Journal of Petroleum & Environmental Biotechnology
ISSN: 2157-7463

Lai, J Pet Environ Biotechnol 2013, 4:4
DOI: 10.4172/2157-7463.1000e119

Editorial | Open Access

Envisaging Environmental Biotechnology

Edward PC Lai*

Department of Chemistry, Carleton University, 1125 Colonel by Drive, Ottawa, Ontario K1S 5B6, Canada

Environmental biotechnology utilizes the biochemical potential of microorganisms and plants for the preservation and restoration of the environment. Over the last 25 years environmental biotechnology has experienced an explosion of new findings and insights sparked in large part by the development of analytical and molecular biology tools [1]. Modern chemical analysis methods like compound specific isotope analysis are now widely used by microbiologists to confirm biodegradation pathways and to identify contaminant sources [2]. Using accellerase with 30% ammonia, enzymatic hydrolysis of wheat straw at 50°C resulted in yields of 76% for glucose and 81% for xylose after only 45 h [3]. Microbial Fuel Cell (MFC) is a device that converts chemical energy into electrical energy by using microorganisms. MFC holds a key in green technology for the production of bioenergy while treating wastewater simultaneously. A cost-effective MFC has been designed with a salt bridge separating the two chambers [4]. Both artificial wastewater and anaerobically digested distillery wastewater were checked to make the MFC functional.

Biological processes have been attracting attention in heavy metals removal by bacterial strains, due to lower operating costs and potential application for even high concentrations of ionic metal species. *Streptomyces lunalinharesii* was able to sorb copper and zinc from aqueous solutions at 25°C to achieve 60%-80% removal at pH 5-6 for a contact time of 30 min [5]. A thermoacidophilic iron-oxidizing archaeon, *Acidianus brierleyi*, was used for oxidation and immobilization of As (III) from acidic refinery wastewater [6]. Fe (III) was microbially produced from Fe(II) and complexed in the archaeal extracellular polymeric substances for effective As(III) oxidation and immobilization as ferric arsenate. Interestingly, biooxidation and cyanidation of gold ores were carried out using mixed *Acidianus brierleyi/Sulfolobus metallicus* cultures on ores from the Copler Gold Mine in Turkey [7]. Bioreactor tests resulted in greater dissolution rates for iron and arsenic, which led to a maximum sulphide oxidation of 98% after 240 h. In the presence of 5% solids (w/v), 95% recovery of gold was achieved during cyanidation from the biooxidized ore. Biosorption technology research continues to use novel biosorbents that provide an economic and sustainable alternative to non-ecofriendly conventional processes. Phytoextraction is an economically and ecologically sound alternative for the remediation of metal-contaminated soils. Willow is a metal phytoextractor plant of interest because it combines gradual contaminant removal with production of biomass that can be valorized in different ways. Two willow clones growing on a metal-contaminated site, Belgisch Rood and Tora, have been reported [8]. Genotypic and phenotypic characterization of the isolated bacteria showed that the Tora endophytic population is more diverse and contains a higher percentage of metal-resistant plant growth promoting bacteria than the Belgisch Rood endophytic population.

Surface functionalization of alumina, iron oxide, silica, titania and zirconia has become of paramount importance for key technological areas in biotechnological and environmental applications [9]. Special emphasis is given to their use as adsorbents for toxic substances and pollutants. A life cycle assessment has been conducted on the production of such nanoparticles using a cradle-to-gate approach [10]. By analysis of the synthetic routes of the reactants, the process energy inputs, the equipment infrastructure and the generated emissions, the environmental impacts of the nanomaterials can be fully determined. However, a huge body of data on the potential hazards of nanomaterials toward human and environmental health already exists [11]. Improved understanding of interactions between biological systems and nanomaterials is needed to design a new generation of microorganisms for efficient removal of the nanomaterials. The molecular mechanisms of cellular uptake of engineered nanoparticles, their intracellular fate, and their tissue distribution within an organism have recently been reviewed [12]. Phenomena such as protein binding and opsonization may have a strong impact on cellular internalization, biodistribution, and immunogenicity of nanoparticles *in vivo*.

Synthetic biology is an emerging engineering field focused on designing artificial biological systems with novel functionalities for use in therapeutics, basic science, biotechnology, and diagnostics. Natural bacteriophages can be genetically modified to deliver engineered payloads into bacteria, thus selectively functionalizing target bacterial populations to produce active biomolecules [13]. In addition, bacteriophages can be engineered as near-real-time microbial diagnostics by using them to transform target bacteria into factories for the production of detectable molecules. In addition, whole-cell biosensors for environmental sensing can be equipped with novel protein or RNA mined from metagenomic sequence databases and realized via DNA synthesis. GenBank® is a comprehensive database that contains publicly available nucleotide sequences for 260000 formally described species [14]. These sequences are obtained primarily through submissions from individual laboratories and batch submissions from large-scale sequencing and environmental sampling projects. Daily data exchange with the European Nucleotide Archive and the DNA Data Bank of Japan ensures worldwide coverage. GenBank is accessible at the NCBI home page (www.ncbi.nlm.nih.gov) through the Entrez retrieval system, which integrates data from the major DNA and protein sequence databases along with taxonomy, genome, mapping, protein structure and domain information, and the biomedical journal literature via PubMed.

Leading researchers in the field of environmental microbiology have speculated on the technical and conceptual developments that will drive innovative research and open new vistas over the next few years [15]. One can also envisage that large-scale implementation of biorefineries will result in sustainable processes with positive

***Corresponding author:** Edward PC Lai, Department of Chemistry, Carleton University, 1125 Colonel by Drive, Ottawa, Ontario K1S 5B6, Canada, E-mail: Edward.Lai@carleton.ca

Received August 28, 2013; **Accepted** August 28, 2013; **Published** September 04, 2013

Citation: Lai EPC (2013) Envisaging Environmental Biotechnology. J Pet Environ Biotechnol 4: e119. doi:10.4172/2157-7463.1000e119

environmental impacts [16]. The products may reduce greenhouse gases and counters the effects of declining fossil fuel availability. Forest biorefineries utilizing gasification are expected to produce significantly fewer pollutant emissions due to the black liquor combined cycle technology. Syngas cleanup conditioning removes contaminants and gas turbine combustion is found to be more efficient and complete than boiler combustion using fossil energy resources. In addition, it is generally accepted that production of power, fuels, chemicals and other products from biomass resources creates a net zero generation of carbon dioxide (a greenhouse gas), as plants are renewable carbon sinks.

References

1. Steffan RJ, Ramos JL (2013) Environmental biotechnology. Curr Opin Biotech 24: 421-422.
2. Spahr S, Huntscha S, Bolotin J, Maier MP, Elsner M, et al.(2013) Compound-specific isotope analysis of benzotriazole and its derivatives. Anal Bioanal Chem 405: 2843-2856.
3. Yazici S, Isci A (2013) The effect of aqueous ammonia soaking on enzymatic hydrolysis of wheat straw. J Renewable Sustainable Energy 5: 033131.
4. Deval A, Dikshit AK (2013) Construction, Working and Standardization of Microbial Fuel Cell. APCBEE Procedia 5: 59-63.
5. Veneu DM, Torem ML, Pino GH (2006) Biosorption of cadmium by green coconut shell powder. Miner Eng 19: 380-387.
6. Okibe N, Koga M, Sasaki M, Hirajima T, Heguri S, et al. (2013) Simultaneous oxidation and immobililzation of arsenite from refinery waste water by thermoacidophilic iron-oxidizing archaeon. Miner Eng 48: 126-134.
7. Ciftci H, Akcil A (2013) Biohydrometallurgy in Turkish gold mining: First shake flask and bioreactor studies. Miner Eng 46-47: 25-33.
8. Weyens N, Beckers B, Schellingen K, Ceulemans R, Croes S, et al. (2013) Plant-associated bacteria and their role in the success or failure of metal phytoextraction projects: first observations of a field-related experiment. Microb Biotechnol 6: 288-299.
9. Treccani L, Yvonne Klein T, Meder F, Pardun K, Rezwan K (2013) Functionalized ceramics for biomedical, biotechnological and environmental applications. Acta Biomaterialia. 9: 7115-7150.
10. Griffiths OG, O'Byrne JP, Torrente-Murciano L, Jones MD, Mattia D, et al. (2013) Identifying the largest environmental life cycle impacts during carbon nanotube synthesis via chemical vapour deposition. J cleaner Production 42: 180-189.
11. Marquardt C, Kühnel D, Richter V, Krug HF, Mathes B, et al. (2013) Latest research results on the effects of nanomaterials on humans and the environment: DaNa – Knowledge Base Nanomaterials. J Phys Conf Ser 429: 012060.
12. Kettiger H, Schipanski A, Wick P, Huwyler J (2013) Engineered nano material uptake and tissue distribution: from cell to organism. Int J Nanomed 8: 3255-3269.
13. Lu TK, Bowers J, Koeris MS (2013) Advancing bacteriophage-based microbial diagnostics with synthetic biology. Trends Biotechnol 6: 325-327.
14. Benson DA, Cavanaugh M, Clark K, Karsch-Mizrachi I, Lipman DJ, et al. (2013) Nucleic Acids Research 41: 36-42.
15. Curtis T, Pronk JT, Frey J, Daran JM, Jansson JK (2013) Crystal ball. Microb Biotechnol 6: 3-16.
16. Bajpai P (2013) Biorefinery in the Pulp and Paper Industry: Academic Press, Elsevier 5: 99-103.