BIOL 3700
Spring, 2021
(Online/Asynchronous Course)
Bioremediation: New Approaches and Trends

Instructor:
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Course Website: Canvas (Pre-recorded lectures)

Course Overview:

Ever increasing human activities including agricultural, urban, or industrial are a major source of environmental pollution. Toxic metal pollution of waters, air, and soils is one of the potential problems, which is an enigma for scientists how to tackle this problem that has threatened the environment. To solve this, conventional remediation approaches have been used, which, however, do not provide acceptable solutions. The development of an alternative remediation strategy for the abatement of a contaminated medium is important for environmental conservation and human health. Bioremediation, an attractive and novel technology, is a multidisciplinary approach that uses biological systems to degrade/transform and/or to rid the soil and water of pollutants. This technology involves the use of plants (phytoremediation), plant-microbe interactions (rhizoremediation), and microbial communities involving stimulation of viable native microbial population (biostimulation), artificial introduction of viable population (bioaugmentation), bioaccumulation (live cells), and use of dead microbial biomass (biosorption) to clean up the contaminated sites. Bioremediation is simple, can be applied over large areas, environmentally friendly, and inexpensive. The use of genetic engineering to further modify plants for uptake,

transport, and sequester metal opens up new avenues for enhancing efficiency of phytoremediation. Various bioremediation approaches adopted to remediate contaminated sites and major concerns associated with phytoremediation as a sustainable alternative are reviewed and discussed.

Text:

Abou-Shanab, R.A.I., El-Sheekh, M.M., Sadowsky, M.J. (2019). Role of Rhizobacteria in phytoremediation of heavy metal impacted sites. *In*: "Emerging and Eco-Friendly Approaches for Waste Management", Springer, Singapore, pp. 299-328.

Abou-Shanab, R.A.I. (2011). Bioremediation: New Approaches and Trends. *In*: biomanagement of Metal Contaminated Soils", M.D. Khan (Ed.)**,** Springer Verlag, The Netherlands, 65-94 (Print ISSN1566-0745).

Reading assignments:

You should read all of the assigned materials, it is important background information for what we will discuss and deliver in the pre-recorded lectures. Most of the assigned reading is in the textbook and some primary literature will be made available on the Canvas site.

Instructional method: Lecture (Slides PowerPoint), Article reviews, and term-papers

Learning objectives: Upon completion of this course you should be able to:

1. Know the differences between the point and non-point source of pollution;
2. Know the different techniques used for clean up the environments from pollutants;
3. Understand the importance of bioremediation as a cost-effective and eco-friendly technology;
4. Know the advantages and disadvantages of the different types of remediation methods;
5. Know the impact of site characteristics to bioremediation rates;
6. Know the impacts of contaminant (types, concentrations, and status) characteristics on bioremediation process;
7. Know how to increase the efficiency of bioremediation;
8. Understand the use of bioremediation in real world applications;

Student's assessment: There are no exams for this course

Grading:

Term-papers: ……..……**100%**

1) The first Term-Paper is due electronically on **March 23** and this based on the lectures given from **Feb. 3** to **March 3rd**.

   *The **1st** term-paper accounts for **35%** of the final grade.*

2) The second term-paper is due electronically on **April 28** and this based on the lectures given from **March 17** to **April 21**.

   *The **2nd** term-paper accounts for **65%** of the final grade*

FINAL COURSE GRADE

Total Course Points

90% [A]; 87% [A-]; 83% [B+]; 80%[B]; 77% [B-]; 73%[C+]; 70%[C]; 67%[C-]; 60%[D+]; 55%[D] and below 55%[F]

Guaranteed Course Grade

Students on the S/N grading system must earn at least 67% (C-) to receive an S grade.

Topics:

- Introduction
- Source of pollution
- Toxicological effects of pollutants on humans and other organisms
- Remediation Technologies
- Phytoremediation Strategies
- General Advantages and limitations of Phytoremediation
- Environmental Factors Affecting Bioremediation
- Advanced Techniques Used to Enhance Bioremediation Process
- Breakthroughs in Phytoremediation: Novel Transgenic Approaches
- Examples of Genetically Engineered Plant used for detoxification of hazardous materials

Course description and lectures and term papers due date's submission.

Lecture	Date	Description
1	Wen. Feb. 3	**Introduction** ➢ Course overview ➢ Environmental pollution ➢ Kinds of pollution ➢ Source of pollution ➢ Toxicological effects of pollutants
2	Wen. Feb. 10	**Remediation Technologies** ➢ *ex-situ* remediation ➢ *in-situ* remediation
3	Wen. Feb. 17	Biological treatment technologies (Bioremediation) o Process of Microbial remediation o Microbial enzymes in bioremediation o Bioremediation strategies ➢ *Ex-situ* Bioremediation
4	Wen. Feb. 24	➢ *In-situ* Bioremediation • Natural attenuation/Intrinsic • Enhanced/engineered site and microbial manipulation
5	Wen. Mar. 3	➢ *In-situ* Bioremediation o Phytoremediation ❖ Phytofiltration ❖ Phytostabilization ❖ Phytodegredation ❖ Phytovolatilization ➢ General advantages and limitations of phytoremediation
Spring break		

6	Wen. Mar. 17	➢ Recent techniques used to enhance phytoremediation process **Case study**: Rhizobacterial effects on Ni-extraction from serpentine soil and uptake by Ni-hyperaccumulator *Alyssum murale*
Mar. 23		***1st term paper submission***
7	Wen. Mar. 24	Bioremediation Technology for Chromium (Cr) Removal from Contaminated Environment **Case study:** Cr(VI) reduction and removal using fungi isolated from tannery-effluent polluted soil.
8	Wen. Mar. 31	Mercury detoxification using genetic engineered *Nicotiana tabacum* • Hg detoxification and tolerance by transgenic *N. tabacum* grown on organic and inorganic Hg polluted media
9	Wen. Apr. 7	Arsenic biotransforming bacteria and As-hyperaccumulator *Petris vittata* mediate phytoremediation of As-contaminated soil **Case study** of As tolerance and As-uptake by *P. vittata* grown in soil contaminated with As(III) and As(VI).
10	Wen. Apr. 14	Algae as a green technology for wastewater treatment, gases emission reduction and biofuels production
11	Wen. Apr. 21	The role of bacteria on heavy metals extraction and uptake by plants grown on multi-metals contaminated soils.
Apr. 28		***2nd term paper submission***