of Earth and Planetary Sciences*. 17, 169-195. doi: 10.1146/annurev.ea.17.050189.001125.

Chiou, Ming-Shen., Li Hsing-Ya. (2002). Equilibrium and Kinetic Modeling of Adsorption of Reactive Dye on Cross-Linked Chitosan Beads. *Journal of Hazardous Materials*. 233-248.

Cho, Dae Haeng., Kim, Eui Yong., and Hung, Yung-Tse. (2010). Heavy Metal Removal by Microbial Biosorbents. *Handbook of Environmental Engineering.* Volume 11: Environmental Bioengineering.

Chojnacka, Katarzyna. (2010). Biosorption and Bioaccumulation- The Prospects for Practical Applications. *Environment International*. 36, 299-307.

Clark, T. M., & Evans, J. (1997). Influence of Chemical Composition on the Crystalline Morphologies of Magnetite. *IEEE Transactions on Magnetics*. 33, 4257-4259.

Coleman, J. E. (1992). Zinc Proteins: Enzymes, Storage Proteins, Transcription Factors, and Replication Proteins. *Annual Review of Biochemistry*. 61: 897-946.

Cornell, R. M. & Schwertmann, U. (1996). The Iron Oxides. VCH, New York.

Cox, B. L., Popa, R., Bazylinski, D. A., Lanoil, B., Douglas, S., Belz, A. (2002). Organization and Elemental Analysis of P-, S-, and Fe-rich Inclusions in a Population of Freshwater Magnetococci. *Geomicrobiology Journal*. 19 (4),387-406.

Das, N. (2010). Recovery of Precious Metals through Biosorption- A Review. *Hydrometallurgy*. 103: 180-189.

DeLong, E. F., Frankel, R. B. & Bazylinski, D. A. (1993). Multiple Evolutionary Origins of Magnetotaxis in Bacteria. *Science*. 259: 803-806.

Denizli, A., Say, R. & Pikin, E. (2003). Removal of aluminium by Alizarin Yellow Attached Magnetic Poly (2-hydroxyethyl methacrylate) Beads. *Reactive and Functional Polymers*. 55 (1) 99-107.

Devouard, B., Posfai, M., Hua, X., Bazylinski, D. A., Frankel, R. B. & Buseck, P. R. (1998). Magnetite from Magnetotactic Bacteria: Size Distributions and Twinning. *American Mineralogist*. 83, 1387-1398.

Diels, L., Corbisier, P., Hooyberghs, L., Glombitza, F., Hummel, A., Tzesos, M., Pümpel, B., Schinner, F. (1995). Biosorption in *Alcaligenes Eutrophus* ER 121. *Biohydrometallurgical Processing*. University of Chile.

Dubbels, B. L., Dispirito, A. A., Morton, J. D., Semrau, J. D., Neto, J. N. E. & Bazylinski, D. A. (2004). Evidence for a Copper-Dependent Iron Transport System in the Marine, Magnetotactic Bacterium Strain MV-1. *Microbiology*. 150, 2931-2945.

Duruibe, J. O., Ogwuegbu, M. O. & Egwurugwu, J. N. (2007). Heavy Metal Pollution and Human Biotoxic Effects. *International Journal of Physical Sciences*. 2 (5), 112-118.

Eden, P. A., Schmidt, T. M., Blackempre, R. P., Pace, N. R., (1991). Phylogenetic Analysis of *Aquaspirillum Magnetotactic* using Polymerase Chain Reaction-Amplified 16S rRNA-specific DNA. *International Journal of Systematic and Evolutionary Microbiology*. 41(2), 324-325.

Esposito, A., Pagnanelli, F. & Veglia, F. (2002). pH-related Equilibria Models for Biosorption in Single Metal Systems. *Chemical Engineering Science*. 57(3): 307-313.

ElAhwany, Amani., Mabrouk, Mona. (2013). Isolation and characterization of a phenol-degrading strain of *Alcaligenes sp*. AM4. *Acta Biologica Hungarica*. 64(1),106-117.

Faivre, D. & Schuüler, D. (2008). Magnetotactic Bacteria and Magnetosomes. *Chem. Rev*.108, 4875-4898.

Faivre, D., Böttger, L. H., Matzanke, B. F., Schüler, D. (2007). Intrazelluläre Magnetit biomineralisation in Bakterien: ein eigener Stoffwechselweg unter Beteiligung von membrangebundenem Ferritin und einer Fe^{2+}-Spezies. *Angewandte Chemie*. 46 (44);8495-8499.

Faivre, D., Menguy, N., Pósfai, M., Schüler, D. (2008). Environmental Parameters Affect the Physical Properties Offast-Growing Magnetosomes. *American Mineralogist*. 93(2–3):463-9.

Farina M, DMS E & HGP LdB (1990). Magnetic Iron–Sulphur Crystals from a Magnetotactic Microorganism. *Nature*. 343: 256-258.

Fdez-Gubieda M Luisa., Muela Alicia, Alonso Javier, ´a-Prieto Ana Garcı, Olivi, Luca, Ferna Rodrigo ´ndez-Pacheco, and Manuel Jose ´ Barandiara. (2013). Magnetite Biomineralization in *Magnetospirillum gryphiswaldense*: Time-Resolved Magnetic and Structural Studies. *ASC Nano*. 7 (4), 3297-3305.

Febrianto, J., Kosasih, A. N., Sunarso, J., Ju, Y.-H., Indraswati, N. & Ismadji, S. (2009). Equilibrium and Kinetic Studies in Adsorption of Heavy Metals using

Biosorbent: A Summary of Recent Studies. *Journal of Hazardous Materials*. 162(2–3): 616- 645.

Felsenstein, Joseph. (1985). Confidence Limits of Phylogenies: An Approach using the Bootstrap. *Evolution.* 39(4), 783-791.

Flies, C., Jonkers, H., deBeer, D., Bosselmann, K., Böttcher, M. & Schüler, D. (2005). Diversity and Vertical Distribution of Magnetotactic Bacteria along Chemical Gradients in Freshwater Microcosms. *FEMS Microbial Ecology*. 52: 185-195.

Frankel B. R., Williams T. & Bazylinski D. (2007). Magnetoreception and Magnetosomes in Bacteria: Magnetoaerotaxis.

Frankel, R. B. & Bazylinski, D. A. (2006). How Magnetotactic Bacteria make Magnetosomes Queue Up. *Trends in Microbiology*. 14:329 -331.

Frankel, R. B. & Blakemore, R. P. (1980). Navigational Compass in Magnetic Bacteria. *Journal of Magnetism and Magnetic Materials*. 15(18): 1562-1564.

Frankel, R. B., Blakemore, R. P. & Wolfe, R. S. (1979). Magnetite in Freshwater Magnetotactic Bacteria. *Science.* 203(4387):1355-6.

Funaki, M., Sakai, H., Matsunaga, T., Hirose, S. (1992). The S Pole Distribution on Magnetic Grains in Pyroxenite Determined by Magnetotactic Bacteria. *Physics of the Earth and Planetary Interiors*. 70(3–4):253-260

Futschik, K., Pfützner, H., Doblander, A., Schönhuber, P., Dobeneck, T., Petersen, N. & Vali, H. (1989). Why not Use Magnetotactic Bacteria for Domain Analyses? *Physica Scripta*. 40: 518-521.

Gadd, G. M. (1990). Heavy Metal Accumulation by Bacteria and Other Microorganisms. *Experientia*. 46: 834-840.

Gao Meiying, Liu Yanli, Dai Shunying, Han Yawei. (2006). *A Novel Magnetotactic Bacterial Strain of Betaproteobacteria from Iron Ore Soil*. Institute of Virology, Chinese Academy of Sciences, Wuhan, 430071, China.

Gao, J., Pan, H., Xiao, T., Barbier, G., Wang, Z., Yue, H. (2006). Isolation and Characterization of Novel Marine Roseobcter Clade Members Producing Unique Intracellular Chromium-Rich Aggregates. *Research Microbiology*. 157: 714-719.

Gunatilake S.K. (2015). Methods of Removing Heavy Metals from Industrial Wastewater. *Journal of Multidisciplinary Engineering Science Studies (JMESS)*. 1 (1):12-18.

Gao, L., Zhuang, J., Nie, L., Zhang, J., Zhang, Y., Gu, N. (2007). Intrinsic Peroxidase-Like Activity of Ferromagnetic Nanoparticles. *Nature. Nanotechnology*. 2, 577-583 10.1038/nnano.2007.260

Gorby, Y. A., Beveridge, T. J. & Blakemore, R. P. (1988). Characterization of the Bacterial Magnetosome Membrane. *Journal of. Bacteriology*. 170, 834-841.

Gould, J. L., Kirschvink, J. & Deffeyes, K. (1978), Bees have Magnetic Remanence: Science (New York, NY).201: (4360),1026.

Greenberg, M., Canter, K., Mahler, I. & Tornheim, A. (2005). Observation of Magnetoreceptive Behavior in a Multicellular Magnetotactic Prokaryote in Higher than Geomagnetic Fields. *Biophysical Journal*. 88: 1496-1499.

Gupta, N., Gaurav, S. S., Kumar, A. (2013). Molecular Basis of Aluminium Toxicity in Plants: A Review. *American Journal of Plant Sciences*. 4:21-37.

Hadibarata, T., Abdullah, F., Yusoff, A. R. M., Ismail, R., Azman, S. & Adnan, N. (2012). Correlation Study between Land Use, Water Quality and Heavy Metals (Cd, Pb, and Zn) Content in Water and Green Lipped Mussels Pernaviridis (Linnaeus.) at the Johor Strait. *Water, Air, & Soil Pollution.* 223(6), 3125-3136.

Hanzlik, M., Winklhofer, M., Petersen, N. (2002). Pulsed-Field-Remanence Measurements on Individual Magnetotactic Bacteria. *Journal of Magnetism and Magnetic Materials*. 248(2), 258-267.

Harasko, G., Pfützner, H. & Futschik, K. (1995). Domain Analysis by Means of Magnetotactic Bacteria. *IEEE Transactions on Magnetics*. 31: 938-949.

Harasko, G., Pfützner, H., Rapp, E., Futschik, K. & Schüler, D. (1993). Determination of the Concentration of Magnetotactic Bacteria by Means of Susceptibility Measurements. *Japanese Journal of Applied Physics*. 32: 252-260.

He, Y. C., Xu, J. H., Su, J. H., Zhou, L. (2010). Bioproduction of Glycolic Acid from Glycolonitrile with a New Bacterial Isolate of *Alcaligenes sp*. ECU0401. *Applied Biochemstry Biotechnoogyl*. 160:1428-1440.

Hergt, R., Hiergeist., R., Zeisberger, M., Schüler, D., Heyen, U., Hilger. (2005). Magnetic Properties of Bacterial Magnetosomes as Potential Diagnostic and Therapeutic Tools. *Journal of Magnetism and Magnetic Materials*. 293(1), 80-86.

Heyen, U. & Schüler, D. (2003). Growth and Magnetosome Formation by Microaerophilic Magnetospirillum Strains in an Oxygen-Controlled Fermentor. *Applied Microbiology and Biotechnology*. 61, 536-544.

Heywood, B. R., Bazylinski, D. A., Garratt-Reed, A., Mann. S., Frankel, R. B. (1990). Controlled Biosynthesis of Greigite (Fe_3S_4) in Magnetotactic Bacteria. *Naturwissenschaften*. 77(11),536-548.

Ho, Y. S. & McKay, G. (2000). The Kinetics of Sorption of Divalent Metal Ions onto Sphagnum Moss Peat. *Water Research*. 34(3), 735-742.

Huggett Jennifer. M. (1995). Formation of Authigenic Illite in Palaeocene Mudrocks from the Central North Sea: A Study by High Resolution Electron Microscopy. *Clays and Clay Minerals*. 43 (6), 682-692.

Ignat, M., Zarnescu, G., Soldan, S. (2007). Magneto-Mechanic Model of the Magnetotactic Bacteria: Applications in the Microactuator Field. *Journal of Optoelectronics and Advanced Materials*. 9, 1169-1171.

Ismail, Z., Salim, K., Othman, S. Z., Ramli, A. H., Shirazi, S. M., Karim, R., & Khoo, S. Y. (2013). Determining and Comparing the Levels of Heavy Metal Concentrations in Two Selected Urban River Water. *Measurement.* 46(10), 4135-4144.

Ivanić, Maja., Vdović, Ned., Barreto, Sandra de Brito., Bermanec, Vladimir., and Sond, Ivan. (2015). Mineralogy, surface properties and electrokinetic behaviour of kaolin clays derived from naturally occurring pegmatite and granite deposits. *Geologia Croatica*. 68 (2), 139-145.

Issa, Bashar ., Obaidat, M Ihab., Albiss, A Borhan., and Haik, Yousef (2013). Magnetic Nanoparticles: Surface Effects and Properties Related to Biomedicine Applications. *International Journal of Molecular Sciences*. 14, 21266-21305.

Iwasaki H, Mori T (1958) Studies on denitrification. III Enzymatic gas production by the reaction of nitrite with hydroxylamine. J Biochem 45, 133-140.

Jain, C. K. (2004). Metal Fractionation Study on Bed Sediments of River Yamuna, India. *Water Research*. 38(3): 569-578.

Jogler, C., Schüler, D. (2009). Genomics, Genetics, and Cell Biology of Magnetosome Formation. *Annual Review of Microbiology*. 63: 501-21.

Jogler, C., Wanner, G., Kolinko, S., Niebler, M., Amann, R., Petersen, N. (2011). Conservation of Proteobacterial Magnetosome Genes and Structures in an

Uncultivated Member of the Deep-Branching Nitrospira phylum. *Proceedings of the National Academy of Sciences Journal*. 1081134–1139.

Kabata-Pendias A. (2000). Trace Elements in Soil and Plants. CRC press. Boca Raton, USA.

Karthikeyan, S., Balasubramanian, R. & Iyer, C. S. P. (2007). Evaluation of the Marine Algae Ulva Fasciata and Sargassum sp. for the Biosorption of Cu (II) from Aqueous Solutions. *Bioresource Technology*. 98: 452-455.

Katarzyna, C. (2010). Biosorption and Bioaccumulation: The Prospects for Practical Applications. *Environment International*. 36(3), 299-307.

Kawaguchi, R., Burgess, J. G., Sakaguchi, T., Takeyama, H., Thornhill, R. H., Matsunaga, T. (1995). Phylogenetic Analysis of a Novel Sulfate-Reducing Magnetic Bacterium, Rs-1, Demonstrates its Membership of the Deltaproteobacteria. *FEMS Microbiology Letter*. 126: 277-282.

Keim, C. M., Lins, U., and Farina, M. (2009). Manganese in Biogenic Magnetite Crystals from Magnetotactic Bacteria. *FEMS Microbiology*. *Letter*. 292: 250–253.

Keim, C. N., Abreu, F., Lins, U., de Barros, H. L., Farina, M. (2004). Cell Organization and Ultrastructure of a Magnetotactic Multicellular Organism. *Journal of Structural Biology*. 145:254 -262

Keim, C. N., Farina, M. (2005). Gold and Silver Trapping by Uncultured Magnetotactic Cocci. *Geomicrobiology Journal*. 22: 55-63.

Keim, C. N., Lins, U. & Farina, M. (2001). Elemental Analysis of Uncultured Magnetotactic Bacteria Exposed to Heavy Metals. *Canadian Journal of Microbiology*. 47, 1132-1136..

Kirschvink, J. L., Hagadorn, J. W. (2000). A Grand Unified Theory of Biomineralization. In *Biomineralization* (ed. BäuerleinE.), ch. 10, pp. 139-150.Weinheim, Germany: Wiley-VCH

Kolinko, I.; Lohsse, A.; Borg, S.; Raschdorf, O.; Jogler, C.; Tu, Q.; Pósfai, M.; Tompa, E.; Plitzko,J.M.; Brachmann, A. (2014). Biosynthesis of Magnetic Nanostructures in a Foreign Organism by Transfer of Bacterial Magnetosome Gene Clusters. *Nature Nanotechnoogy*. 9: 193-197.

Komeili, A., Li, Z., Newman, D. K., Jensen, G. J. (2006). Magnetosomes are Cell Membrane Invaginations Organized by the Actin-Like Protein MamK. *Science*. 311(5758): 242-245.

Komeili, A., Vali, H., Beveridge, T. J. & Newman. D. K. (2004). Magnetosome Vesicles are Present before Magnetite Formation and MamA is Required for their Activation. *Proceedings of the National Academy of Sciences Journal*. USA 101:3839-3844.

Kopp, R. E., Kirschvink, J. L. (2008). The Identification and Biogeochemical Interpretation Offossil Magnetotactic Bacteria. *Earth-Science Reviews*. 86(1-4):42-61.

Kopp, R. E., Weiss, B. P., Maloof, A. C., Vali, H., Nash, C. Z., Kirschvink, J. L. (2006). Chains, Clumps, and Strings: Magnetofossil Taphonomy with Ferromagnetic Resonance Spectroscopy. *Earth and Planetary Science Letters*. 247(1–2):10-25.

Krichevsky, A., Smith, M. J., Whitman, L. J., Johnson, M. B., Clinton, T. W., Perry, L. L. (2007). Trapping Motile Magnetotactic Bacteria with a Magnetic Recording Head. *Journal of Applied Physics*. 101 (1) 014701–014706.

Krishna, M. P., Varghesem, R., Babu, A. V., Hatha, A. A. (2012). Bioaccumulation of Cadmium by Pseudomonas sp. Isolated from Metal Polluted Industrial Region Environ. *Environmental Research, Engineering and Management*. 3, 58-64.

Kumar, A., Cameotra, S. S., Gupta, S. (2012). Screening and Characterization of Potential Cadmium Biosorbent *Alcaligenes* Strain from Industrial Effluent. *Journal of Basic Microbiology*. 52 (2), 160-6.

Kumar, R., Bhatia, D., Singh, R. & Bishnoi, N. R. (2012). Metal Tolerance and Sequestration of Ni(II), Zn(II) and Cr(VI) Ions from Simulated and Electroplating Wastewater in Batch Process: Kinetics and Equilibrium Study. *International Biodeterioration & Biodegradation*. 66, 82-90.

Kumar, Y. P., King, P. & Prasad V. S. K. R. (2006). Zinc Biosorption on Tectona Grandis L. Leaves Biomass: Equilibrium and Kinetic Studies. *Chemical. Engeering. Journal*. 124, 63-70.

Kundu, Srikanya., Kale, Anup., Banpurkar, Arun., Ogale S. B. (2009). On the Change in Bacterial Size and Magnetosome Features for *Magnetospirillum Magnetotacticum* (MS-1) under High Concentrations of Zinc and Nickel. *Biomaterials*. 30(25), 4211-4218.

Lane, D. J. (1991). 16S/23S rRNA Sequencing. In: Nucleic Acid Techniques in Bacterial Systematics (Stackbrandt E and Goodfellow M, eds.). Wiley, Chichester, 115-176.

Larrasoaña C Juan., Liu Qingsong, Hu Pengxiang, Roberts P Andrew, Mata Pilar, Civis Jorge, Sierro J Francisco, and Pérez-Asensio N José. (2014). Paleomagnetic and Paleoenvironmental Implications of Magnetofossil Occurrences in Late Miocene Marine Sediments from the Guadalquivir Basin, SW Spain. *Frontiers in Microbiology*. 5 (71), 1-17.

Lefèvre, C. T. & Bazylinski, D. A. (2013). Ecology, Diversity, and Evolution of Magnetotactic Bacteria. *Microbiology and Molecular Biology Reviews*. 77: 497-526.

Lefèvre, C. T., Abreu, F., Lins, U., Bazylinski, D. A. (2011). A Bacterial Backbone: Magnetosomes in Magnetotactic Bacteria. M. Rai, N. Duran (Eds.), *Metal Nanoparticles in Microbiology*, Springer-Verlag, Berlin. 75-102.

Lefevre, C., Abreu, F., Schmidt, M., Lins, U., Frankel, R., Hadlund, B., Bazylinski, D. (2010b). Moderately Thermophilic Magnetotactic Bacteria from Hot Springs in Nevada USA. *Applied Environmental Microbialogy*. 76:3740-3743.

Lerner, A. (2012). Aluminum as an Adjuvant in Crohn's Disease Induction. Lupus. 2012 Feb; 21(2):231-8.

Lin, W., Li, J., Schüler, D., Jogler, C., and Pan, Y. (2009). Diversity Analysis of Magnetotactic Bacteria in Lake Miyun, Northern China, by Restriction Fragment Length Polymorphism. *Systmic Applied Microbiol*ogy. 32,:342-350.

Lin, W., Wang, Y., Gorby, Y., Nealson. K. & Pan, Y. (2013). Integrating Niche-Based Process and Spatial Process in Biogeography of Magnetotactic Bacteria. *Scientific Reports*. 3: 1643.

Lins, U., McCartney, M. R., Farina, M., Frankel, R. B., Buseck, P. R. (2005). Habits of Magnetosome Crystals in Coccoid Magnetotactic Bacteria. *Applied Environmental Microbiology.* 71:4902-4905.

Liu, X., Xie, J., Liu, W., Huo, Q., Qiu, G. (2006). Research on Isolating Bacteria by Using Magnetophoresis. *Chinese Journal of Biotechnology*. 26(4), 70-74.

Liu, Y., Gao, M., Dai, S., Peng, K., Jia, R. (2006). Characterization of Magnetotactic Bacteria and their Magnetosomes Isolated from Tieshan Iron Ore in Hubei Province of China. *Materials Science and Engineering.* 26(4), 597-601.

Lodeiro Pablo, Gudina˜ Ángel , Herrero Luz , Herrero Roberto, Sastre de Vicente Manuel. (2010). Aluminium Removal from Wastewater by Refused Beach Cast Seaweed. Equilibrium and Dynamic Studies. *Journal of Hazardous Materials*. 178: 861-866.

Lovley, D. R., Stolz, J. F., Nord, G. L., Jr., Phillips E. J. P. (1987). Anaerobic Production of Magnetite by a Dissimilatory Iron-Reducing Microorganism. *Nature*. 330:252-254.

Lowenstam, H. A. (1981). Minerals formed by organisms. *Science*. 211: 1126-1131

Lower, B. H. & Bazylinski, D. A. (2013). The Bacterial Magnetosome: A Unique Prokaryotic Organelle. *Journal of Molecular Microbiology and Biotechnology*. 23: 63-80.

Nuruddin M F, Sadaqat Ullah Khan, Nasir Shafiq, Tehmina Ayub. (2014). Comparison of Physical and Chemical Properties of Micro-silica and Locally Produced Metakaolin and Effect on the Properties of Concrete. *Conference: IEEE Colloquium on Humanities, Science and Engineering (CHUSER)*, at Penang, Malaysia.

Mack, C., Wilhelmi, B., Duncan, J. R. & Burgess, J. E. (2007). Biosorption of Precious Metals. *Biotechnology. Advance*. 25(3), 264-271.

Madigan, M. T., Martinko, J. M. & Parker, J. (2003). *Brock Biology of Microorganisms 10th Edition*. Prentice-Hall Canada Inc., Toronto.

Magdalena Zabochnicka-Świątek1 & Małgorzata Krzywonos. (2014). Potentials of Biosorption and Bioaccumulation Processes for Heavy Metal Removal. *Polish Journal of Environmental Studies*. 23: 551-561

Malkoc, E. (2006). Ni (II) Removal from Aqueous Solution using Cone Biomass of Thujaorientalis. *Journal of Hazardous Materials*. B137: 899-908.

Mann, S., Sparks, N. H. C., Frankel, R. B., Bazylinski, D. A. & Jannasch, H. W. (1990). Biomineralization of Ferrimagnetic Greigite (Fe_3S_4) and Iron Pyrite (FeS_2) in a Magnetotactic Bacterium. *Nature*. 343: 258-261.

Martel, S. (2010). Microrobotic Navigable Entities for Magnetic Resonance Targeting. *Conf Proc IEEE Eng Med Biol Soc*. 1942–5. DOI: 10.1109/ IEMBS.2010.5627768.

Martel, S., Tremblay, C. C., Ngakeng, S., Langlois, G. (2006). Controlled Manipulation and Actuation of Micro-Objects with Magnetotactic Bacteria. *Applied Physic Letter*. 89: 233904-233906.

Martin Rulík, Prem Prashant Chaudhary. (2014). Molecular Identification of the Occurrence of Magnetotactic Bacteria in Fresh Water Sediments (Czech Republic). *Brazilian Journal of Microbiology*. 45(4), 1255-1261

Marulanda, A. L. B. & Harcum, S. W. (2000). Removal of Copper and Aluminum Ions from Solution by Immobilized Cyanidium caldarium: Radioactive Waste Management and Environmental Restoration. *Radioactive Waste Management and Environmental Restoration.* 22 (3). 223-237.

Maruyama, K., Takeyama, H., Nemoto, E., Tanaka, T., Yoda, K.. (2004). Single Nucleotide Polymorphism Detection in Aldehyde Dehydrogenase 2 (ALDH2) Gene using Bacterial Magnetic Particles Based on Dissociation Curve Analysis. *Biotechnology Bioengeering*. 87: 687-694.

Mason, A. & Simkiss, K. (1982). Sites of Mineral Deposition in Metal-Accumulating Cells. *Exp. Cell Research*. 139: 383-391.

Matsubara, T. (1970). Studies on Denitrification. XII. Gas Production from Amines and Nitrite. *The Journal of Biochemistry*. 67: 229-235.

Matsunaga, T. & Kamiya, S. (1987). Use of Magnetic Particles Isolated from Magnetotactic Bacteria for Enzyme Immobilization. *Applied Microbiology Biotechnology*. 26: 328-332.

Matsunaga, T. & Okamura, Y. (2002). Molecular Mechanism of Bacterial Magnetite Formation and its Application. *Biological Biomimetic Materials-Properties To Function*. 724: 11-24.

Matsunaga, T., Sakaguchi, T. & Tadokoro, F. (1991). Magnetite Formation by a Magnetic Bacterium Capable of Growing Aerobically. *Applied Microbiology Biotechnology*. 35: 651-655.

Matsunaga, T., Tadokoro, F., and Nakamura, N. (1990). Mass Culture of Magnetic Bacteria and their Application to Flow Type Immunoassays. *IEEE Transactions on Magnetics.* 26: 1557-1559.

Matsunaga, T., Togo, H., Kikuchi, T., Tanaka, T. (2000). Production of Luciferase–Magnetic Particle Complex by Recombinant *Magnetospirillum* sp. AMB-1. *Biotechnology and Bioengineering*. 70(6), 704-709.

Mazo-Zuluaga, J., Barrero, C. A., Diaz-Teran, J.; Jerez, A. (2003). Thermally Induced Magnetite-Haematite Transformation. *Hyperfine Interactions*. 148-149(1-4):. 153-161.

McCartney, M. R., Lins, U., Farina, M., Buseck, P. R., Frankel, R. B. (2001). Magnetic Microstructure of Bacterial Magnetite by Electron Holography. *European Journal of Mineralogy*. 13(4), 685-689.

Meena, A. K, Mishra, G. K, Rai, P. K, Rajagopal, C., Nagar, P. N. (2005). Removal of Heavy Metal Ions from Aqueous Solution using Carbon Aerogel as an Adsorbent. *Journal of Hazardous Materials*. 122: 161-170.

Meldrum, F. C., Mann, S., Heywood, B. R., Frankel, R. B., and Bazylinski, D. A. (1993). Electron Microscopy Study of Magnetosomes in a Cultured Coccoid Magnetotactic Bacterium. *Proceedings of the Royal Society B: Biological Sciences Journal*. 251, 231-236. doi: 10.1098/rspb.1993.0034

Miller, J. L., Hubbard, C. M., Litman, B. S. & Macdonald, T. L. (1989). Inhibition of Transducin Activation and Guanosine Triphosphatase Activity by Aluminum Ion. *Journal of Biological Chemistry*. 264: 243-250.

Moench, T. T. (1988). *Bilophococcus Magnetotacticus* gen.nov.sp, a Motile Magnetic Coccus. *Antonie van Leeuwehoek*. 54: 483-496.

Meshram, Pratima., Pandey B.D., Mankhand, T.R. (2014). Extraction of lithium from primary and secondary sources by pre-treatment, leaching and separation: A comprehensive review. *Hydrometallurgy*.15: 192–208.

Moench, T. T., & Konetzka, W. A. (1978). A Novel Method for Isolation and Study of a Magnetotactic Bacterium. *Archives of Microbiology*. 119: 203-212.

Mohamed, I. (2011). Water Quality Assessment of Sg. Skudai. Final Year Project Report, Degree of Civil Engineering, Faculty of Civil Engineering, Universiti Teknologi Malaysia.

Mohri, H., Takeuchi, S. & Fujimoto, T. (1979). Domain and Grain Observation using a Colloid Technique for Grain-Oriented Si-Fe with Coatings. *IEEE Transactions on Magnetics*. 15: 1346.

Moisescu Cristina, Ardelean I Ioan, and Benning G Liane. (2014). The Effect and Role of Environmental Conditions on Magnetosome Synthesis. *Frontiers in Microbiology*. 5 (49) 1-12.

Moisescu Cristina, Bonneville Steeve, Staniland Sarah, Ardelean Ioan & Benning G. Liane (2011). Iron Uptake Kinetics and Magnetosome Formation by

Magnetospirillum Gryphiswaldense as a Function of pH, Temperature and Dissolved Iron Availability. Volume 28, 2011 - *Issue 7:19th International Symposium on Environmental Biogeochemistry (ISEB).*

Mokrani, N., Felfoul, O., Afkhami Zarreh, F. (2010). Magnetotactic Bacteria Penetration into Multicellular Tumor Spheroids for Targeted Therapy. *Conf Proc IEEE Eng Med Biol Soc.* 4371–4.

Mora, C. V., Davison, M., Wild, J. M., Walker, M. M. (2004). Magnetoreception and its Trigeminal Mediation in the Homing Pigeon. *Nature*. 432, 508–511.

Naja, G. & Volesky, B. (2011). The Mechanism of Metal Cation and Anion Biosorption. *Microbial Biosorption of Metals*. 19- 58.

Nakamura, C., Burgess, J. G., Sode, K., Matsunaga, T. (1995). An Iron-Regulated Gene, magA, Encoding an Iron Transport Protein of *Magnetospirillum sp*. Strain AMB-1. *Journal of Biological Chemistry.* 270(47), 28392-6

Nakamura, C., Sakaguchi, T., Kudo, S., Burgess, J. G., Sode, K. & Matsunaga, T. (1993). Characterization of Iron Uptake in the Magnetic Bacterium *Aquaspirillum sp*. AMB-1. *Applied. Biochemstry. Biotechnology*. 39-40, 169-176. doi: 10.1007/BF02918987.

Nanthakumar, K., Karthikeyan, K. & Lakshmanaperumalsamy, P. (2009). Investigation on Biosorption of Reactive Blue 140 by Dead Biomass of *Aspergillus niger* HM11: Kinetics and Isotherm Studies. *Global Journal of Biotechnology & Biochemistry*. 4(2), 169-178.

Naresh, M., Das, S., Mishra, P., Mittal, A. (2012). The Chemical Formula of a Magnetotactic Bacterium. *Biotechnology Bioengeering.* 109(5):1205-1216.

Naresh, M., Gopinadhan, K., Sekhar, S., Juneja, P., Sharma, M., Mittal, A. (2009). NSOM/HRTEM Characterization of Biologically Derived Cubo-Octahedral Nanomagnets. *IEEE Transactions on Magnetics* . 45(10):4861-4864.

Naresh, M., Hasija, V., Sharma, M., Mittal, A. (2010). Synthesis of Cellular Organelles Containing Nano-Magnets Stunts Growth of Magnetotactic Bacteria. *Journal of Nanoscience and Nanotechnology.* 10(7), 4135-44.

Nei, M. & Kumar, S. (2000). *Molecular Evolution and Phylogenetics*. Oxford University Press, New York.

Nelson A. Stephen. (2014). Weathering & Clay Minerals, EENS 2110. Tulane University. Kabata-Pendias Alina and Pendias Henryk. 2000, Trace elements in soils and plants. 3rd ed. Includes bibliographical references (p. 331). ISBN 0-8493-1575-1(book).

Nilanjana, D. (2010). Recovery of Precious Metals through Biosorption: A Review. *Hydrometallurgy*. 103(1-4), 180-189.

Ochiai, E. I. (1987). General Principles of Biochemistry of the Elements. Plenum N.Y.

Oestreicher, Z., Lower, S. K., Lin, W. & Lower, B. H. (2012). Collection, Isolation and Enrichment of Naturally Occurring Magnetotactic Bacteria from the Environment. *Journal of Visualized Experiments*. 69: e50123. doi: 10.3791/50123.

Oestreicher, Zachery Walter John, (2012). Magnetotactic Bacteria: Isolation, Imaging, and Biomineralization. Thesis, Doctor of Philosophy, Ohio State University, Geological Sciences.

Ota, H., Takeyama, H., Nakayama, H., Katoh, T., Matsunaga, T. (2003). SNP Detection in Transforming Growth Factor-Beta1 Gene using Bacterial Magnetic Particles. *Biosensors and Bioelectronics*. 18: 683-687.

Pan, H., Zhu, K., Song, T., Yu-Zhang, K., Lefèvre, C., Xing, S., Liu, M., Zhao, S., Xiao, T., Wu, L. F. (2008). Characterization of a Homogeneous Taxonomic Group of Marine Magnetotactic Cocci within a Low Tide Zone in the China Sea. *Environmental Microbiology*. 10(5):1158-64.

Pan, Y., Lin, W., Li, J., Wu, W., Tian, L., Deng, C. (2009b). Reduced Efficiency of Magnetotaxis in Magnetotactic Coccoid Bacteria in Higher than Geomagnetic Fields. *Biophysical Journal*. 97(4): 986-91.

Panda, G. C., Das, S. K., Chatterjee, S., Maity, P. B., Bandopadhyay, T. S. & Guha, A. K. (2006). Adsorption of Cadmium on Husk of Lathyrus Sativus: Physico-Chemical. Study. *Colloids and Surfaces*. B 50(1):49-54.

Parisa, Tajer Mohammad, Ghazvini., RouhaKasra, Kermanshahi., Ahmad NozadGolikand & Majid Sadeghizadeh. (2014). Isolation and Characterization of a Novel Magnetotactic Bacterium From Iran: Iron Uptake and Producing Magnetic Nanoparticles in *Alphaproteobacterium* MTB-KTN90. *Jundishapur Journal of Microbiology*. 7(9):e19343.

Park, J., Won, S. W., Mao, J., Kwak, I. S. & Yun, Y. S. (2010). Recovery of Pd(II) from Hydrochloric Solution using Polyallylamine Hydrochloride-Modified

Escherichia Coli Biomass. *Journal of Hazardous Materials*. 181(1–3):794-800.

Pavan, F. A., Mazzocato, A. C., Jacques, R. A., Dias, S. P., Peel Ponkan. (2008). A Potential Biosorbent for Removal of Pb (II) Ions from Aqueous Solution. *Biochemical Engineering Journal*. 40: 354-362.

Peoples, O. P. & Sinskey, A. J. (1989). Poly-beta-hydroxybutyrate (PHB) Biosynthesis in *Alcaligenes eutrophus* H16. Identification and Characterization of the PHB Polymerase Gene (phbC). *The Journal of Biological Chemistry*. 264: 15298-15303.

Pereira-Bomfim, M. G. C., Antonialli-Junior, W. F., & Acosta-Avalos, D. (2015). Effect of Magnetic Field on the Foraging Rhythm and Behavior of the Swarm-founding Paper Wasp Polybia paulista Ihering (Hymenoptera: Vespidae). *Sociobiology*. 62(1):99-104.

Petermann, H. & Bleil, U. (1993). Detection of Live Magnetotactic Bacteria in South Atlantic Deep-Sea Sediments. *Earth and Planetary Science Letters*. 117: 223–228.

Petersen, N., Von Dobeneck, T. & Vali, H. (1986). Fossil Bacterial Magnetite in Deep-Sea Sediments from the South Atlantic Ocean. *Nature*. 320, 611-615.

Posfai, M., Arato, B., Schüler, D., Flies, C., Bazylinski, D. A., Moskowitz, B. M. & Frankel, R. B. (2006). Properties of Intracellular Magnetite Crystals Produced by *Desulfovibrio Magneticus* RS-1. *Earth and Planetary Science Letters*. 249: 444-455.

Pósfai, M., Buseck, P. R., Bazylinski, D. A. & Frankel, R. B. (1998). Iron Sulfides from Magnetotactic Bacteria: Structure, Composition, and Phase Transitions. *American Mineralogist*. 83, 1469-1481.

Postec, A., Tapia, N., Bernadac, A., Joseph, M., Davidson, S., Wu, L. F. (2012). Magnetotactic Bacteria in Microcosms Originating from the French Mediterranean Coast Subjected to Oil Industry Activities. *Microbial Ecology*. 63(1):1–11.

Preetha, B. & Viruthagiri, T. (2007). Batch and Continuous Biosorption of Chromium(VI) by *Rhizopus Arrhizus*. *Separation and Purification Technology*. 57(1):126-133.

Qu, Yingmin., Zhang, Xuemei., Xu, Jiao., Zhang, Weijiang., Guo, Yu (2014). Removal of Hexavalent Chromium from Wastewater using Magnetotactic Bacteria. *Separation and Purification Technology*, 136, 10-17.

Qu, Yingmin., Zhang, Xuemei., Xu, Jiao., Zhang, Weijiang., Guo, Yu. (2014). Removal of Hexavalent Chromium from Wastewater using Magnetotactic Bacteria. *Separation and Purification Technology*. 136: 10-17.

Rahn-Lee, Lilah and Komeili, Arash. (2013). The Magnetosome Model: Insights into the Mechanisms of Bacterial Biomineralization. *Frontiers in Microbiology*. 4: 352.

Rao, P. S., Kalyani, S., Reddy, K. N. N. S. & Krishnaiah, A. (2005). Comparsion of Nickel (II) and Copper (II) Ions from Aqueous Solution by Sphaeroplea and Acid Treated *Sphaeroplea Algae*. *Sci Tech*. 40: 3149-3165.

Rengaraj, S., Joo, C. K., Kim, Y., Yi, J. (2003). Kinetics of Removal of Chromium from Water and Electronic Process Wastewater by Ion Exchange Resins: 1200H, 1500H and IRN97H. *Journal of Hazardous Materials*. 102: 257-275.

Richter, M., Kube, M., Bazylinski, D. A., Lombardot, T., Glöckner, F. O., Reinhardt R. (2007). Comparative Genome Analysis of Four Magnetotactic Bacteria Reveals a Complex Set of Group-Specific Genes Implicated in Magnetosome Biomineralization and Function. *Journal of Bacteriology*. 189(13): 4899-910.

Safronova, N. S., Venitsianov, E. V., Ershova, E. Y., Kocharyan, A. G., Seren'kaya, E. P., Zhil'tsova, L. I., & Sedykh, E. M. (1997). Analytical Methods for Determining the Content and Forms of Heavy Metals in Natural Water Bodies. *Water Resources*. 24(4): 439-447.

Saikia, J Bhaskar., Parthasarathy, Gopalakrishnarao. (2010). Fourier Transform Infrared Spectroscopic Characterization of Kaolinite from Assam and Meghalaya, Northeastern India. *International Journal of Modern Physics*. 1: 206-210.

Saitou, N. & Nei, M. (1987). The Neighbor-Joining Method: A New Method for Reconstructing Phylogenetic Trees. *Molecular Biology and Evolution*. 4: 406-425.

Sakaguchi, T., Arakaki, A. & Matsunaga, T. (2002). *Desulfovibrio magneticus* sp. nov., a novel sulfate-reducing bacterium that produces intracellular single-domainsized magnetite particles. *International Journal of Systematic and Evolutionary Microbiology*. 52: 215-221.

Sakaguchi, T., Burgess, J. G. & Matsunaga, T. (1993). Magnetite Formation by a Sulphate-Reducing Bacterium. *Nature*. (Lond.) 365: 47-49.

Salata, O. V. (2004). Applications of Nanoparticles in Biology and Medicine. *Journal of. Nanobiotechnol*. 2: 1–6

Santhi, T., Manonmani, S. & Smitha, T. (2010). Kinetics and Isotherm Studies on Cationic Dyes Adsorption onto Annona Squmosa Seed Activated Carbon. *International Journal of Engineering Science and Technology*, 2: 287-295.

Sarı, Ahmet ., Tuzen, Mustafa. (2009). Equilibrium, Thermodynamic and Kinetic Studies on Aluminum Biosorption from Aqueous Solution by Brown Algae (*Padina pavonica*) Biomass. *Journal of Hazardous Materials.* 171: 973-979.

Sarikaya, M. (1994). An Introduction to Biomimetics: A Structural Viewpoint. *Microscopy Research and Technique. Tech*. 27: 360-375

Sayyed, R. Z., Chincholkar, S. B. (2010). Growth and Siderophores Production in *Alcaligenes Faecalis* is Regulated by Metal Ions. *Indian Journal of Microbiology*. 50(2), 179–182.

Scheffel, A., Gärdes, A., Grünberg, K., Wanner, G., Schüler, D. (2008). The Major Magnetosome Proteins MamGFDC are not Essential for Magnetite Biomineralization in *Magnetospirillum Gryphiswaldense* but Regulate the Size of Magnetosome Crystals. *Journal of Bacteriology*. 190(1): 377-86.

Scheffel, A., Gruska, M., Faivre, D., Linaroudis, A., Plitzko, J. M. & Schüler. D. (2005). An Acidic Protein Aligns Magnetosomes along a Filamentous Structure in Magnetotactic Bacteria. *Nature*. 440 (7080), 110-114.

Schleifer, K. H., Schuler, D., Spring, S., Weizenegger, M., Amann, R., Ludwig, W.. (1991). The genus *Magnetospirillum gen*. nov., description of *Magnetospirillum gryphiswaldense* sp. nov. and transfer of *Aquaspirillum magnetotacticum* to *Magnetospirillum magnetotacticum* comb. nov. *Systematic and Applied Microbiology* . 14: 379-385.

Schübbe, S., Kube, M., Scheffel, A., Wawer, C., Heyen, U., Meyerdierks, A. (2003). Characterization of a Spontaneous Nonmagnetic Mutant of *Magnetospirillum gryphiswaldense* Reveals a Large Deletion Comprising a Putative Magnetosome Island. *Journal of Bacteriology*. 185: 5779-5790.

Schüler, D. & Baeuerlein, E. (1996). Iron-Limited Growth and Kinetics of Iron Uptake in *Magnetospirillum Gryphiswaldense*. *Archives of Microbiology*. 166: 301-307. doi: 10.1007/s002030050387.

Schüler, D. & Köhler, M. (1992). The Isolation of a New *Magnetic Spirillum*. *Zentralbl. Mikrobiol*. 147: 150-151.

Schüler, D. (1999). Formation of Magnetosomes In magnetotacticbacteria. *Journal of Molecular Microbiology and Biotechnolog.* 1(1), 79-86

Schüler, D. (2002). The Biomineralization of Magnetosomes in *Magnetospirillum Gryphiswaldense*. *International Microbiology*. 5: 209 -214

Schüler, D. (2008). Genetics and Cell Biology of Magnetosome Formation in Magnetotactic Bacteria. *FEMS Microbiology Reviews*. 32: 654-672.

Schüler, D., Frankel, R. B. (1999). Bacterial Magnetosomes: Microbiology, Biomineralization and Biotechnological Applications. *Applied Microbiology Biotechnology*. 52(4), 464-73.

Schüler, D., Schleifer, H. (2005). In: Brenner D. J., Krieg, N. R., Staley, J. T, (eds). The Genus *Magnetospirillum*. Bergey's Manual of Determinative Bacteriology. Springer, Berlin Heideberg New York, P 28-31.

Schwertmann, U., Cornell, R. M., (1991). Iron Oxides in the Laboratory: Preparation and Characterization. Weinheim, Cambridge: VCH.

Selvi, A Tamil ., Anjugam E ., Devi, R, Archana , Madhan, B. , Kannappan, S. and Chandrasekaran, B. (2012). Isolation and Characterization of Bacteria from Tannery Effluent Treatment Plant and Their Tolerance to Heavy Metals and Antibiotics. *Asian Journal of Experimental Sciences*. 3 (1): 34 -41.

Sharma, V. K. & Sohn, M. (2009). Aquatic Arsenic: Toxicity, Speciation, Transformations and Remediation. *Environment International*. 35(4): 743-759.

Simkiss, K. (1994). Amorphous Minerals in Biology. Bull. Institut Oceanogr. Monaco n. speècial 14: 49-54.

Simmons, S., Edwards, K. (2007). Geobiology of Magnetotactic Bacteria. In: Schüler D, ed. Magnetoreception and Magnetosomes in Bacteria. 3rd ed. Berlin: Springer-Verlag, 77-102.

Simmons, S. L., Edwards K. J. (2007). Unexpected Diversity in Populations of the Many-Celled Magnetotactic Prokaryote. *Environmental Microbiology.* 9: 206-215

Simmons, S. L., Bazylinski, D. A. & Edwards, K. J. (2006). South-seeking Magnetotactic Bacteria in the Northern Hemisphere. *Science*. 311: 371-374.

Simmons, S. L., Sievert, S. M., Frankel, R. B., Bazylinski, D. A. & Edwards, K. J. (2004). Spatiotemporal Distribution of Marine Magnetotactic Bacteria in a Seasonally Stratified Coastal Salt Pond. *Applied Environmental Microbiology*. 70: 6230-6239.

Singh, Neetu., Balomajumde, Chandrajit. (2016). Simultaneous Biosorption and Bioaccumulation of Phenol and Cyanide using Coconut Shell Activated Carbon Immobilized *Pseudomonas Putida* (MTCC 1194). *Journal of Environmental Chemical Engineering*. 4: 1604-1614.

Singh, K. P., Mohan, D., Singh, V. K. & Malik, A. (2005). Studies on Distribution and Fractionation of Heavy Metals in Gomti River Sediments—A Tributary of the Ganges. *India.Journal of Hydrology*. 312(1), 14-27.

Singh, M. R. (2007). Impurities-Heavy Metals: IR Prespective. [Last cited on 2009 Aug 10].

Snowball, L. Zillén., P. Sandgren. (2002). Bacterial Magnetite in Swedish Varved Lake-Sediments: a Potential Bio-Marker of Environmental Change. *Quatern Int*. 88 (1):13-19.

Sode, K., Kudo, S., Sakaguchi, T., Nakamura, N., Matsunaga, T. (1993). Application of Bacterial Magnetic Particles for Highly Selective mRNA Recovery System. *Biotechnology Techniques.* 7(9), 688-694

Song, Hui-Ping., Li, Xin-Gang., Sun, Jin-Sheng., Xu, Shi-Min., Han, Xu. (2008). Application of a Magnetotactic Bacterium, *Stenotrophomonas sp*. to the Removal of Au(III) from Contaminated Wastewater with a Magnetic Separator. *Chemosphere*. 72: 616-621.

Song, Huiping., Li, Xingang., Sun, Jinsheng., Yin, Xiaohong., Wang, Yanhong., Wu Zhenhua. (2007). Biosorption Equilibrium and Kinetics of Au(III) and Cu(II) on Magnetotactic Bacteria. Chinese Journal of Chemical Engineering. 15(6), 847-854.

Song, H., Li, X., Sun, J., Xu, S., Hua, X. (2008). Application of a Magntotactic Bacterium, *Stenotrophomonas sp*. to the Removal of Au(III) from Contaminated Wastewater with a Magnetic Separator. *Chemosphere*. 72: 616-621.

Sorty, Ajay, Madhusudan. & Shaikh, Nasir, Rasul. (2015). Novel Co-Enrichment Method for Isolation of Magnetotactic Bacteria. *Journal Basic Microbiology*. 55: 520-526.

Spark, K. M., Wells, J. D., Johnson, B. B. (1995). Characterizing Trace Metal Adsorption on Kaolinite. *European Journal of Soil Science*. 46:. 633-640.

Sparks, N. H. C., Mann, S., Bazylinski, D. A, Lovley, D. R, Jannasch, H. W. & Frankel, R B. (1990). Structure and Morphology of Anaerobically Produced Magnetite by a marine magnetotactic bacterium and a dissimilatory Iron-Reducing Bacterium, *Earth and Planetary Science Letters*., in press.

Spring, S. & Schleifer, K. H. (1995). Diversity of Magnetotactic Bacteria. *Systematic and Applied Microbiology*. 18: 147-153.

Spring, S., Amann, R., Ludwig, W., Schleifer, K. H., van Gemerden, H. & Petersen, N. (1993). Dominating Role of an Unusual Magnetotactic Bacterium in the Microaerobic Zone of a Freshwater Sediment. *Applied and Environmental. Microbiology*. 59, 2397-2403.

Spring, S., Amann, R., Ludwig, W., Schleifer, K-H, Schüler, D., Poralla, K. & Petersen, N. (1994). Phylogenetic Analysis of Uncultured Magnetotactic Bacteria from the Alpha-Subclass of Proteobacteria. *Systematic and Applied Microbiology*. 17: 501-508.

Spring, S., Lins, U., Amann, R., Schleifer, K. H., Ferreira, L. C. S., Esquivel, D. M. S. & Farina, M. (1998). Phylogenetic Affiliation and Ultrastructure of Uncultured Magnetic Bacteria with Unusually Large Magnetosomes. *Archives of Microbiology*. 169: 136-147.

Staniland, S., Ward, B., Harrison, A., van der Laan, G., Telling, N. (2007). Rapid Magnetosome Formation Shown by Real-Time X-ray Magnetic Circular Dichroism. *Proceedings of the National Academy of Sciences Journal*. 104(49):19524-19538.

Staniland, S., Williams, W., Telling, N., Van Der Laan, G., Harrison, A. & Ward, B. (2008). Controlled Cobalt Doping of Magnetosomes in Vivo. *Nature and Nanotechnol*. 3: 158-162, doi:10.1038/nnano.2008.35.

Steinberger, B., Petersen, N., Petermann, H., Weiss, D. G. (1994). Movement of Magnetic Bacteria in Time-Varying Magnetic Fields. *Journal of Fluid Mechanics*. 273(1), 189-211.

Stephen C Bondy (2010). The Neurotoxicity of Environmental Aluminum is Still an Issue. *Neurotoxicology*. 31(5), 575-581.

Stolz, J. F., Chang, S. R. & Kirschvink, J. L. (1986). Magnetotactic Bacteria and Single Domain Magnetite in Hemipelagic Sediments. *Nature*. 321: 849-51.

Sun, J. B., Duan, J. H., Dai, S. L., Ren, J., Guo, L., Jiang, W. (2008b). Preparation and Anti-Tumor Efficiency Evaluation of Doxorubicin-Loaded Bacterial Magnetosomes: Magnetic Nanoparticles as Drug Carriers Isolated from *Magnetospirillum Gryphiswaldense*. *Biotechnology and Bioengeering*. 101: 1313-1320.

Sun, J. B., Duan, J. H., Dai, S. L., Ren, J., Zhang, Y. D., Tian, J. S. (2007). In Vitro and in Vivo Antitumor Effects of Doxorubicin Loaded with Bacterial Magnetosomes (DBMs) on H22 Cells: The Magnetic Bio-Nanoparticles as Drug Carriers. *Cancer Letter*. 258: 109-117. doi:10.1016/j.canlet.

Tajer-Mohammad-Ghazvini P., Kasra-Kermanshahi R., Nozad-Golikand A., & Sadeghizadeh M. (2013). A Green Chemical Technique for the Synthesis of Magnetic Nanoparticles by Magnetotactic Bacteria. World Academy of Science, Engineering and Technology, *International Science Index 74*: (7): 683–6.

Tamura, K., Stecher, G., Peterson, D., Filipski, A. & Kumar, S. (2013). MEGA6: Molecular Evolutionary Genetics Analysis version 6.0. *Molecular Biology and Evolution*. 30: 2725-2729.

Tanaka, T., Maruyama, K., Yoda, K., Nemoto, E., Udagawa, Y. (2003). Development and Evaluation of an Automated Workstation for Single Nucleotide Polymorphism Discrimination using Bacterial Magnetic Particles. *Biosensors and Bioelectronics*. 19: 325–330

Tang, T., Zhang, L., Gao, R., Dai, Y., Meng, F. & Li, Y. (2012). Fluorescence Imaging and Targeted Distribution of Bacterial Magnetic Particles in Nude Mice. *Applied Microbiology and Biotechnology*. 94: 495-503. doi:10.1007/s00253-012-3981-8.

Tang, Y. S., Wang, D., Zhou, C., Ma, W., Zhang, Y. Q., Liu, B. (2011). Bacterial Magnetic Particles as a Novel and Efficient Gene Vaccine Delivery System. *Gene Therapy*. pp. 1-9.

Tangaromsuk, J., Pokethitiyook, P., Kruatrachue, M. & Upatham, E. S. (2002). Cadmium Biosorption by *Sphingomonas Paucimobilis* Biomass. *Bioresource Technology*. 85(1), 103-105.

Tassist, Amina., Lounici, Hakim., Abdi Nadia., Mameri, Nabil. (2010). Equilibrium, Kinetic and Thermodynamic Studies on Aluminum Biosorption by a Mycelial

Biomass (*Streptomyces Rimosus*). *Journal of Hazardous Materials*. 183: 35-43.

Taylor, A. P. & Barry, J. C. (2004). Magnetosomal Matrix: Ultrafine Structure may Template Biomineralization of Magnetosomes. *Journal of Microscopy*. 213: 180-197.

Thanapalasingam, Vynavi (2005). Pollution Status of the Sungai Skudai River System Through Heavy Metals. Masters thesis, Universiti Teknologi Malaysia, Faculty of Science.

Thevenon, Florian., Graham, D Neil., Chiaradia, Massimo., Arpagaus, Philippe., Wildi, Walter., Poté, John. (2011). Local to Regional Scale Industrial Heavy Metal Pollution Recorded in Sediments of Large Freshwater Lakes in Central Europe (lakes Geneva and Lucerne) Over the Last Centuries. *Science of the Total Environment*. 239-247.

Thomas-Keprta, K. L., Bazylinski, D. A., Kirschvink, J. L., Clemett, S. J., McKay, D. S., Wentworth, S. J. (2000). Elongated Prismatic Magnetite Crystals in ALH84001 Carbonate Globules: Potential Martian Magnetofossils. *Geochimica et Cosmochimica Acta*. 64: 4049-4081.

Thornhill, R. H., Grant Burgess, J., Sakaguchi, T., Matsunaga, T. (1994). A Morphological Classifi-Cation of Bacteria Containing Bullet-Shaped Magnetic Particles. *FEMS Microbiology Letters*. 115(2-3), 169-76.

Tomljenovic, L. (2011). Aluminum and Alzheimer's Disease: After a Century of Controversy, is there a Plausible Link? *J Alzheimers Dis*. 23(4): 567-98.

Towe, K. M. & Moench, T. T. (1981). Electron-Optical Characterization of Bacterial Magnetite. *Earth and Planetary Science Letters*. 52: 213-220.

Tuzen, Mustafa & Soylak, Mustafa (2008). Biosorption of Aluminum on *Pseudomonas Aeruginosa* Loaded on Chromosorb 106 Prior to its Graphite Furnace Atomic Absorption Spectrometric Determination. *Journal of Hazardous Materials*. 154: 519-525.

Turick, C.E., Apel, W.A. and Carmiol, N.S. (1996) Isolation of hexavalent chromium-reducing anaerobes from hexavalent-chromium-contaminated and noncontaminated environments. *Applied Microbiology and Biotechnology*. 44: 683-688.

Ulysses, L. & Marcos, F. (1999). Phosphorus-rich Granules in Uncultured Magnetotactic Bacteria. *FEMS Microbiology Letters*. 172: 23-28.

Ulysses, L., McCartney Martha, R., Marcos, F., Frankel Richard, B., Buseck Peter, R. (2006). Crystal Habits and Magnetic Microstructures of Magnetosomes in Coccoid Magnetotactic Bacteria. *Anais da Academia Brasileira de Ciências Journal*. 78(3): 463-74.

Umamaheswari, B. & Rajaram, R. (2014). Isolation of CSMBs for the Biodegradation of Recalcitrant Pollutants. *International Journal of Current Microbiology and Applied*. 3(11): 833-848.

Ullrich, Susanne., Michael, Kube., Sabrina, Schübbe., Reinhardt, Richard., Schüler Dirk. (2005). A Hypervariable 130-Kilobase Genomic Region of *Magnetospirillum gryphiswaldense* Comprises a Magnetosome Island Which Undergoes Frequent Rearrangements during Stationary Growth. *Journal Of Bacteriology*. 187(21): 7176–7184.

Veado, M. A. R. V., Pinte, G., Oliveira, A. & Revel, G. (1997). Application of Instrumental Neutron Activation Analysis and Inductively Coupled Plasma-Mass Spectrometry to Studying the River Pollution in the State of Minas Gerais. *Journal of Radioanalytical and Nuclear Chemistry*. 217(1): 101-106.

Veetil, Arun Kumar Thaliyil., James, Joel., Subash, Sujith., Joy, Dilip., Lipin, Dev M.S and Thankamani, V. (2012). Characterization of *Alcaligenes faecalis* GPA-1 Producing Thermostable Extracellular α-amylase. *Research in Biotechnology*. 3(4): 19-27.

Vicente-Beckett, V. A., Pascual, C. B., Kwan, C. S. & Beckett, R. (1991). Levels and Distribution of Trace Metals in Sediments of Laguna Lake (Philippines) and its Tributary Rivers. *International Journal of Environmental Analytical Chemistry*. 45(2): 101-116.

Vijayaraghavan, K., & Yun, Y. S. (2008). Bacterial Biosorbents and Biosorption. *Biotechnology Advances*. 26(3), 266-291.

Volesky, B. (2007). Biosorption and Me. *Water Research*. 41: 61-68.

Walcott, C., Gould, J. L. & Kirschvink, J. L. (1979). Pigeons have Magnets. *Science*. 184: 180-182.

Wang, E-Jiang'., Xia Si-Qingl., Cwen, Ling'., Zhao, Jian-Fbl., Chovelon, Jean-Marc'., Nicole, Jaffi-ezic-renaul. (2006). Biosorption of Cadmium(I1) and Lead(I1) Ions from Aqueous Solutions onto Dried Activated Sludge. *Journal of Erammmntd Sclerues.* Vol IS, No 5, pp 840-844.

Wang, Yanhong., Gao, Hong., Sun, Jinsheng., Li, Jing., Su, Yanxia., Ji, Yulan., Gong, Chunmei. (2011). Selective Reinforced Competitive Biosorption of Ag (I) and Cu (II) on *Magnetospirillum Gryphiswaldense*. *Desalination*. 270: 258-263.

Wang, Y., Sun, J. (2005). Biosorption of Heavy Metal Ions by Activated Sludge Cultivated with Culture Medium of MTB. *Huaxue Gongye Yu Gongcheng*. 22: 255-8. [Article in Chinese].

Wei, Y. B., Zhang, H. X., Jiang, W. & Qiu, J. F. (1994). Morphological Characteristics of Magnetotactic Bacterium from the East Lake in Wuchang and Isolation of its Strain WD-1. *Journal of Wuhan University (Natural Science Edition)*. 6: 115-120.

Weisberg, M. K., Prinz, M., Clayton, R. N. & Mayeda, T. K. (1992). Formation of Layered in CR2 Chondrites: A Petrologic and Oxygen Isotope Study Meteoritics. 27: 306.

Wenbing, Li .,Longjiang, Yu., Pengpeng, Zhou & Min, Zhu. (2007). A *Magnetospirillum* Strain WM-1 from a Freshwater Sediment with Intracellular Magnetosomes. *World Journal of Microbiology and Biotechnology*. 23:1489-1492.

Wettstein, A. (1991). Failure to Find a Relationship between Mnestic Skills of Octogenarians and Aluminium in Drinking Water. International Archives of Occupational and Environmental Health. 63(2): 97-103.

Widdel Friedrich (2010). Theory and Measurement of Bacterial Growth. Grundpraktikum Mikrobiologie. 4. Sem. (B.Sc.) Universität Bremen. 04 May, 2007 / corrected version: 05 June, 2010.

Wiltschko R., & Wiltschko, W. (2012). The Magnetite-Based Receptors in the Beak of Birds and their Role in Avian Navigation. *Journal of Comparative Physiology A*. 199: 89-98.

Wolfe, R. S., Thauer, R. K., Pfennig, N. (1987). A “Capillary Racetrack” Method for Isolation of Magnetotactic Bacteria. *FEMS Microbial Letter*. 45: 31-35.

Wu, F., Hu, Z., Xu, J., Tian, Y., Wang, L., Xian, Y. (2008). Immobilization of Horseradish Peroxidaseon Self-Assembled (3-mercaptopropyl) Trimethoxysilane Film: Characterization, Direct Electrochemistry, Redox Thermodynamics and Biosensing. *Electrochimica Acta*. 53(28):8238-8244.

Won, Sung., Wook., Choi., Sun, Beom., Yun, Yeoung-Sang. (2013). Binding sites and mechanisms of cadmium to the dried sewage sludge biomass. *Chemosphere*. 93:146-151.

Wood, H. G., Clark, J. E. (1988). Biological aspects of inorganic polyphosphates. *Annual Review of Biochemistry*. 1988. 57(1),235–60.

Xiang, L., Wei, J., Jianbo, S., Guili, W., Feng, G. & Ying, L. (2007). Purified and Sterilized Magnetosomes from *Magnetospirillum Gryphiswaldense* MSR-1 were not Toxic to Mouse Fibroblasts in Vitro. *Letters in Applied Microbiology*. 45(1), 75-81.

Xiao, Z., Lian, B., Chen, J., Henry Teng, H. (2007). Design and Application of the Method for Isolating Magnetotactic Bacteria. *Chinese Journal of Geochemistry*. 26: 252-258.

Yan, Lei., Yue, Xiaoxuan., Shuang, Chen Peng., Xu, Zhiliang., Li, Yang., Li Hongyu. (2012). Biocompatibility Evaluation of Magnetosomes Formed by *Acidithiobacillus Ferrooxidans*. *Materials Science and Engineering*. C 32: 1802-1807.

Yan, Lei., Zhang, Shuang., Chen, Peng., Wang, Weidong., Wang, Yanjie., Li, Hongyu. (2013). Magnetic Properties of *Acidithiobacillus Ferrooxidans*. *Materials Science and Engineering*. C 33: 4026-4031.

Yan, L., Zhang, S., Chen, P., Liu, H., Yin, H. & Liu, T. (2012) Magnetotactic Bacteria, Magnetosomes and their Application. *Microbiological Research.* 167: 507-519.

Yang, C. D., Takeyama, H., Tanaka, T., Matsunaga, T. (2001). Effects of Growth Medium Composition, Iron Sources and Atmospheric Oxygen Concentrations on Production of Luciferase-Bacterial Magnetic Particle Complex by a Recombinant *Magnetospirillum Magneticum* AMB-1. *Enzyme and Microbial Technology*. 29(1), 13-19.

Yee, N., Benning, L. G., Phoenix ,V. R. & Ferris, F. G. (2004). Characterization of Metal-Cyanobacteria Sorption Reactions: A Combined Macroscopic and Infrared Spectroscopic Investigation. *Environmental Science and Technology*. 38: 775-782.

Yokel R.A. (2016). Aluminum: Properties, Presence in Food and Beverages, Fate in Humans, and Determination. *Encyclopedia of Food and Health.* 128–134.

Yoza, B., Arakaki, A., Maruyama, K., Takeyama, H., Matsunaga, T. (2003). Fully Automated DNA Extraction from Blood using Magnetic Particles Modified with a Hyperbranched Polyamidoamine Dendrimer. *Journal of Bioscience and Bioengineering*. 95: 21-26.

Zabochnicka-Swiatek, M. & Krzywonos, M. (2014). Potentials of Biosorption and Bioaccumulation Processes for Heavy Metal Removal. *Polish Journal of Environmental Studies*. 23 (2), 551-561.

Zachery Oestreicher, Steven K. Lower, Eric Rees, Dennis A. Bazylinski, & Brian H. Lower. (2013). Magnetotactic Bacteria from Pavilion Lake, British Columbia. *Frontiers in Microbiology*. 4: 406.

Zhang Shuang , Yan Lei , Li Hongyu and Liu Hetao. (2012). Optimal Conditions for Growth and Magnetosome Formation of *Acidithiobacillus Ferrooxidans*. *African Journal of Microbiology Research*. 6(32), 6142-6151.

Zhang, L., Jiang, Y., Ding, Y., Povey, M., York, D. (2007). Investigation into the Antibacterial Behaviour of Suspensions of ZnO Nanoparticles (ZnO nanofluids). *Journal of Nanoparticle Research*. 9 (3), 479-89.

Zhang, Y., Zhang, X., Jiang, W., Li, Y., Li, J. (2011). Semicontinuous Culture of *Magnetospirillum Gryphiswaldense* MSR-1 Cells in an Autofermentor by Nutrient-Balanced and Isosmotic Feeding Strategies, *Journal of Nanoparticle Research*. 77: 5851-5856.

Zhu, K., Pan, H., Li, J., Yu-Zhang, K., Zhang, S. D., Zhang, W. Y. (2010). Isolation and Characterization of a Marine *Magnetotactic Spirillum* Axenic Culture QH-2 from an Intertidal Zone of the China Sea. *Research in Microbiology*. 161(4): 276-83.

Zou, H. S., Chu, Z. Q. & Lin, G. (2007). A Novel Recovery Technol. of Trace Precious Metals from Waste Water by Combining Agglomeration and Adsorption. *Transactions of Nonferrous Metals Society of China*. 17(4): 858-863.

Zümriye, A. & Hanife, G. (2002). Binary Biosorption of Iron (III) and Iron(III)-Cyanide Complex Ions on *Rhizopus nrrhizu*: Modelling of Synergistic Interation. *Process Biochemistry*. 38: 161-173.