CURRICULUM VITAE

1. **Name:** LALA BEHARI SUKLA

   https://scholar.google.co.in/citations?user=SaflpMUAAAAJ&hl=en.

2. **Official Address:** Institute For Applied Environmental Biotechnology Innovation
   Bhubaneswar -751013.
   Res. +91-0674-2300352,
   Cell: +91-9937081852
   E-mail: suklalb@yahoo.co.in,
   lbsukla@immt.res.in

3. **Current Designation:** Director,IAEBI &Professor AcSIR

4. **Department:** R&D
5. **Date of Birth :** 28.12.1949

6. **Academic Qualification:** B.Sc(Engg) Metallurgy., M.Tech Metallurgy

7. **Area of Specialization:**
   Biomineral processing for extraction of metal values from ores, concentrates and wastes. Bioleaching, Biobenefication, Bioadsorption, Bioprecipitation, Bioremediation, Microbial strain improvement.

8. **Research Experience**

   i) 39 years of R & D experience in the area of biomineral processing and Heading the ***Bioresources Engineering department*** of Institute of Minerals and Materials Technology (IMMT), Bhubaneswar.One year experience at Institute For Applied Environmental Biotechnology,Bhubaneswar.

9. **Research Contribution**

Research Guidance at Ph. D. Level : 9

(Annexure I)

Research Guidance for M.Sc. Dissertation : 50

Involvement in Research Projects : 15

(Annexure II)

Technology Transfers : 5

(Annexure III)

Publications of Research Papers/Articles : 171

(Annexure IV)

Publications in Conference Proceedings : 18

(Annexure V)

Patents : 10

(Annexure VI)

Books Edited/ Book Chapters : 4/26

(Annexure VII)

10. Awards

- **The Misra Award**: IIME Best Paper Published Award on Hydro-Electro-Bio Processing, 2012 recieved in the International Conference on Mineral processing Technology, MPT-2013

- **Prof. S.R. Vyas Memorial award 2010** by association of Microbiologists of India (AMI) towards his significant contribution for the **development of "Microbiology"** in India.

- **Best Paper Award** for the paper presented at 13th National Conference on New Frontiers in Life Science, Organized on the occasion of Odisha Bigyan Congress during 9-11 December, 2010.

- **IIME Mineral Beneficiation Award: Academic / R&D for the year 2009** for his outstanding contribution to the development in the field of Mineral Engineering.

- **Sita Ram Rungta Memorial Award 2007:** of SGAT for the year 2007 for outstanding work in the field of bio-mineral processing.

- **Nilamani Devi –Biswanath Das Award** of IIM for the year 2001 for excellent work in the area of Biohydrometallurgy

- **Best Poster Award** (2nd prize) at NMD-ATM of IIM held at Bhilai, 2000 for the paper 'Extraction of metal values from zinc concentrate using *Thiobacillus ferrooxidans.'*

- **Editorial Board Member of Scientific Reports, a journal from Nature Publishing Group, the publishers of Nature**. Mr. Sukla is the editorial board member of the World Environment journal (Scientific & Academic Publishing) and International Journal of Nonferrous Metallurgy

- Senior consultant of Hydromet Solution.

11. Membership of Professional Bodies

- Vice Chairman, Cafeta-Innova Technical Society, Orissa chapter
- Vice President of Association of microbiologists of India(AMI)-Cuttack-Bhubaneswar Chapter
- Member of American Society for Microbiology
- Life Member of Indian Institute of Metals
- Life Member of Association of Microbiologists of India
- Life Member of Indian Institute of Mineral Engineers
- Life Member of the Indian Institute of Chemical Engineers
- Life member of Orissa Bigyan Academy
- Member of Project Monitoring Committee, Department of Biotechnology (DBT) New Delhi.
- Member of PAC, Biotechnology Dep Member, subject Research Committee (Biot-technology) of Utkal University, Bhubaneswar artment, Utkal University.
- Member of ENVIS Center on environmental biotechnology

12. Countries Visited

1. Institute of Environmental Engineering, Polish Academy of Science, Poland. From 16thMay 1996 to June 2nd 1996, under the joint programme on microbial desulphurization coal and bacterial leaching of low grade ore.

2. Stolberg Inginieur Beratung GmbH(Consulting company) Germany from 3rd September to 31st October,1984 Discussed and contributed to the design engineering for pilot plant on Extraction of Copper from complex sulphide ore/concentrate to be created at IMMT.

3. Higher Institute of Mining and Geology, Sofia, Bulgaria in connection with the bacterial leaching project, Sept. 1988 to October 1988.

4. Department of metallurgy, National Technical University of Athens, Greece from 1st Nov. 1988 to 6th Nov.1988 to regarding bacterial leaching project.

13. Detail Scientific Contribution

Significant R&D contributions in the field of Biomineral processing are highlighted below:

1. Establishment of a group of iron (III) reducing bacteria (IRB) to convert the goethite (α-FeOOH) present in the original lateritic Nickel ore to magnetite under an anaerobic condition and subsequently release the bound Co (III) and Ni (II) through leaching. An anaerobic dissimilatory iron (III) reducing bacterial consortium capable of using acetate or glucose as carbon source (electron donor) and lateritic ore as terminal electron

acceptor, changes the initial light brown colour of the ore to dark brown. The change in colour is due to the conversion of goethite to magnetite. This phase transformation aids in enhanced extraction of nickel from the goethite matrix.

2. Mechanism of reaction by Bacterial (*Acidithiobacillus ferrooxidans)* attachment in form of biofilm through Exopolysaccharides formation over the ore was established. Biofilm grown on uranium ore substrate was used for the study. Micro- Raman analysis revealed the different constituents of molecular polymeric substances(EPS) while AFM images indicated bacterial cells surrounded by EPS.

3. Biologically fabricated nanostructures are naturally occurred advanced materials. Keeping this in view, attempts were made to isolate fungi from different mine area and utilized them for biosynthesis of nano particles and characterized them with respect to different shape, size and composition.

4. A new technology on "Microbial Desulphurization of calcined petroleum coke(CPC) has been developed under my leadership. The sulphur content in the CPC was reduced to meet stringent standards of emission in the electrolytic smelting of alumina. An international project was sponsored by ALCOA,USA.

5. Several new microorganism have been isolated to selectively remove alumina and silica from low grade iron ore**.** High alumina and silica content in the iron ore affects coke rate, reducibility and productivity in blast furnace operation.

Annexure I

Ph.D Degree Awardees

1. Dr.Mousumi Mishra (SRF) received Ph.D degree on "Microbial Beneficiation of Aluminium and Iron ore" from Utkal University 2015.

2. *Dr. Sunil Kumar Behera* received Ph.D degree on "Microbial Dissolution of Nickel and Cobalt Using Molecular Tools", from Utkal University in Biotechnology (2013).

3. *Dr. Alok Prasad Das* received Ph.D degree on "Microbial Extraction of Manganese from Manganese ore" from SOA University in Biotechnology (2013).

4. *Dr. Sradhanjali Singh* has received Ph.D. degree in Microbiology on "Studies on microbial dissolution of copper during bioleaching of low-grade chalcopyrite ore" from Utkal University (2011).

5. *Dr. Lipika Patnaik* received Ph.D degree on "Studies on extraction of metal values from complex sulphide concentrates using *Acidithiobacillus ferrooxidans* from Utkal University in Life Science (2006).

6. *Dr. Smaranika Mohapatra* received Ph.D degree on "Biomineral Processing of Nickel Ore" from Kalyani University (2009).

7. *Dr.Celin Acharya* received Ph.D degree on "Microbial Desulphurization of coal and bioleaching of Manganese ore" from Utkal University in Life Science (2000).

Scholars Registered for PhD

1. *Ms.Monalisa Pradhan* has registered for Ph.D degree in Microbiology on "Bio-beneficiation of Iron ore" in North Odisha University.

2. *Ms. Jacintha Esther* has registered for Ph.D degree in Engineering on "Applications of Dissimilatory Iron Reducing Bacteria (DIRB) for recovery of Ni and Co from low-grade lateritic nickel ore" in AcSIR, India

Annexure II

International Projects

- ❖ Leaching of Lithium from used lithium ion batteries, NISSAN, Chennai , Feb 2013-Dec 2014.-Team member
- ❖ Laboratory testing of copper oxide ore of M/S-Mawarid Mining Company,Oman sponsored by EIL, May 2011-Aug 2011 - Team member
- ❖ Microbial desulphurization of Assam coal, lignite and polish coal was jointly carried out between IMMT, Bhubaneswar and Institute of Environmental Science, Polish Academy of Science, Poland-Project leader as from Indian side.

- Microbial desulphurization of petroleum coke sponsored by ALCOA, USA- Project Leader

- Characterization and recovery of copper from low-grade copper tailing dump of Lusaka copper mines of Zambia- Team member.

- Studies on Microbial Desulphurization of calcined petroleum coke, ALCOA Phase-II, USA-Project Leader

National Projects

- Enhanced recovery of nickel and cobalt from COB using Dissimilatory Iron Reducing Bacteria (DIRB) sponsored by CSIR, Delhi, Jan 2011-Present. Project Leader

- Bio mineral processing for extraction of metal values from ores/ concentrates/wastes. Planning Commission, Feb 2004 – March 2007 (CORE - 20), 10^{th} Five Year Plan Program, Network project, - Leader of the project and coordinating the R&D work of IMMT, NML and IICB.

- Extraction of Nickel and Cobalt from lateritic nickel ore and chromite over burden of Orissa using microbial technique, Department of Science and Technology, New Delhi, Gap-109, (Dec 2003- Nov 2006), - Project Leader.

- Evaluation of process variables in continuous scale bio oxidation of complex sulphide ores/concentrates of Ambamata / Sikkim, Ministry of Coal & Mines, New Delhi and Department of Science and Technology, New Delhi, (Nov 2000 – April 2002), - Project Leader.

- Microbiological desulphurization of coal and metal recovery from mine wastes and low grade ores by hydrometallurgical and microbial methods, Collaborative project: CSIR & polish Academy, (September 2000-Feb 2003), - Project Leader.
- 2000 tonne bio heap leaching plant of low grade copper for extraction of copper ore using *Acidithiobacillus ferroxidans*. at Malanjkhand Copper Projects (HCL, India) sponsored by Hindustan Copper limited Kolkata- Project Leader
- Area coordinator of Eastern zone on algal oil production from micro- algae, DBT (2009 -2011). a) Raceway pond facilities b)Eastern Zone Culture collection centre

- Development of Microbial process for recovery of Nickel and Cobalt from Chromite overburden, Sukinda (OMC, Bhubaneswar). - Project Leader

- Microbial removal of phosphorus from LD slags of Vishakhapatinum Steel plant. - Project Leader

Annexure III

Biomineral processing holds great promise and practical significance in India. This technology has attained commercial acceptability world wide. The following technology has been transferred to the industry under my leadership.

- 2000 Tonne Bio-heap leaching plant has been set up at HCL, Malanjkhand.
- Microbial desulphurization of calcined petroleum coke process was developed .This process has been taken by ALCOA, USA.
- Microbial process technology to recover nickel and cobalt from Chromite over burden has been developed, which has drawn attention of Orissa Mining Corporation.
- Microbial dephosphorization of LD slag has been successfully done and technology was transferred to Vishakhapattanum steel plant. The technology developed will be commercialized in our country.
- Continuous bioreactor plant of 160 liter capacity was set up at IMMT, Bhubaneswar to treat concentrates of copper and Zinc ore
- 15 & 30 tonne Bio-heap leaching plant has been setup at IMMT, Bhubaneswar to treat low grade copper ore.
- 2000 tonne Bioheap leaching plant at Hindustan Copper Limited,Malanjkhand,Indihas been set up.The plant includes Bioheap leaching ,Solvent Extraction and Electrowinning.
- Eight number of Raceway pond of 40,000liter capacity was designed and Installed. Set up of culture collection repository for brackish water microalgae, Screen potential microalgae for biofuel production,Set up of mass culture protocols for production of 20 Kg/day algal biomass through raceway ponds,Microalgal Harvesting with flocculation

(i) Recovery of copper from Lean sulphide/chalcopyrite ore by bio-heap leaching technology followed by solvent extraction and electro winning at Malanjkhand copper project (HCL, Kolkotta).

2000 tonne bio heap leaching plant of low grade copper has been set up for extraction of copper ore under my supervision, at Malanjkhand Copper Projects (HCL, India) sponsored by Ministry of Mines, GOI, New Delhi. India is in short supply of copper, for which the copper minerals are obtained through two sources,

i.e., from copper ores mined from indigenous mines, and from the imported concentrates. The quantum of available low-grade chalcopyrite copper ores is about 10-12 million tons at Malanjkhand having an average copper content of ~ 0.3%, which is well below the cut off grade of 0.45% Cu suitable for concentrators. The quantum of this waste is being added regularly during the mining of copper ore. This would immensely contribute to the copper needs of our country, provided an appropriate technology is available for commercial exploitation. Moreover, it would utilize the vast amounts of lean grade ores lying as wastes at the mine site, which is in the other hand responsible for 'Acid Mine Drainage' causing environmental pollution. Therefore, Institute of Minerals and Material Technology, Bhubaneswar under my leadership has made an all out effort in collaboration with Hindustan Copper Limited (HCL) to exploit these lean grade ores in recovering copper metal through bio-heap leaching technology.

The process consists of bacterial heap leaching , bacterial film oxidation , solvent extraction , and electrowinning . Bacterial film oxidation (BACFOX) unit has been specially designed to grow microorganisms responsible for leaching of chalcopyrite based copper ore at a faster rate. The copper bearing leach liquor is utilized for recovery of copper through solvent extraction where the metal is concentrated in the copper pregnant electrolyte used for electrowinning of 99.94% pure copper metal.

ii. Area coordinator of eastern zone on algal oil production from micro- algae, funded by Department of Biotechnology, New Delhi.

Continued use of petroleum sourced fuels is now widely recognized as unsustainable because of depleting supplies and the contribution of these fuels to the accumulation of carbon dioxide in the environment causing global warming. It is estimated that there will be a 60% increase in global energy requirement by 2030 over its present consumption level. Out of this 45% will be accounted by India and China alone. Thus along with carbon sequestration, there is need for an alternative fuel that is renewable and has lower carbon footprint or is carbon neutral. Renewable, carbon neutral, transport fuels are necessary for

environmental and economic sustainability. Biodiesel derived from oil crops is a potential renewable and carbon neutral alternative to petroleum fuels. Unfortunately, biodiesel from oil crops, waste cooking oil and animal fat cannot realistically satisfy even a small fraction of the existing demand for transport fuels. Microalgae offer an attractive alternative source as they have potential biodiesel productivity of Biodiesel than oil crops like Oil palm, Rape seed, Jatropha and bioethanol from Sugarcane or Corn. Microalgal renewable fuel production is about 10,000 gallons/acre/year. Moreover they do not need agricultural land and can sequester the CO_2 emitted by fossil fuel based power plants too. Thus it is imperative to develop a suitable technology package for the mass cultivation, harvesting and processing of microalgae and examine its techno-economic feasibility for production of bio-diesel and other value added products. Like plants, microalgae use sunlight to produce oils but they do so more efficiently than crop plants. Oil productivity of many microalgae greatly exceeds the oil productivity of the best producing oil crops.

The photosynthetic efficiency of aquatic biomass results to be much higher (6–8% average) than that of terrestrial (1.8–2.2%, average). Microalgae are sunlight-driven cell factories that convert carbon dioxide to potential biofuels, foods, feeds and high-value bioactive, Microalgae can provide several different types of renewable biofuels. These include methane produced by anaerobic digestion of the algal biomass; biodiesel derived from microalgal oil and photo biologically produced biohydrogen . Like plants, microalgae use sunlight to produce oils but they do so more efficiently than cropplants.Oil productivity of many microalgae greatly exceeds the oil productivity of the best producing oil crops.

Microalgae, like higher plants, produce storage Lipids in the form of triacyglycerols (TAGs). Comparatively algae produce more oil than any other oilseeds which are currently in use. Many microalgal species can be induced to accumulate substantial quantities of lipids, often greater than 60% of their biomass. The lipid and fatty acid contents of Microalgae vary in accordance with

culture conditions. Microalgae are known to accumulate more lipids in stress conditions. Researchers identified the most dramatic increases in the lipid content of the cultures during N-deficient conditions. Biochemical studies have also suggested that acetyl-CoA carboxylase (ACCase), a biotin-containing enzyme that catalyzes an early step in fatty acid biosynthesis, may be involved in the control of this lipid accumulation process. Therefore, it may be possible to enhance lipid production rates by increasing the activity of this enzyme via genetic engineering.

Micro-algae species selection:

- Appropriate microalgae species for maximization of biomass productivity in Indian climatic regimes.
- Standardization of optimum conditions for biomass productivity with respect to nutrients, temperature, light and other controlling factors like carbon source.

- **Mass cultivation protocols:**
  - Issues related to cost effective scale up & design of raceway ponds/ photo bioreactors to ensure high algal biomass productivity.
- **Harvesting & Downstream Processing:**
  - Economic design for harvesting algal oil, quality assessment of biodiesel and complete utilization of biomass for energy and nutrient recovery.

iii. Development of microbial process for recovery of nickel and cobalt from chromite overburden, Sukinda funded by Orissa Mining Corporation, Bhubaneswar.

The project entitled **"Development of Microbial Process for Recovery of Nickel and Cobalt from Chromite Overburden, Sukinda"** aims at recovering of nickel and cobalt values from chromite overburden sample at Kaliapani mines through a process of biohydrometallurgy. Under this Programme, representative sample were grown from Kaliapani mines, characterized, activated,

followed by bioleaching and recovery of metal values. Through solvent extraction and electrowinning synthesis of findings are discussed below. The leaching of nickel from chromite overburden is mainly dependent on the type of mineralization. The over burden sample is lateritic and highly weathered. The mineralogical studies indicated that there is no separate nickel bearing mineral phase in the lateritic nickel ore. Goethite (fco ore) and chromite phase contains most of the nickel in the raw lateritic ore. The mineralogy of the raw lateritic ore in this study reveals the presence of goethite, ferrihydrites (as major minerals), Surinamite quartz as (minor mineral phase) and traces of hematite and chromite. In the activated overburden at 600^0C the minerals present were hematite with mines, surimarite quartz and traces of magnetite. Leading studies were carried out in shake flask and 1 Kg, 1000 Kg scale under laboratory condition, to optimize the process parameter. It was observed that extraction of nickel and cobalt was found to be 66.94% and 72.7% respectively in optimum conditions in shake flask. Nickel and cobalt recovery were 60 and 65 %, respectively after a period of 60 days in1kg scale. After about 9 months, the percentage of nickel and cobalt recovery was found to be 35% and 40% and the process is still showing an increasing trend of leaching. Based on the optimized condition studies have been carried out on in column leaching 1000 kg scale and bioheap leaching on 10 tone scale. The experiments have been carried out using nickel resistant strain on the chromite overburden samples supplied by OMC. Nickel resistant strain of *Acidithiobacillus ferrooxidans* was developed by adapting the strain to different concentrations of nickel ranging from 0.1 to 1.5 gpl. It was observed that *A. ferrooxidans* was able to tolerate 1.5 gpl nickel in solution. Then with the nickel resistant *A. ferrooxidans* further leaching experiments were carried out.

The percentage of nickel recovery was around 25% for the heap (ten ton) after running it for about 9 months whereas the amount of cobalt recovery was 31% approximately after running it for the same duration.

As regards the processing of Ni-laterites bacterial leach liquor for recovery of nickel, our aim is to recover other useful metal values such as zinc, manganese and cobalt also for which the impurities like Fe, Al and Cr from the leach solution were precipitated with $CaCO_3$ at pH 4.4 followed by filtration to reject the impurities. Many precipitation techniques such as treatment with lime slurry, $CaCO_3$, NaOH, Na_2S, MgO, etc. both at low and higher pH have been used for the removal of impurities, out of which the $CaCO_3$ treatment has been found to be the most useful. The leach liquor after treatment with $CaCO_3$ was quantitatively free from iron, but it still contained some Al and Cr. For removal of the remaining Al and Cr impurities quantitatively from the solution, the pH of $CaCO_3$ treated solution should be maintained either at pH 5.4 by addition of ammonia, or be maintained at pH 5.03 by addition of NaOH solution. However, the treatment with ammonia solution is preferable. The Fe, Al and Cr-free solution bearing zinc, manganese, cobalt and nickel values were treated through solvent extraction using TOPS-99 and Cyanex 272 to recover the individual metal values as shown in the process flow-sheet. The metal values (Zn, Mn, Co and Ni) present in the Ni-laterites bacterial leach liquor were separated using hollow fiber membrane module using TOPS-99 and Cyanex 272 as the mobile carrier. Central Composite Design (CCD) technique was used for simultaneous separation of zinc and manganese. With the optimized conditions, i.e., 720 ml/min flow rate, 0.597 M [TOPS-99], 4.99% [H_2SO_4] and 3.625 pH, complete removal of zinc and manganese from the leach liquor was achieved in 5 and 60 min., respectively. From the Zn and Mn-free leach liquor, cobalt was separated using 0.8 M Cyanex 272 with intermittent pH adjustment of the feed solution to 6.5. The flow rate and H_2SO_4 concentration in strip solution were 720 mL/min and 5%, respectively. The separation of cobalt was completed in one hour leaving only 3.8 g/m^3 cobalt in the feed solution. The co-permeation of nickel with cobalt was only 8 g/m^3.

High pure nickel was deposited from the pregnant electrolyte by using synthetic spent electrolyte and actual bio leach liquor. Current efficiency during electro winning is 55% and the energy consumption was about 5kWh/kg.

Process modeling and simulation help in obtaining the optimum conditions under which a system can be operated to get the maximum benefit. In the present study empirical models were developed to optimize the process parameters for maximizing bacterial leaching of nickel and cobalt.

. The unit operations involved in the process is explained earlier. OMC requested IMMT to provide the basic engineering process package to recover nickel from 100 T heap to set up a pilot plant. The unit operations involved in the process is studied in laboratory scale only and continuous operation from chromite overburden to metal has not been under taken. The conceptual engineering process package is provided with earlier experience and on the literature basis. The unit operations involved in the proposed process is crushing, roasting, bioleaching, precipitation, solvent extraction and electro winning.

iv. Microbial removal of phosphorus from LD slags of Vishakhapattanum Steel plant

LD slag contains lime which varies from 40-49%. Due to presence of Ca in high amount, it can be used as flux in blast furnace provided it's phosphorous is reduced to <0.5%. Thus removal of phosphorous from LD slag is important for increasing the cost efficiency of the steel plant. The solubilization of phosphorous from LD slag is carried out with the help of microorganisms. Microorganisms are reported to produce organic acids like citric acid, oxalic acid, gluconic acid butyric acid, etc. and convert unavailable phosphate to available phosphate. This phenomenon is called as microbial phosphorus solubilization or microbial phosphate solubilization. The phosphorus solubilising microorganisms used in this study are *Pseudomonas aureginosa*, *Pseudomonas putida, Bacillus sphericus, Bacillus polymyxa* and one unidentified bacteria isolated from soil.

Representative samples received from Vishakhapattanum Steel Plant were taken for chemical analysis and P_2O_5 in LD slag samples was found to be 1.73%. The

experiments were carried out under different conditions such as variation of pulp-density [10% and 50% (w/v)] of LD slag, size fraction, and microorganisms. All the experiments were performed at 35^{o}C, 150 rpm in Kunher orbital shaker.

27%-50% of phosphorous was removed from LD slag during shake flask experiments at 10% pulp-density at 35^{o}C temperature in a period of 60 days at 150 rpm. Two sets of experiments were also conducted at 1 tonne scale with the material received from VSP. Using *Bacillus polymyxa* maximum phosphorous removal obtained was 34% and 40.58% from Set I and Set II (1 ton Scale) respectively. Scanning electron microscopy was performed to see the phase distribution of Calcium, Silica, Phosphorus, Manganese, Ferrous and Aluminium in the original and biologically treated LD Slag samples. Micrographs show presence of Calcium, Silica and Phosphorus in the same zone. Phosphorus is present in the calcium silicate matrix. In case of biologically treated samples concentration of phosphorus in the calcium silicate matrix is less when compared to untreated LD slag. Before conducting the 5 ton trial experiments at VSP Plant site, some training was given to VSP personals on microbiological methods. For this a manual was prepared on Microbiological methods.

VI . Silver Nano Particles

The present process consists of use of the extracellular enzymes syntheses by the fungus grown in a growth media. A fungus *Penicillium purpurogenum* NPMF (MTCC 7356) was used for this study. For production of biomass, sterile media was inoculated with fungal spores aseptically & incubated at 35^{o}C under shaking condition. After growth of fungus, biomass was separated and resuspended in distilled water. After incubation with water the culture filtrate so generated was added with $AgNO_3$. Absorbance spectrum of reaction mixture was monitored with the help of UV-VIS spectrophotometer (CECIL) in the range of 200 – 800 nm. Spectra were recorded at regular time interval. UV-VIS spectra of culture filtrate without any addition of silver nitrate was also recorded. The morphology,

structure of the silver metal nanoparticle was observed with help of Transmission electron microscopy (FEI TECHNAI G^2), at a operating voltage of 200 kV. Range of concentration of silver nitrate was from 0.25 mM to 5 mM. Range of pH used was 4 to 9.

Antimicrobial activity of the above synthesized silver colloid solution was determined on pathogenic gram negative bacteria like *E.coli* and *Pseudomonas aeruginosa*, and gram positive bacteria like *Staphylococcus aureus.A US patent has been filed*

VII. Infrastructure created at IMMT, Bhubaneswar

a) Continuous bioreactor plant of 160 liter capacity was set up at IMMT, Bhubaneswar to treat concentrates of copper and zinc ores.

b) 15 & 30 Ton Bio-heap leaching plant has been setup at IMMT, Bhubaneswar to treat low grade copper ore.

c) Culture Laboratory for micro algae has been established at IMMT, Bhubaneswar for eastern zone.

d) 40,000 liters raceway pond for growing algal culture has been setup at IMMT, Bhubaneswar under my leadership

VIII. International Standing

Metallurgical Transactions-B, Transactions of The Institution of Mining and Metallurgy –Section C (London); Hydrometallurgy; Proceedings of Australasian Institute of Mining & Metallurgy Mineral, Canadian Metallurgical Quarterly, International Journal of Mineral Processing, Ertz Metal, Scandinavian Journal of Metallurgy, World Journal of Microbiology and Biotechnology, Acoustic Letters, International Journal of Environmental Studies, Fuel, Journal of Chemical Technology & Biotechnology, Separation Science & Technology, Minerals & Metallurgical Processing, European Journal of Mineral Processing & Environmental Processing, Applied Biochemistry & Biotechnology, Minerals Engineering, Ecological Modelling, Bioresource Technology, Research and Microbiology.

National Standing

Transactions of The Indian Institute of Metals, SGAT Bulletin, Steel India, Indian Journal Microbiology, Journal of Microbial World, Indian Journal of Chemical Technology, Journal of Indian Institute of Science. **(Annexure IV)**

Sl. No	Title	Authors	Name of the Journal	Vol.	Year	Page
171.	Molecular identification of indigenous manganese solubilising bacterial biodiversity from manganese mining deposits	Shreya Ghosh, Sansuta Mohanty, Sanghamitra Nayak, Lala B. Sukla and Alok P. Das	Journal of Basic Microbiology	DOI:10.1002/jobm.201500477	2015	
170.	Sequential bioreduction - bioleaching and bioreduction - chemical leaching hybrid tests for enhanced copper recovery from a concentrator ball mill reject sample	Sandeep Panda, Jacintha Esther, Tilothama Bhotra, Nilotpala Pradhan, Lala Behari Sukla, Barada Kanta Mishra and Ata Akcil	Hydrometallurgy	157	2015	171-177
169.	Enhanced recovery of nickel from chromite overburdern (COB) using Dissimilatory Fe (III) reducers: A novel Bio-Reduction Acid Leaching (BRAL) approach	Jacintha Esther, Sandeep Panda, Lala Behari Sukla, Nilotpala Pradhan, Chinmaya K Sarangi and Tondepu Subbaiah	Hydrometallurgy	155	2015	110-117
168.	Reductive dissolution by waste newspaper for enhanced meso-acidophilic bioleaching of copper from low grade chalcopyrite: A new concept of biohydrometallurgy	Sandeep Panda, Avijit Biswal, Srabani Mishra, Prasanna Kumar Panda, Nilotpala Pradhan, Umaballava Mohapatra, Lala Behari Sukla, Barada Kanta Mishra and Ata Akcil	Hydrometallurgy	153	2015	98-105
167.	Bio-beneficiation of iron ore using heterotrophic micro-organisms	Sitharashmi Sahu, Madhushree Kundu, Lala Behari Sukla	Journal of Microbiology and Biotechology Research	5 (2)	2015	54-60
166.	Consequences of manganese compounds: A review	S. Ghosh, S.Mohanty, L. B. Sukla and A.P.Das	Toxicological and Environmental Chemistry	Vol. 96 (7)	2014	981-997
165.	Biological sequestration and retention of cadmium as CdS nanoparticles by the microalga Scenedesmus-24	Jayashree Jena, Nilotpala Pradhan, V. Aishvarya, Rati Ranjan Nayak, Bisnu Prasad Dash, Lala Behari Sukla, Prasanna Kumar Panda, Barada Kanta Mishra	Journal of Applied Phycology	DOI: 10.1007/s10811-014-0499-8	2014	1-10
164.	Fe (III) reduction strategies of Dissimilatory Iron Reducing Bacteria: A Review	J.Esther, **L.B.Sukla,** N.Pradhan, S.Panda	Korean Journal of Chemical Engineering	Accepted	2014	1-14

163.	Extraction and characterization of biocompatible hydroxyapatite from fresh water fish scales for tissue engineering scaffold	N Panda, K Pramanik and**L.B.Sukla**	Bioprocess and Biosystems Engineering	37(3)	2014	433-440
162.	Biomineral Processing: A Valid Eco-Friendly Alternative for Metal Extraction. Research & Reviews	J.Esther, S.Panda, **L.B.Sukla,**N.Pradhan	Journal of Microbiology and Biotechnology	3(4)	2014	01 - 10
161.	Degradation Mechanism and Control of blended eri and tasar silk nano fiber	N Panda, A Biswas, L. B. Sukla, K Pramanik	Applied Biochemistry and Biotechnology	DOI: 10.1007/s12010-014-1151-4	2014	
160.	Recovery of copper from a surface altered chalcopyrite contained ball mill spillage through bio-hydrometallurgical route	S. Panda, P.C.Rout, C.K. Sarangi, S.Mishra, N.Pradhan, U.B.Mohapatra, T.Subbiah, L.B.Sukla, B.K.Mishra	Korean Journal of Chemical Engineering	31	2014	452-460
159.	Microalga Scenedesmus sp.: A Potential Low Cost Green Machinery for Silver Nanoparticle Synthesis	J.Jena, N.Pradhan, R.R.Nayak, B.P.Das, L.B. Sukla, P.K.Panda	Journal of Microbiology and Biotechnology	24(4)	2014	522-533
158.	Application of some eco-diversified mineral oxidizers and reducers towards development of a sustainable biotechnological industry.	S. Panda, S.Mishra, N.Pradhan, U.Mohapatra, L.B.Sukla	Current Biochemical Engineering Journal	1(2)	2014	117-124
157.	Biogenic synthesis of floral-shaped gold nanoparticles using a novel strain	E.Priyadarshini, N.Pradhan, L.B.Sukla, P.K.Panda, B.K.Mishra	Talaromyces flavus Annals of Microbiology	64	2014	1055-1063
156.	Extraction and characterization of biocompatible hydroxyapatite from fresh water fish scales for tissue engineering scaffold.	N.N.Rath, K.Pramanik, L.B.Sukla	Bioprocess and Biosystems Engineering	37(3)	2014	
155.	Controlled synthesis of gold nanoparticles using Aspergillus terreus IF0 and its antibacterial potential against gram negative pathogenic bacteria.	E.Priyadarshini, N.Pradhan, L.B.Sukla, P.K.Panda, B.K.Mishra	Journal of Nanotechnology	**DOI: 10.1155/2014/653198**	2014	

154.	Inhibition of pathogenic bacterial biofilm by biosurfactant produced by Lysinibacillus fusiformis S9.	A.K.Pradhan, N.Pradhan, L.B.Sukla, P.K.Panda, B.K.Mishra	Bioprocess and Biosystems Engineering.	37(2)	2014	139-149
153.	Effect of dissimilatory Fe(III) reducers on bio-reduction and nickel–cobalt recovery from Sukinda chromite-overburden	J. Esther, S. Panda, S. K. Behera, L. B. Sukla, N.Pradhan, B. K. Mishra	Bioresource Technology	146	2013	762-766
152.	Application of lipopeptide biosurfactant isolated from a halophile: Bacillus tequilensis CH for inhibition of biofilm.	A.K.Pradhan, N.Pradhan, G.Mall, H.T.Panda, L.B.Sukla, P.K.Panda, B.K.Mishra	Applied Biochemistry and Biotechnology	171(6)	2013	
151.	Two step meso-acidophilic bioleaching of chalcopyrite containing ball mill spillage and removal of the surface passivation layer	S. Panda, P.K. Parhi, B.D. Nayak, N. Pradhan, U.B. Mohapatra, L.B. Sukla	Bioresource Technology	130	2013	332–338
150.	Biosynthesis and characterization of silver Nanoparticles using microalga C*hlorococcum humicola* and its antibacterial activity.	J. Jena, N. Pradhan, B. P. Dash, L.B.Sukla, P.K.Panda	International Journal of Nanomaterials and Biostructures	3(1)	2013	1-8
149.	Bioleaching of copper from pre and post thermally activated low grade chalcopyrite contained ball mill spillage.	S. Panda, N.Pradhan, U.Mohapatra, S. K. Panda, S. S. Rath, D. S. Rao, B.D.Nayak, L. B. Sukla, B. K. Mishra	Front. Environ. Sci. Eng.	7(2)	2013	281-293
148.	Recovery of nickel from chromite overburden, Sukinda using Aspergillus Niger supplemented with manganese.	S.K.Behera, P.P.Panda, S.K.Saini, N.Pradhan, L.B.Sukla	Korean Journal of Chemical Engineering	30(2)	2013	392-399
147.	Evaluation of microbial population and attachment study during Bio-heap leaching at Malanjkhand Copper Project.	S.Singh, S.Panda, S.Mishra, N.Pradhan, L.B.Sukla, B.K.Mishra	International Journal of Environment and Waste Management	11(1)	2013	75-88

146.	Microbial Reductive leaching:A new Approach for Extraction of metal values from laterites.	S.K. Behera and **L.B.Sukla**	Journal of Soceity of Geoscientists and Allied Technology	13	2013	77-84
145.	Biological extraction of nickel: A value added metal from chromite overburden.	J.Esther,**L.B.Sukla**,N.Pradhan and B.K.Mishra	Journal of the society of Geoscientist and allied technology	13(2)	2013	48-53
144.	Evaluation of microbial population and attachment study during Bio-heap leaching at Malanjkhand Copper Project.	Sradhanjali Singh, Sandeep panda, Srabani Mishra, Nilotpala Pradhan,**Lala Behari Sukla** &Barada Kanta Mishra.	International Journal of Environment and waste Management	11(1)	2013	75-86
143.	Two step meso-acidophilic bioleaching of chalcopyrite containing ball mill spillage and removal of the surface passivation layer	S. Panda, P.K. Parhi, B.D. Nayak, N. Pradhan, U.B. Mohapatra, L.B. Sukla	Bioresource Technology	130	2013	332–338
142	Biosynthesis and characterization of silver Nanoparticles using microalga chlorococcum humicola and its antibacterial activity	Jayashree Jena, Nilotpala Pradhana, Bisnu Prasad Dash, Lala Behari Sukla, Prasanna kumar Panda	International Journal of Nanomaterials and Biostructures	3(1)	2013	1-8
141	Fungal biomining of low grade manganese ore	A.P. Das, N.Pradhan, L.B.Sukla and S. Nayak	International Mineral Processing Congress, IMPC-2012, New Delhi	2	2012	645
140	Application of Iron reducing bacteria for recovery of nickel and cobalt chromite overburden	N.Pradhan, R.R.Nayak, D.K.Mishra, E.Priyadarshini, L.B.Sukla and B.K. Mishra	International Mineral Processing Congress, IMPC-2012, New Delhi	1	2012	329
139	Homology modeling and docking studies of FabH (β-ketoacyl-ACP synthase III) enzyme involved in type II fatty acid biosynthesis of Chlorella variabilis: a potential algal feedstock for biofuel production	Namrata Misra, Mahesh Chandra Patra, Prasanna Kumar Panda, Lala Bihari Sukla, Barada Kanta Mishra	Journal of biomolecular structure & dynamics		2012	
138	Microbial Treatment of Lateritic Ni-ore for Iron Beneficiation and Their	Nilotpala Pradhan, R.R. Nayak, D.K. Mishra, E Priyadarshini, L.B. Sukla,		Vol.2, No.5	2012	

	Characterization	B.K. Mishra				
137	Structural Modification of Chalcopyrite Ore for Enhanced Copper Recovery	Sradhanjali Singh1,Bansi Dar Nayak, Rama Chandra Mohanty, Swaranjit S. Cameotra, Lala Beheri Suklaand Dong-Jin Kim	Materials Transactions	171	2012	72
136	Reductive Acid Leaching of Low Grade Manganese Ores	Alok Prasad Das, Sarpras Swain1, Shriyanka Panda, Nilotpala Pradhan, Lala Behari Sukla	Geomaterials	2	2012	70
135	Microbial Recovery of Manganese Using Staphylococcus epidermidis	Alok Prasad Das, Lala Behari Sukla, Nilotpala Pradhan	International Journal of Nonferrous Metallurgy	1	2012	9-12
134	Study on surface alteration behavior during column bioleaching	B.K.Mohapatra, S.Singh, L.B.Sukla, K.S.Rao and B.K.Mishra	Mineral Processing & Extractive Metall. Rev.	33	2012	1-17
133	Extraction of nickel by microbial reduction of lateritic chromite overburden of Sukinda, India	S. K. Behera, S.K.Panda, N. Pradhan, L. B. Sukla and B.K. Mishra	Bioresource Technology	125	2012	17-22
132	Isolation and characterization of biosurfactant from Psudomonas-Aeruginosand its use in biosorption study	S.Singh, A.V.Madav, L.B.Sukla, Dong-Jin Kim	Keroan Society for Geosystem Engineering	2.5.3-2.4	2012	456
131	Insights into heap bioleaching of low grade chalcopyrite ores -A pilot scale study	S. Panda, K. Sanjay, L.B. Sukla, N. Pradhan, T. Subbaiah, B.K. Mishra, M.S.R. Prasad, S.K. Ray	Hydrometallurgy	125-126	2012	157-165
130	Glycerol-3 Phosphate Acyltransferase Structural and Active Site Identifi cation Through In Silico Approach	Namrata Misra, Prasanna Kumar and Lala Bihari Sukla	Journal of Natural Science, Biology and Medicine	2, 3	2012	50-51
129	Homology Modeling and Docking Studies of FabH (ß-ketoacyl-ACP synthase III) 2 Enzyme Involved in type II Fatty Acid Biosynthesis of Chlorella variabilis - Potential Algal Feedstock for Biofuel Production	Namrata Misra , Mahesh Chandra Patra Prasanna Kumar Panda , Lala Bihari Sukla and Barada Kanta Mishraa	Journal of Biomolecular Structure & Dynamics	-	2012	1-17

128	Microbial Extraction of Nickel from Chromite Overburdens in Presence of Surfactant	S. K. Behera & L. B. Sukla	Transactions of Nonferrous Metals Society of China	22	2012	238-242
127	Dissolution of heavy metals from (ESP) dust of a coal based Sponge iron plant by fungal leaching	K. Pradip Jena , C. S. K. Mishra , D. K. Behera , S. Mishra * and L. B. Sukla	African Journal of Environmental Science and Technology	6(3)	2012	
126	Extraction of copper from bacterial leach liquor of a low grade chalcopyrite test heap using LIX 984N-C	S. Panda, P.K. Parhi, N. Pradhan, U.B. Mohapatra, L.B. Sukla and K.H. Park	Hydrometallurgy	121-124	2012	116-119
125	Microalgae of Odisha Coast as a Potential Source for Biodiesel Production	Jayashree Jena , Manoranjan Nayak , Himansu Sekhar Panda , Nilotpala Pradhan , Chandragiri Sarika, Prasanna Ku. Panda , Bhamidipati V. S. K Rao , Rachapudi B. N. Prasad , Lala Behari Sukla	World Environment	2(1)	2012	12-17
124	Fungal Beneficiation of high alumina containing iron ore Tailings	M.Pradhan,M.Mishra,**L.B. Sukla**& C.N.Rath	Dynamic Biochemistry Process biotechnology and molecular Biotechnology	Accepted	2012	
123	Enhanced Inorganic Carbon Uptake by Chlorella sp. IMMTCC-2 under AutotrophicConditions for Lipid Production and CO2 Sequestration	V. Aishvarya1, N. Pradhan, R. R. Nayak, **L. B. Sukla** and B. K. Mishra	Journal of Applied Phycology	24	2012	1455-1463
122	Survey and Documentation of Brackish Water Algal Diversity from East Coast Region of Odisha, India	Himansu Sekhar Panda, Manoranjan Nayak, Biswaranjan Das, Bikram Kumar Parida, Jayashree Jena, Sukumar Bhakta, Sandeep Panda, Prasanna Kumar Panda, **Lala Bihari Sukla**	World Environment	1(1)	2011	20-23
121	Study on reaction mechanism of bioleaching of Nickel and Cobalt from lateritic chromite	S.Behera, S.Singh, N.Pradhan, **L.B.Sukla,** B. K.Mishra	International Biodeterioration & Biodegradation	65(7)	2011	1035-1042

	overburdens					
120	In situ synthesis of entrapped silver nanoparticles by a fungus-Penicillium purpurogenum	Nilotpala Pradhan, Rati Ranjan Nayak, Arun Kumar Pradhan, **LalaBehari Sukla** and Barada Kanta Mishra	Journal of Nanoscience and Nanotechnology Letters	3 (5)	2011	659-665
119	Bio-hydrometallurgical Processing of Low Grade Chalcopyrite for the Recovery of Copper Metal	S. Panda, C.K. Sarangi, N. Pradhan, T. Subbaiah, **L.B. Sukla***, B.K.Mishra, G.L. Bhatoa, M.S.R. Prasad and S.K. Ray	Korean Journal of chemical engineering	28(7)	2011	1025-1031
118	Study On Surface Alteration Behaviour During Column Bioleaching	B.K. Mohapatra, S.Singh, S. Srinivas Rao, L.B. Sukla & B.K. Mishra	Mineral Processing & Extractive Metallurgy	33(6)	2012	374-390
117	Population coverage analysis of T-Cell epitopes of Neisseria meningitidis serogroup B from Iron acquisition proteins for vaccine design	Namrata Misra,Prasanna Kumar Panda, Kavita Shah, Lala Bihari Sukla, Priyanka Chaubey	Bioinformation	6(7)	2011	255-261
116	Manganese Biomining: A Review	A.P. Das, **L.B. Sukla**, N. Pradhan, S. Nayak	Bioresources Technology	Online	2011	
115	Screnning of fresh water microalgae from Eastern region of India for sustainable biodiesel production	M. Nayak, J. Jena, S. Bhakta, S.S. rath, C. Sarika, B.V.S.K. Rao, N. Pradhan, M.T. Arasu, S.K. Mishra, P.K. Panda, R.B.N Prasad, **L.B. Sukla**, B.K. Mishra	International Journal of Green Energy	8(6)	2011	
114	Microbial Recovery of Nickel and Cobalt from Pre-treated Chromite Overburdens of Sukinda Mines using Aspergillus niger	Sunil Kumar Behera*, Prangya Parimita Panda and **Lala Behari Sukla**	Recent Research in Science and Technology	3(6)	2011	28-33
113	Dephosphorization of LD slag by phosphorus solubilising bacteria	Marhual, N.P; Pradhan, N; Mohanta, N.C; **Sukla, L.B** and Mishra, B.K.	International Biodeterioration & Biodegradation	65	2011	404-409
112	Extraction of Copper from Malanjkhand Low-Grade Ore by*Bacillus stearothermophilus*	Singh, Sradhanjali; **Sukla, L.B**AND Mishra, B. K	Indian Journal Of Microbiology	DOI 10.1007/s12088-011-0073-x	2011	
111	Phyco-diversity assessment of bahuda	S. Bhakta, S. K. Das, M. Nayak, J. Jena, P.K.	Recent Research in Science and	2(4)	2011	80-89

	river mouth areas of East coast of odisha, india	Panda and **L. B. Sukla**	Technology			
110	Green synthesis of Silver Nanoparticle by Penicillium purpurogenum NPMF: The Process and Optimization	R.R.Nayak, N.Pradhan, S.Mishra, **L.B.Sukla** and B.K.Mishra	Journal of Nanoparticle Research	DOI 10.1007/s11051-	2010	56

Sl. No	**Title**	Authors	**Name of the Journal**	Vol.	**Year**	**Page**
109	Microbial Beneficiation of Salem Iron Ore Using Penicillium Purpurogenum	M Mishra, M Pradhan, **L.B. Sukla** and B.K. Mishra	Minerals and Materials Transaction B	42(1)	2010	13-19
108	Evaluation of microbial population and attachment study during Bio-heap leaching at Malanjkhand Copper Project	Sradhanjali Singh, Sandeep Panda, Srabani Mishra, Nilotpala Pradhan, **Lala Behari Sukla** and Barada Kanta Mishra	International Journal of Environment and waste Management (Accepted)	11, 1	2013	75-86
107	Role of Microbial Technology in Mineral Processing	**L.B.Sukla**	Journal of Sustainable Planet	1	2010	21-30
106	Synthesis and photo-physical properties of polymeric soft materials and its application in FRET based DNA sensor	Rati Ranjan Nayak, N. Pradhan, **L. B. Sukla** & B. K. Mishra	International Journal of Plastic Technology	14 (Supplement 1)	2010	S1-S6
105	Bioleaching of low-grade uranium ore using Acidithiobacillus *ferrooxidans*	S.Pal, D. Pradhan, T.Das, **L.B.Sukla**and G. Roy Chaudhury	Indian Journal of Microbiology	50, No. 1	2010	70-75
104	Microbial Removal of Alumina and Silica from low grade iron ores	M. Mishra, **L.B. Sukla** and B.K. Mishra	SGAT Bulletin	10, No. 1	2009	1-11
103	Recovery of Copper Values from Bio-Heap Leaching of Low Grade Malanjkhand Chalcopyrite Ore	**L. B. Sukla,** K. C. Nathsarma, J. R. Mahanta, S. Singh, S. Behera, K.S. Rao, T. Subbaiah and B.K. Mishra	Korean Journal of Chemical Engineering	26, No. 6	2009	11-30
102	Biological leaching of nickel and cobalt from lateritic nickel ore of Sukinda mines	S. Mohapatra, C. Sengupta, B.D. Nayak, **L.B. Sukla** and B.K. Mishra	Korean Journal of Chemical Engineering	Vol 26 (1)	2009	1-7
101	Microbial recovery of uranium using native fungal strains	A. Mishra, N. Pradhan, R.N. Kar, **L.B. Sukla** and B. K. Mishra	Hydrometallurgy	Vol 95 Issues 1-2	2009	175-177

100	Biomineral processing-implications to Judicious conservation of resource (Review).	**L.B.Sukla**	GEO-Spectrum Interface	Vol 3 No.-1	2008	1-9
99	Effect of thermal treatment on recovery of nickel and cobalt from Sukinda lateritic nickel ore using microorganism.	S. Mohapatra, C. Sengupta, B.D. Nayak, **L.B.Sukla** and B.K. Mishra	Korean Journal of Chemical Engineering	25(5)	2008	1070-1075
98	Micro Raman analysis and AFM imaging of*Acidithiobacillus ferrooxidans* bio-film grown on uranium ore	N. Pradhan, S. K. Pradhan, **L. B. Sukla** and B. K. Mishra	Research in Microbiology	159	2008	557-561
97	Differential bioleaching of copper by mesophilic and moderately*thermophilicacidophilicconsortium*enriched from same copper mine water sample	N.P. Marhual, N. Pradhan, R.N. Kar, **L.B. Sukla** and B.K. Mishra	Bioresource technology	99 (17)	2008	8331-8336
96	Bioleaching of low grade copper ore using indigenous microorganism	D. Pradhan, S. Pal, G. Roy Choudhury, T.Das and **L.B. Sukla**	Indian journal of chemical technology	Vol 15 No.6	2008	588-592
95	Percolation Bacterial Leaching Of Low Grade Chalcopyrite Using Acidophilic Microorganism	K.S. Rao, A. Mishra, G. Roy Choudhry, B.K. Mohapatra, T. Das, **L.B. Sukla** and B.K. Mishra	Korean Journal of Chemical Engineering	23(3)	2008	5-13
94	Bio dissolution of Copper from Khetri Lagoon Material by Adapted Strain ofAcidithiobacillus Ferrooxidans	M. Mishra, S. Singh, T. Das, R. N. Kar, L.B. Sukla and B.K. Mishra	Korean Journal of Chemical Engineering	Vol 25 No. 3	2008	5-13
93	Heap Bioleaching of Chalcopyrite: A Review	N. Pradhan, K.C. Nathsarma, K. Srinivasa Rao, L.B. Sukla and B.K. Mishra	Minerals Engineering (Elsevier) (Hottest Paper)	Vol 21	2008	355-365
92	Dissolution kinetics of Chromite burden by using mineral acids	P.K. Swain, G. Roy Choudhury andL.B. Sukla	Korean J. Chem. Eng.	Vol 24	2007	932-935
91	Microbial reduction of nickel from Sukinda chromite overburden byAcidithiobacillus Ferrooxidans andAspergillus strains.	S. Mohapatra, S. Bohidar, N. Pradhan, R.N. Kar & L.B. Sukla	Hydrometallurgy	85	2007	1-8
90	Beneficiation of Iron Ore Slime using A. niger and B. circulans	N. Pradhan, B. Das, C.S. Gahan, R.N. Kar and L.B. Sukla	Bioresource Technology (Elsevier)	Vol 97	2006	1876-1879

89	Prediction of sulphur removal withAcidithiobacillus sp. using artificial net works	C. Acharya, S. Mohanty, L.B. Sukla and V.N. Mishra	Ecological Modelling	Vol 190	2006	223 –230
88	Isolation and characterization of fungal strains from Jaduguda Uranium Mines	M. Pattnaik, A. Mishra, R. N. Kar and L. B. Sukla	Journal of Microbial World	-	2006	102-110
87	Bioleaching of Malanjkhand Low-Grade Copper Ore	L.B. Sukla, G. Roy Chaudhury, R.N. Kar, T. Das, N. Pradhen and V.N. Mishra	International Conference on Non-ferrous Metals	-	2005	1-11
86	Solubilization of inorganic phosphates by fungi isolated from agriculture soil	N. Pradhan and L.B. Sukla	African Journal of Biotechnology	5(10)	2005	850-854
85	Biological elimination of Sulphur from high sulphur coal by Aspergillus like fungi	C. Acharya, L.B. Sukla and V.N. Misra	Fuel	Vol-84	2005	1597-1600
84	Growth of Thiobacillus ferrooxidans in different media and leaching of sphalerite concentrate	Lipika Patnaik, L.B. Sukla and R.N. Kar	Indian journal of microbiology	Vol 44 No.4	2004	285-290
83	Biological removal of sulfur using coal derived inocula	C. Acharya, L.B. sukla and V.N. Misra	International conference of Green Processing	-	2004	61-64
82	Microbial desulphurization of different coals	C. Acharya, R.N. Kar and L.B. Sukla	Applied Biochemistry and Biotechnology	118	2004	47-64
81	Fungal leaching of manganese ore	C. Acharya, R.N. Kar, L.B. Sukla and V.N. Misra	Transaction of Indian Institute of Metals	57	2004	501-508
80	Bio depyritisation of coal	C. Acharya, L.B. Sukla and V.N. Misra	Journal of Chemical Technology and Biotechnology	Vol 79	2004	1-12
79	Cobalt and Zinc Extraction from Sikkim Complex Sulphide Concentrate	M.K. Ghosh, L.B. Sukla and V.N. Misra	Transaction of Indian Institutes of Metals	57(6)	2004	617-621
78	Biomineral processing towards green technology	L.B. Sukla & V.N. Mishra	Industries & MInes		2004	59-65
77	Removal of phosphorus from LD slag using Heterotrophic bacteria	N .Pradhan, B. Das, S. Acharya, R.N. Kar, L.B. Sukla and V.N. Misra	Minerals & Metallurgical Processing (M&MP, SME),	21(3)		149-152
76	Studies on reaction mechanism of bioleaching of manganese ore	C. Acharya, R.N. Kar and L.B. Sukla	Minerals Engineering	Vol 16	2003	1027-1030

75	Bio-dissolution of zinc sulfide concentrate in 160 l 4 stage continuous bioreactor	C.K. Pani, S. Swain, R.N. Kar, G.Roy Chaudhury, L.B. Sukla and V.N. Misra	Minerals Engineering	Vol 16	2003	1019-1021
74	Integrated Microbial and radiolysis process for Desulphurization of2high sulphur coals	S. M. Tripathy, K. K. Mishra, Vandana Sakhare, L. B. Sukla and Celin Acharya	Bharatiya Vaigyanika evam Audyogika Anusandhan Patrika (BVAAP)	Vol 11 No.1	2003	27-33
73	Microbial removal of phosphorus from L.D Slag	N.Pradhan, R.N. Kar, B.Das, L.B. Sukla and V.N. Misra	(Eds.) Utilization of Bioresource, Allied publishers, New Delhi	-	2002	345-348
72	A comparative study for Bioleaching of various manganese ores	C. Acahrya, R.N. Kar, L.B. Sukla and V.N. Misra	(Eds.) Mineral Biotechnology-2002, Allied Publishers, New Delhi	-	2002	122-125
71	Microscopic studies to evaluate the leaching rates of different sulphide minerals present in sphalerite concentrate during bioleaching	Lipika Patnaik, C.K. Pani, B.K. Nayak, B.C. Acharya, G. Roy Choudhury, R.N. Kar and L.B. Sukla	Published in International conference on Advance in Material and Materials Processing N. Chakrabati, U. K. Chaterjee. (Eds) Tata Mc Graw Hill	-	2002	550-554
70	Leaching Behavior of different sulphide minerals during bioleaching - A microscopic approach	B.K. Nayak, B.C. Acharya, R.N. Kar, L.B. Sukla and V.N. Misra	(Eds) Mineral Biotechnology-2002, Allied publishers, New Delhi	-	2002	101-106
69	Changes in bacterial population during bioreactor leaching of zinc sulphide concentrate	S. Swain, C.K. Pani, E. Shukla, R.N. Kar, G.Roy Chaudhury, L.B. Sukla and V.N. Misra	Mineral Biotechnology-2002, Allied Publishers , New Delhi	-	2002	87-93
68	Continuous bioreactor leaching of complex sulphide concentrate- problems and remedial measures	C.K. Pani, S. Swain, R.N. Kar, G. Roy. Chaudhury and L.B. Sukla	Mineral Biotechnology-2002, Allied Publishers , New Delhi	-	2002	74-80
67	Bioleaching of sulphide concentrates using Thiobacillus ferrooxidans	C.K. Pani, L. Pattanaik, R.N. Kar, G. Roy Chaudhury and L.B. Sukla	Indian journal of Microbiology	42	2002	137-139

66	Application of bioreactor technology in mineral industries	L.B.Sukla, R.N. Kar, A.K. Jouhri, P.S.R. Reddy, B.K. Mohapatra and V.N. Misra	Allied publishers, New Delhi	-	2002	255-267
65	Effect of different media on growth ofThiobacillus ferrooxidans and leaching of zinc concentrate	L. Pattanaik, L.B. Sukla and R.N Kar	Trans. IIM	-	2002	
64	A comparative study for microbiological oxidation of ferrous iron under shake flask and bioreactor conditions	C. Acharya, R.N. Kar and L.B.Sukla	Indian Journal of Microbiology	42	2002	59-62
63	Bioleaching of Sikkim lead concentrate in shake flasks as well as in bioreactor using Thiobacillus ferrooxidans	C.K. Pani, L. Patnaiak, R.N. Kar, G. Roy Chaudhury and L.B. Sukla	Proceeding International conference	-	2002	539-544`
62	Kinetics of lignite desulphurization by Thiobacillus ferrooxidans	C. Acharya, R.N. Kar and L.B.Sukla	Asian Journal of Microbiology, Biotechnology & Environmental Science	4(1)	2002	137-142
61	Microbial Removal of Phosphorus from low L.D. slag	N. Pradhan, R.N. Kar, B. Das, L.B. Sukla and V.N. Misra	In Utilization of Bioresource, Eds-A.Sree, Y.R. Rao, B. Nanda, Vibhuti N Misra	-	2002	345-348
60	Bioleaching of low grade manganese ore with Pencillium citrinum.	C. Acharya, R.N. Kar and L.B. Sukla	The European journal of Mineral processing & Environmental protection	Vol 2 No3	2002	197-204
59	Bioleaching characteristics of bhotang sulphides	B.K. Nayak, B.C. Acharya and L.B. Sukla	Indian Journal of Geology	Vol 74 No. 1-4	2002	161-174
58	Bioleaching of fly ash	S. Swain, B.N. Sahoo and L.B. Sukla	Trans of Indian Institute of metals	Vol 55 No-3	2002	103
57	Extraction of manganese from low grade Mishikhal ore using pyeriferiferious lignite in acidic medium	P.K. Naik, S.C. Das and L.B.Sukla	Minerals & Metallurgical processing	Vol 19 No 2	2002	110-112
56	Application of stastical design in the leaching study of low grade manganese ore	P.K. Naik, L.B. Sukla and S.C. Das	Separation Science & Technology	Vol 37 No 6	2002	1375-1389
55	Microbial extraction of manganese from low grade manganese ore	C. Acharya, R.N. Kar and L.B. Sukla	Transactions of Indian Institute of Metals, Journal	Trans IIM, 54(3)	2001	99-103

Sl. No	Title	Authors	Name of the Journal	Vol.	Year	Page
54	Leaching of Sikkim zinc concentrate in Bioreactor using Thiobacillus ferrooxidans	R.N. Kar, G.Roychoudhury and L. B. Sukla	Trans. Indian Institute of Metal	Vol 54	2001	145-148
53	Influence of pH on BioLeaching of copper and zinc from complex sulphide concentration using Thiobacillus ferrooxidans	Lipika Patanayik, R.N. Kar and L.B. Sukla	Trans. Indian Institute of Metal	Vol.54 No. 4	2001	139- 144
52	Bacterial removal of sulphur from three different coals	C. Acharya, R.N. Kar andL.B. Sukla	Fuel (England), Journal of Fuel	Vol-8	2001	2207-2216
51	BioLeaching of Fly ash	L.B. Sukla, S. Swain, B.N. Sahoo and R.P. Das	Secotox World congress 2001 proceedings. Editors-I. Twardowska, E. Kmiecik	ISBN 83-88316-10-9	2001	273-276
50	Aqueous SO2 leaching studies on Nishikhal manganese ore through factorial experiment	P.K. Naik, L.B. Sukla and S.C. Das	Hydro metallurgy	Vol 54	2000	217-228
49	Bioleaching of zinc industry sludge	B. Bhattacharya, S. Acharya and L.B. Sukla	Proceedings of Mineral Processing, Waste and Environment Management,	-	2000	162-169
48	A Process for recovery of manganese from low grade manganese ore through bioleaching method	**L.B. Sukla,** G. Roy Chaudhury, R.N. Kar, S.C. Panda, R.K. Paramguru and R.P. Das	Proceedings of International Symposium on Beneficiation, Agglomeration and Environment (ISBAN-99), Bhubaneswar, 20-22 January	-	1999	216-221
47	Desulphurization of low ash and high sulphur coal from Assam	C. Acharya, G.V. Rao, R.N. Kar and **L.B. Sukla**	The Indian Mining and Engineering Journal, Special Issue: Processing and Beneficiation	Vol 38 No. 3	1999	32-33

46	Toxic effect of lead on the growth of penicillin species	C.Acharya, R.N.Acharya, R.N. Kar, **L.B. Sukla**	Indian Inst. science	Vol 79	1999	295-302
45	Removal of sulphur from Assam coal by bacterial conditioning and flotation	C. Acharya, G.V. Rao, I. Twardowska, R.N. Kar and **L.B. Sukla**	Journal of Chemical Technology & Biotechnology	Vol 74	1999	945-948
44	Leaching of chromite overburden with various native bacterial strains	C. Acharya, R.N. Kar and**L.B. Sukla**	World Journal of Microbiology and Biotechnology	Vol 14	1998	769-771
43	Effect of chemical pretreatment on bacterial desulphurization of coal	S.S. Tripathy, R.N. Kar, S.K. Mishra, I. Twardowska and **L.B. Sukla**	Fuel	Vol 77 No.8	1998	859-864
42	Adsorption of Zn(II) from aqueous solution and industrial effluent by saw dust of SAL (Sorea Robusta) and its thermodynamic study	P.K. Bisoi and **L.B. Sukla**	Journal of Environmental Resource	Vol 5No. 1-4	1997	32-36
41	Microbial depyritisation of Assam Coal	C. Acharya, R.N. Kar, S.K. Mishra, I. Twardowska and **L.B.Sukla**	Indian Journal of Microbiology	Vol 37	1997	21-24
40	Microorganisms & their potentiality in solving various metallurgical problems	G. Roy Chaudhury and **L.B. Sukla**	IIM Metal News	Vol 18 No.6	1996	14-16
39	Bioleaching of lateritic nickel ore by ultrasound	R.N. Kar, **L.B. Sukla**, K.M. Swamy and V.V. Panchanadikar	Metallurgical and Materials Transactions (USA)	Vol 27B	1996	1-4
38	Biosorption of heavy metals on the*Aspergillus niger* biomass	P.K. Bisoi, S. Acharya and **L.B. Sukla**	In C.A. Jerez, T. Vargas, H. Toledo and J.V. Wiertz (Eds.) Bio hydro-	Vol 2	1995	307-314

			metallurgical Processing			
37	Alkali removal from Fe-Mn slag by microbial beneficiation	S.K. Mukherjee, T.M. Srinivasan, R.N. Kar, G. Roy Chaudhury and **L.B. Sukla**	Steel India	Vol 18 No.1	1995	42-45
36	Effect of ultrasonic irradiation on bioleaching of Sukinda nickel ore	K.L. Narayana, K.M. Swamy, V.V. Panchanadikar, R.N. Kar and L.B. Suk**la**	Acoustics Letters	Vol 18 No.12	1995	227-232
35	Extraction of cobalt and nickel from lateritic nickel ore using*Rhizopus arrhizus*	R.N. Kar, **L.B. Sukla,** V.V. Panchanadikar, S. Choudhury and R.K. Mishra	In T. Vargas, C.A. Jerez, J.V. Wiertz and H. Toledo (Eds.) Bio hydrometallurgical Processing	Vol 1	1995	417-424
34	Bioleaching of copper convertor slag using *Aspergillus niger* isolated from lateritic nickel ore	**L.B.** Sukla**,** R.N. Kar and V.V. Panchanadikar	International Journal of Environmental Studies	Vol 47	1995	81-86
33	Bioleaching of lateritic nickel ore using *Penicillium species*	**L.B. Sukla,** R.N. Kar, V.V. Panchanadikar, S. Choudhury and R.K. Mitra	Transactions of Indian Institute of Metals	Vol 48 No.2	1995	103-106
32	Biosorption of copper from copper industrial effluents - A case study	S.P. Mishra, P.K. Bisoi, E. Subudhi, G. Roy Chaudhury, R.N. Kar and **L.B.** Sukla	In S.R.S. Sastri, R.B. Rao, P.S.R. Reddy and H.S. Ray (Eds.) Indian Mineral Industry, Energy Environment and Resource Development, Allied Publishers, New Delhi	-	1995	385-390.
31	Bioleaching of lateritic nickel ore using some fungal species	**L.B. Sukla**, R.N. Kar, V.V. Panchanadikar, S. Choudhury and R.K. Mishra	In S.R.S. Sastri, R.B. Rao, P.S.R. Reddy and H.S. Ray (Eds.) Indian Mineral Industry, Energy Environment and Resource Development, Allied Publishers, New Delhi	-	1995	328-334

30	Bioleaching of Sukinda laterite using ultrasonics	**L.B. Sukla**, K.M. Swamy, K.L. Narayan, R.N.Kar and V.V Panchanadikar	Hydrometallurgy	Vol 37	1994	387-391
29	Heterotrophic microorganisms - A novel tool for mineral industries	G. Roy Chaudhury, R.N. Kar, V.V. Panchanadikar, **L.B. Sukla** and R.P. Das	In H.S. Ray and A.K. Mitra (Eds.) Utilization of Natural Resources - Chemical Eng. Approach, Wiley Eastern Ltd., New Delhi		1994	90-97
28	Bioleaching of copper converter slag using Aspergillus niger isolated from lateritic nickel ore	**L.B. Sukla**, R.N. Kar and V.V. Panchanadikar	International Journal of Environmental Studies, Sec-B, Env. Science and Technology (USA)	Vol 47	1993	81-86
27	Bioleaching of lateritic nickel ore using indigenous micro flora	**L.B. Sukla** and V.V. Panchanadikar	In A.E. Torma, J.E. Wey and V.I. Lakhmanan (Eds.) Biohydrometallurgy Techniques	Vol 1	1993	378-380
26	Bioleaching of Sukinda lateritic nickel ore using fungal strain	**L.B. Sukla,** R.N. Kar and V.V. Panchanadikar	In Recent Trends in Biotechnology, Ed. C. Ayyanna, Tata McGraw Hill Publishing Company Ltd.	-	1993	1258-1310
25	Bioleaching of Sukinda lateritic nickel ore using ultrasonic	**L.B. Sukla,** K.M. Swamy, K.L. Narayana, R.N. Kar and V.V. Panchanadikar	Proceedings of Hydrotech-93 held at RRL-Bhubaneswar, October 5-6	-	1993	-
24	Application of Ultrasonic in improvement of fungal strain	K.M. Swamy, **L.B. Sukla,**K.L. Narayana, R.N. Kar and V.V. Panchanadikar	Acoustics Letters (U.K)	Vol 17 No.3	1993	45-49
23	Microbial leaching of lateritic nickel ore	**L.B. Sukla,** V.V. Panchanadikar and R.N. Kar	World Journal of Microbiology and Biotechnology	Vol 9	1993	255-257
22	BioLeaching of lateritic nickel ore using a heterotrophic microorganism	**L.B. Sukla** and V.V. Panchanadikar	Hydro metallurgy (Elsevier/ Netherlands)	Vol 32	1993	373-379

21	Removal of heavy metals from mine water using sulphate reducing bacteria	R.N. Kar, B.N. Sahoo and **L.B. Sukla**	Poll. Res	Vol 11 No.1	1992	13-18
20	Bioleaching of Rajapura Dariba ore in 4 ton column	G. Roy Chaudhury, **L.B. Sukla,** R.P. Das, R.S. Sharma and S.C. Banawat	Metallugical Transacion -B	23/1	1992	91-93
19	Microbial leaching of lateritic nickel ore	**L.B. Sukla**, V.V. Panchanadikar and R.N. Kar	World Journal of Microbiology and Biotechnology	Vol 9	1992	255-257
18	Leaching of copper converter slag with Aspergillus niger culture filtrate	**L.B.** sukla**,** R.N. Kar, V.V. Panchanadikar	Bio Metals	Vol 5	1992	169-170
17	Bioleaching of Rajapura Dariba ore	G. Roy Chaudhury, **L.B. Sukla,** R.P. Das, R.S. Sharma and S.C. Banawat	International Mineral Processing Congress	Vol 5	1991	19
16	Biobenefication of limestone	R.N. Kar, G. Roy Chaudhury, **L.B. Sukla** and R.P. Das	Proc. 3rd ISBA	-	1991	155
15	Kinetics of iron oxidation as well as precipitation by Thiobacillus ferrooxidans inpresence and absence of various metal ions.	R.N. Kar, G. Roy Chaudhury, **L.B. Sukla** and R.P. Das	Erzmetall	Vol 44	1991	212
14	Bioleaching of Rajapura Dariba ore in small columns	G. Roy Chaudhury, **L.B. Sukla,** R.P. Das, R.S. Sharma and S.C. Banawat	Scandinavian Journal of Metallurgy	Vol 19	1990	269
13	Sulphation kinetics of zinc sulphide with ammonium sulphate and ammonium bisulphate	S.C. Panda, **L.B. Sukla** and P.K. Jena	Canadian Metallurgical Quarterly	Vol 29 No.2	1990	141-146
12	The effect of silver ion on the kinetics of biochemical leaching of chalco-pyrite concentrate	**L.B. Sukla**, G. Roy Chaudhury and R.P. Das	Transactions of Institute of Mining and Metallurgy (London), Sec. C	Vol 99 C-43	1990	C43-46
11	Utilization of low grade pyrite through bacterial leaching	G. Roy Chaudhury, **L.B. Sukla** and R.P. Das	International Journal of Mineral Processing	Vol 26	1989	275

10	Leaching of nickel and cobalt bearing lateritic overburden chrome ore in hydrochloric acid and sulphuric acid	**L.B. Sukla,** S.B. Kanungo and P.K. Jena	Transactions of Indian Institute of Metals	Vol 2 No.1	1989	27-35
9	Bacterial leaching of Rajapura Dariba zinc ores	G. Roy Chaudhury, **L.B. Sukla**, R.P. Das, R.S. Sharma and S.C. Banawat	Proc. ILZIC, 31.1	-	1988	
8	Preferential extraction of cobalt lateritic nickel ore or concentrate by leaching in aqueous sulphur dioxide solution	S.B. Kanungo, **L.B. Sukla** and P.K. Jena	Transactions of Indian Institute of Metals	Vol 41 No.6	1988	527-532
7	Kinetics of nickel dissolution from roasted laterites	**L.B.** Sukla and R.P. Das	Transactions of Indian Institute of Metals	Vol 40	1987	351-353
6	Leaching behavior of Sukinda Lateritic nickel ore with sulphuric acid	**L.B.** Sukla and R.P. Das	Transactions of Institute of Mining and Metallurgy (London)	Sec-C Vol 95	1986	C53-C55
5	Recovery of cobalt, nickel and copper from converter slag through roasting with ammonium sulphate and sulphidic acid	**L.B. Sukla,** S.C. Panda and P.K. Jena	Hydro metallurgy	Vol 16	1986	153-165
4	Kinetics of biochemical leaching of sphalerite concentrate	G. Roy Chaudhury, **L.B.** Sukla and R.P. Das	Metallurgical Transactions (USA)	Vol 16 B	1985	6677-6680
3	Low temperature Sulphation of some base metal sulphides	**L.B.** Sukla**, S.C. Panda P.K. Jena**	Transactions of Indian Institute of Metals	Vol 35 No.2	1982	62-166
2	Extraction of nickel through reduction roasting and ammonia cal leaching of lateritic nickel ores	S.C. Panda, **L.B. Sukla,** P.K. Rao, P.K. Jena	Transaction of Indian Institute of Metals	Vol 33	1980	162-165
1	Recovery of Metal values Through Segregation roasting of their ores	S.C. Panda, **L.B. Sukla**, Kanta Rao and P.K. Jena	Metals and Minerals Review	Vol Xviii, No.8	1978	299-30

Annexure V

Publications in Conference Proceedings

1. Application of improved BACFOX bioreactor technology for recovery of copper from low grade chalcopyrite through heap bioleaching. (2013) S.Panda, N.Pradhan, U.Mohapatra, **L.B.Sukla**. In proceeding of: Exploitation of lean grade ore,ore fines and urban ores:Challenges,problems and solutions(LGO-2013)
2. Bioremediation and bioleaching potential of multimetal resistant microorganism. (2013) A.P.Das, S.Swain, N.Pradhan**, L.B.Sukla**. In proceeding of: International Seminar On Mineral Processing Technology (MPT-2013)
3. Microbial processing of various low grade ores and wastes. (2013) **L.B.Sukla**.In proceeding of: International Seminar On Mineral Processing Technology (MPT-2013)
4. Pioneering dissimilatory iron reducing bacteria to enhance nickel extraction from chromite overburden. (2013) J.Esther, **L.B.Sukla**, N.Pradhan, B.K.Mishra. In proceeding of: International Seminar On Mineral Processing Technology (MPT-2013). Vol-II; 656-659
5. Potential of microorganisms for Metal nanoparticle bio-synthesis. **L.B.Sukla**, N. Pradhan, E.Priyadarshini, J.Jena. (2013) In proceeding of: 2nd International Conference on Tissue Engineering & Regenerative Medicines (ICTERM-2013)
6. Calcium Phosphate Nanoparticles Mediated Gene Therapy for Breast Cancer (2013) R.Mund, N.Panda, A.Biswas, **L.B.Sukla**. In proceeding of: 2nd International Conference on Tissue Engineering & Regenerative Medicines (ICTERM-2013)
7. C.K. Pani, L. Patnaiak, R.N. Kar, G. Roy Chaudhury and **L.B. Sukla.** (2002) Bioleaching of Sikkim lead concentrate in shake flasks as well as in bioreactor using Thiobacillus ferrooxidans. Proceeding International conference, 539-544
8. B. Bhattacharya, S. Acharya and **L.B. Sukla.** (2000)Bioleaching of zinc industry sludge.Proceedings of Mineral Processing, Waste and Environment Management, 162-169
9. **L.B. Sukla,** G. Roy Chaudhury, R.N. Kar, S.C. Panda, R.K. Paramguru and R.P. Das. (1999) A Process for recovery of manganese from low grade manganese ore through bioleaching method. Proceedings of International Symposium on Beneficiation, Agglomeration and Environment (ISBAN-99), Bhubaneswar, 20-22 January,216-221
10. **L.B. Sukla,** K.M. Swamy, K.L. Narayana, R.N. Kar and V.V. Panchanadikar (1993)Bioleaching of Sukinda lateritic nickel ore using ultrasonic. Proceedings of Hydrotech-93 held at RRL-Bhubaneswar, October 5-6

11. R.N. Kar, G. Roy Chaudhury, **L.B. Sukla** and R.P. Das. (1991) Biobenefication of limestone. Proc. 3rd ISBA,155
12. G. Roy Chaudhury, **L.B. Sukla**, R.P. Das, R.S. Sharma and S.C. Banawat. (1988) Bacterial leaching of Rajapura Dariba zinc ores. Proc. ILZIC, 31.1
13. A.P. Das, N.Pradhan, **L.B.Sukla** and S. Nayak. (2012) Fungal biomining of low grade manganese ore. XXVI International Mineral Processing Congress, IMPC-2012, New Delhi. 2; 645
14. N.Pradhan, R.R.Nayak, D.K.Mishra, E.Priyadarshini, **L.B.Sukla** and B.K. Mishra. (2012) Application of Iron reducing bacteria for recovery of nickel and cobalt chromite overburden. XXVI International Mineral Processing Congress, IMPC-2012, New Delhi. 1; 329

Annexure-VI

Patents

Sl. No	Title	Authors, Patent Number and Year
1.	A process for extraction of copper from chalcopyrite concentrate through bacterial leaching technique	L. B. Sukla, G. Roy Chaudhury and R. P. Das, 1994
2.	A process for the recovery of copper, nickel cobalt from converter slag through bacterial method	L. B. Sukla, R. N. Kar and V. V. Panchanadikar, 187882, 1994
3.	An improved process for the bacterial desulphurization of coal	L. B. Sukla and R. N. Kar, 1996
4.	Extraction of zinc from Sikkim zinc concentrate using *Thiobacillus ferrooxidans*	L. B. Sukla, R. N. Kar, G. Roy Chaudhury, C. K. Pani and L. Patnaik, 2000369/DEL/2002, 222211
5.	Microbial removal of Sulphur from lignite	C. Acharya, R. N. Kar and L. B. Sukla. V. N. Misra, 2005
6.	Microbial removal of Phosphorus from LD slag	L. B. Sukla, R. N. Kar, B. Das, N. Pradhan and V. N. Misra, 474/DEL/2004, 2006
7.	Extraction of manganese from Low grade manganese ore using **Pencillium citrinum**	C. Acharya, R. N. Kar, L. B. Sukla and V. N. Misra, 529/DEL/2004, 2006
8.	A process for extraction of nickel ore from lateritic nickel ore	L. B. Sukla & V. V. Panchanadikar, 185154, 2000
9.	An improved process for the recovery of manganese from manganese dioxide ore	P. K. Naik, L. B. Sukla and S. C. Das, 809/DEL/2004, 219858, 2007
10.	A process for obtaining highly stable silver colloidal solution with tunable particle size and shape using a strain Penicillium purpurogenum NPMF	N. Pradhan, R.R. Nayak, L.B.Sukla and B.K.Mishra (US Patent filled)

Annexure-VII

Books Edited

Sl. No.	Title	Authors	Publisher	Year
1.	Applied & Industrial Biotechnology	**Editors:L.B.Sukla,** Sundeep Panda, Jacintha Esther	Institute for Applied Environmental Biotechnology Innovation	2015
2.	Environmental Microbial Biotechnology	**Editors: L.B.Sukla,** N.Pradhan, S.Panda, B.K.Mishra	Springer ISBN-NO- 978-3-319-19017-4	2015
3.	Mineral Biotechnology	**Editors:** B. K. Mishra**, L. B. Sukla** and K.S. Rao	Institute of Minerals and Materials Technology, Bhubaneswar ISBN: 987-81-7525-814-3	2007
4.	Mineral Biotechnology	**Editors: L. B. Sukla** and V. N. Mishra	Allied Publisher , New Delhi ISBN: 81-7764-349-5	2002

Book Chapters

Sl. No.	Book	Chapter	Authors	Publishers	Year
26.	Applied & Industrial Biotechnology	Microbes in Acidic environments: Potential Biotechnological Tools Applied for Industrial Leaching of Metals	Sandeep Panda, Srabani Mishra, Nilotpala Pradhan, Lala Behari Sukla	Institute for Applied Environmental Biotechnology Innovation	2015
25.	Applied & Industrial Biotechnology	Microbial Beneficiation: An Effective Alternative for Utilization of Low Grade Iron Ore	M. Mishra, R.C. Mohanty, L.B. Sukla	Institute for Applied Environmental Biotechnology Innovation	2015
24.	Applied & Industrial Biotechnology	Biometallurgy: Greener Technology for Mineral Recovery from Wastes	A.P. Das, S. Ghosh, S. Mohanty and L.B. Sukla	Institute for Applied Environmental Biotechnology Innovation	2015
23.	Environmental Microbial Biotechnology	Microalgae: Cultivation and Application	V.Aishvarya · J.Jena · M.Pradhan · P.K.Panda · L.B.Sukla	Springer,ISBN: 978-3-319-19017-4, pp-289-312	2015
22.	Environmental Microbial Biotechnology	Advances in Manganese Pollution and Its Bioremediation	A.P.Das · S.Ghosh · S.Mohanty · L.B.Sukla	Springer,ISBN: 978-3-319-19017-4, pp-313-328	2015
21.	Environmental	Neutrophilic Bacteria in	Jacintha Ester ·	Springer,ISBN:	2015

	Microbial Biotechnology	Iron Mineral Transformation and Their Applications	Lala Behari Sukla	978-3-319-19017-4, pp-159-178	
20.	Environmental Microbial Biotechnology	Microbe–Mineral Interactions: Exploring Avenues Towards Development of a Sustainable Microbial Technology for Coal Beneficiation	Srabani Mishra · Sandeep Panda · Nilotpala Pradhan · Lala Behari Sukla Surendra Kumar Biswal · Barada Kanta Mishra	Springer,ISBN: 978-3-319-19017-4, pp-33-52	2015
19.	Microbiology for Minerals, Metals, Materials and the Environment	Application of Microbes for Metal Extraction from Mining Wastes	Sandeep Panda, Srabani Mishra, Nilotpala Pradhan, Umaballav Mohaptra, Lala Behari Sukla and Barada Kanta Mishra	CRC Press, pp-no-208-229 ISBN: 978-1-4822-5729-8 DOI: 10.1201/b18124-9	2015
18.	Industrial and Environmental Biotechnology	Microbial Mining through Heap Leach Technology	S.Panda, S.Mishra, N.Pradhan, U.B. Mohapatra, B.K. Mishra and **L..B.Sukla**		2014
17.	Geomicrobiology and Biogeochemistry **Editors:** N. Parmar and A. Singh	Microbial Recovery of Nickel from Lateritic (Oxidic) Nickel Ore: A Review	**L.B.Sukla,** S. K. Behera, N. Pradhan	Springer-Verlag Berlin Heidelberg ISBN: 978-3-642-41836-5	2014
16.	Environmental Technology	Large scale cultivation of Brackish water isolates *Scenedesmus* sp. in raceway pond for biodiesel production	**L.B. Sukla**, Manoranjsn Nayak, Jayashree Jena et. al.	Daya Publishimg House, New Delhi	2013
15.	Microbial Biotechnology **Editors:** Dr. B.B. Mishra, Dr. H.N. Thatoi	Application of Phosphorus Solublizing Micro-organism in Biomineral Processing	N. Pradhan & **L.B. Sukla**	A.P.H Publishing Corporation, New Delhi	2010
14.	Energy Technology Perspective **Editors:** Neale R Neelameggham, Ramana G. Reddy, Cyynthia K. Belt and Edgar E. Vidal	Microbial Reduction of Lateritic Nickel ore for Enchanced Recovery of Nickel and Cobalt Through Bio-hyderometallurgical Route	**L.B. Sukla**, B.K. Mishra, N. Pradhan, R.K. Mohapatra, B.K. Mohapatra, B.D. Nayak	TMS (The minerals, metals & materials Society)	2009

13.	Mineral Characterisation and processing **Editors:**Vibhuti N. Mishra, P.S.R. Reddy, B.K. Mohapatra	Microorganisms as Tools for Mineral Processing	**L.B. Sukla** & V.N. Mishra	Allied Publishers Private Limited	2004
12.	Pollution in urban industrial environment **Editors:** S.N. Das, Y.V. Swamy, K.K. Rao, V.N. Misra	Biochemical Characteristics of Native Microorganisms Isolated from Sukinda Chromite Overburden	N. Pradhan,R.N. Kar, **L.B. Sukla** & V.N. Mishra	Allied Publishers Private Limited	2004
11.	Computer Application in Minerl Industry **Editors:** K.K. Rao, P.S.R. Reddy, Vibhuti N Misra	Sulphur Removal Estimation with Thiobacillus Sp. using Neural Networks	C. Acharya, S. Mohanty and **L.B. Sukla**	Allied Publishers Private Limited	2003
10.	Advances in Materials and Materials Processing **Editors:** N. Chakraborti, U.K. Chatterjee	Bioleaching of sikkim lead concentrate in shake flasks as well as in bioreactor using Thiobacillus Ferrooxidansi	C.K. Pani, L. Patnaik, R.N. Kar, G.Roy Chaudhury and **L.B. Sukla**	Tata McGraw-Hill Publishing Company Limited	2002
9.	Advances in Materials and Materials Processing **Editors:** N. Chakraborti, U.K. Chatterjee	Microscopic studies to evalute the leading rates of different sulphides minerals present in sphalerite concentrate during bioleaching	L. Patnaik,C.K. Pani, B.K. Nayak, B.C. Acharya, G.Roy Chaudhury, R.N. Kar and **L.B. Sukla**	Tata McGraw-Hill Publishing Company Limited	2002
8.	Ecotoxicology and Environmental Safety on the Verge of the Third Millennium: Trends, Threats and Challenges **Editors:** I. Twardowska, E. Kmiecik	Bioleaching of Fly Ash	**L.B. Sukla**, S. Swain, B.N. Sahoo and R.P. Das	Secotox	2001
7.	Indian Mineral Industry, Energy Environment and Resource Development **Editors:**S.R.S. Sastri, R.B. Rao, P.S.R. Reddy and H.S. Ray	Biosorption of copper from copper industrial effluents - A case study	S.P. Mishra, P.K. Bisoi, E. Subudhi, G. Roy Chaudhury, R.N. Kar and**L.B. Sukla**	Allied Publishers, New Delhi	1995

6.	Bio hydro-metallurgical Processing **Editors:** C.A. Jerez, T. Vargas, H. Toledo and J.V. Wiertz	Biosorption of heavy metals on the*Aspergillus niger* biomass	P.K. Bisoi, S. Acharya and**L.B. Sukla**		1995
5.	Bio hydro-metallurgical Processing **Editors:** C.A. Jerez, T. Vargas, H. Toledo and J.V. Wiertz	Extraction of cobalt and nickel from lateritic nickel ore using *Rhizopus arrhizus*	R.N. Kar, **L.B. Sukla,** V.V. Panchanadikar, S. Choudhury and R.K. Mishra		1995
4.	Indian Mineral Industry, Energy Environment and Resource Development **Editors:** S.R.S. Sastri, R.B. Rao, P.S.R. Reddy and H.S. Ray	Bioleaching of lateritic nickel ore using some fungal species	**L.B. Sukla,** R.N. Kar, V.V. Panchanadikar, S. Choudhury and R.K. Mishra	Allied Publishers, New Delhi	1995
3.	Utilization of Natural Resources - Chemical Eng. Approach **Editors:** H.S. Ray and A.K. Mitra	Heterotrophic microorganisms - A novel tool for mineral industries	G. Roy Chaudhury, R.N. Kar, V.V. Panchanadikar,**L.B. Sukla** and R.P. Das	Wiley Eastern Ltd., New Delhi	1994
2.	Biohydrometallurgy Techniques **Editors:** A.E. Torma, J.E. Wey and V.I. Lakhmanan	Bioleaching of lateritic nickel ore using indigenous micro flora	**L.B. Sukla** and V.V. Panchanadikar	Warrendale, UK: Minerals, Metals and Materials Society	1993
1.	Recent Trends in Biotechnology **Editors:** C. Ayyanna	Bioleaching of Sukinda lateritic nickel ore using fungal strain	**L.B. Sukla**, R.N. Kar and V.V. Panchanadikar	Tata McGraw Hill Publishing Company Ltd.	1993

Activities of Institute for Applied Environmental Biotechnology Innovation(IAEBI)

1. Seminar and Workshops

a) Seminar on Bioremediation-28th March 2015.

The Institute For Applied Environmental Biotechnology Innovation was inaugurated on 28 th March 2015. The details about Inauguration of the In published in 1st April 2015 Samaj. Unlike many other scientific fields, the area of Applied Environmental Biotechnology has been gaining momentum with aid of novel technology. Bioremediation Seminar was organised during inauguration of the institute. Dr.R.C. Mohanty, Emiritus Scientist Utkal University, Vani Vihar gave the inauguration lecture. Prof.L.B.Sukla gave a lecture on future plan in the area of Environmental Biotechnology. The Institute completed Seminar on "Bioremediation" on 28th March 2015. A seminar Proceeding volume was released by the Chief Guest **Prof. R.C. Mohanty,** Emeritus Professor, Utkal University. Dr Celin Acharya, scientist BARC delivered the guest Lecture on "**Microbial Bioremediation of Uranium**".Eminent Scientists, Engineers and students from various institution like BARC, Mumbai, Utkal University, CSIR-IMMT, SOA university, NIT-Rourkela attended the seminar.

b) World Environment day Celebration.-5th June 2015.

Institute has organised World Environment Day on 5th June 2015. On this occasion, Institute had organised activities like photo contest on environmental sustainability among school children, release of book on biotechnology and plantation of trees in the premises of the institute. The Institute had received 20 photos from different schools in around Bhubaneswar. These photos were judged by expert in the area and 1st,2ndand 3rd prizes were given to students. The book on Environmental Biotechnology was released on this occasion. The book contains a set of review papers related to bioleaching, bioremediation,biofuels and aommon scientific principles.

c) Workshop on Microbiology in the development of Sustainable Technology - 26th July 2015.

Biomineral processing is considered beneficial over the conventional pyro and hydro-metallurgical methods employed in the field as later have several drawbacks such as exhaustive use of energy, high capital investment; require high technological outlay; high temperature and pressure; effective only with specific grade ores and environmental concerns with effluent discharge. Hence, scientist and researchers have taken emmensse steps to provide suitable, effective biomineral processing technologies. With the economic development, the demand for various metals are on the rise.However, due to extensive mining and extraction in these past years, there is depletion of high-grade ores.Hence, there exists a look-out for alternative sustainable technologies to extract metals from low-grade ores. The intervention of indigenous microbes have reported to provide potential extraction methods.Hence, through this workshop, we would like to enlighten and motivate young minds with the understanding of mineral industry and the need for sustainable technologies.

The summary of the document will include fundamental of bioleaching and its application in different wide ranging ores, wastes etc. Our Institute is to play a key role in the future of Biomineral processing. The workshop will provide a basis for understanding of mineral biotechnology process in great detail.

d) 2nd Carbon Sequestration Seminar 2015 On Role of Microalgae in Developing A Sustainable Society (RMDSS -2015)

Role of Microalgae in Developing A Sustainable Society (RMDSS -2015) was jointly organised by State Pollution Control Board, Odisha, Indocan Technology Solutions, The Institute Of Engineers(India), Institute For Applied Environmental Biotechnology Innovation,17th December, 2015 at Bhubaneswar".

The national level seminar is dedicated to dissemination of advanced knowledge in the area of microalgae based carbon sequestration from flue gas and further bio-refinery

technologies for utilizing the biomass. It is designed to provide a strong platform to the stakeholders; policy-makers, professionals, academicians, industrialists and regulators to facilitate exchange of latest scientific achievements for the benefit of the region, particularly, for the state of Odisha which is sitting on an expansive coal reserve and is under tremendous pressure for generating more and more thermal power.Chief Guest Shree T. K. Chand, CMD, NALCO; inaugurated the seminar with lighting of the lamp. He expressed his persistent efforts on low carbon manufacturing technologies and interests on contributing to the global efforts on sustainable growth. He admired the initiative taken by NALCO – CPP and the objectives achieved at the India's 1st pilot plant on carbon sequestration using microalgae, and further, encouraged to scale-up of the plant to facilitate application in commercial scale in other industries.Shree Siddhanta Das, (IFS), Addl. PCCF, Chaired and presided the inaugural Session**,** delivered the Plenary Talk on "Emission Reduction Technology Demonstration Plant at NALCO".He further emphasised the urgent need to adopt promising technologies in India to minimise global climate change in India. He appreciated the attempts taken by NALCO for its efforts to contribute to the regions climate change action plan.Shree Rajiv Kumar, (IFS) Member Secretary, State Pollution Control Board, Odisha, Guest of Honor, advocated on the urgent need of "reducing Green House Gas emission" and "green technologies". He stressed on the states Climate Change Action Plan Mandates and the support of Odisha governments policy towards the cause.Dr. T. Venugopalan, Technical Adviser to MD, Tata Steel Limited and Guest of Honor to the seminar advocated and explained various carbon capture and sequestration technologies being developed globally. He further asserted the commitment of Tata Steel towards adopting the sustainable technologies for the purpose.Shree Siddhanta Das, (IFS), Addl. PCCF, Receiving the "Bias for Action" Award for Climate Change Action Plan 2015.Nalco Director (Prod.), V. Balasubramanyam and AGM, S. K. Naik Received the "Proactive Climate Change Action Industry Award" for NALCO - CPP.Prof. Ranjan R. Pradhan Convener of 2nd Carbon Sequestration Seminar, proposed the "Vote of Thanks" and explained the theme of the seminar and the objectives to the guests, invited speakers and

participants during the Inaugural Session. During Technical session made a presentation on India's 1st Microalgae Based Carbon Sequestration Plant at NALCO; Process and Impacts.

Technical Session ,I (Invited Speakers) Chaired by : Convenor, Prof. L. B. Sukla, (Director, Institute for Applied Environmental Biotechnology Innovation, Bhubaneswar.During technical session Prof.Sukla made a presentation on MicroAlgae Technology For Environment Management.The agenda for 2nd carbon sequestration is available in the website. http://4css.in/2nd/agenda.php

2. Paper Published

- Molecular cloning and expression of lipase and its application for biodiesel production. Rajesh Kumar Sahoo, Enketeswara Subudhi, Lala Behari Sukla, Mohit Kumar,At: Trivandrum, Kerala, , Ordinal: BR40, Conference: New Horizons in Biotechnology 2015, Affiliation: National Institute for Interdisciplinary Science & Technology (NIIST), Poster Â· November 2015.

DESCRIPTION

Biodiesel is a mixture of mono-alkyl esters or fatty acid methyl esters produced from vegetable oils, animal fats, waste cooking oil by using transesterification process in the presence or absence of catalysts and has the similar property of petroleum-based fuel, Metagenomics overcomes the disadvantages of isolation and cultivation procedures of the traditional microbial method, and thus greatly broadens the space of microbial resource utilization. Odisha finds a position in the thermophilic map of India being bestowed with four clusters of thermophilic hot springs namely ATRI,TAPTAPANI, TAROBALO and DEULJHARI and expected to be conferred with an unexplored microbial strain which could be a possible source of novel enzymes. In this work using functional metagenomic, solvent tolerant lipase is retrieved from Taptapani hotspring with the potential to biodiesel using vegetable oil.

https://www.researchgate.net/publication/287948478_Molecular_cloning_and_expression_of_lipase_and_its_application_for_biodiesel_production

- Molecular identification of indigenous manganese solubilising bacterial biodiversity from manganese mining deposits by Shreya Ghosh, Sansuta Mohanty, Sanghamitra Nayak, Lala B. Sukla and Alok P. Das Journal of Basic Microbiology , 16 October 2015 Full publication history,
  Doi: 10.1002/jobm.201500477

ABSTRACT

Manganese (Mn) ranks twelfth among the most exuberant metal present in the earth's crust and finds its imperative application in the manufacturing steel, chemical, tannery, glass, and battery industries. Solubilisation of Mn can be performed by several bacterial strains which are useful in developing environmental friendly solutions for mining activities. The present investigation aims to isolate and characterize Mn solubilising bacteria from low grade ores from Sanindipur Manganese mine of Sundargh district in Odisha state of India. Four morphologically distinct bacterial strains showing visible growth on Mn supplemented plates were isolated. Mn solubilising ability of the bacterial strains was assessed by visualizing the lightening of the medium appearing around the growing colonies. Three isolates were gram negative and rod shaped while the remaining one was gram positive, coccobacilli. Molecular identification of the isolates was carried out by 16S rRNA sequencing and the bacterial isolates were taxonomically classified as Bacillus anthrasis MSB 2, Acinetobacter sp. MSB 5, Lysinibacillus sp. MSB 11, and Bacillus sp. MMR-1 using BLAST algorithm. The sequences were deposited in NCBI GenBank with the accession number KP635223, KP635224, KP635225 and JQ936966, respectively. Manganese solubilisation efficiency of 40, 96, 97.5 and 48.5% were achieved by MMR-1, MSB 2, MSB 5 and MSB 11 respectively. The efficiency of Mn solubilisation is suggested with the help of a pH variation study. The results are discussed in relation to the possible mechanisms involved in Manganese solubilisation efficiency of bacterial isolates.

- Sequential bioreduction bioleaching and bioreduction chemical leaching hybrid tests for enhanced copper recovery from a concentrator ball mill reject sample.

Sandeep Panda · Jacintha Esther · Tilothama Bhotra · Nilotpala Pradhan · Lala Behari Sukla · Barada Kanta Mishra · Ata Akcil,
Journal of Hydrometallurgy 2015, 157, PP: 171-177

- Bio-beneficiation of iron ore using heterotrophic microorganisms.

Sitharashmi Sahu, Madhushree Kundu, Lala Behari Sukla, Journal of Microbiology and Biotechology Research 2015, 5 (2), PP: 54-60

- Enhanced recovery of nickel from chromite overburden (COB) using Dissimilatory Fe (III) reducers: A novel Bio-Reduction Acid Leaching (BRAL) approach, Jacintha Esthera, Sandeep Pandaa, Lala Behari Suklaa, Nilotpala Pradhana, Chinmaya Kumar Sarangia, Tondepu Subbaiaha published at Hydrometallurgy Journal, Available online 29 April 2015, 155 PP:110-117.

- Reductive dissolution by waste newspaper for enhanced meso-acidophilic bioleaching of copper from low grade chalcopyrite: A new concept of biohydrometallurgy, .Sandeep Panda · Avijit Biswal · Srabani Mishra · Prasanna Kumar Panda · Nilotpala Pradhan · Umaballava Mohapatra · Lala Behari Sukla · Barada Kanta Mishra · Ata Akcil , Journal of Hydrometallurgy (Impact Factor: 2.22) 2015 153 PP:98-105.

3. Book Published

- Book on "Applied & Industrial Biotechnology" has been published. Editors Lala Behari Sukla, Sandeep Panda, Jacintha Esther.

This book "Applied & Industrial Biotechnology" was recently published by the Institute for Applied Environmental Biotechnology Innovation, Bhubaneswar, India. Articles were invited from scientists and academicians working in the various fields of microbiology, biotechnology, Environmentalists, chemists and related areas; were compiled and presented in the present book as an edited volume. This book contains a set of review papers mainly on topics which are new application for bio leaching, bio remediation, bio surfactants, bio fuels, from lignocelluloses biomass, different aspects of environmental biotechnology that are already practiced by industries chemical industries, in particular, GIS based mapping and common scientific principles etc.There are eleven chapters in this book.

4. Book chapter published/submitted

S. Ghosh, S. Mohanty, L.B. Sukla And A.P. Das

Biomining: An Emerging Technology for Manganese Recovery and Recycling, Chapter-2

"Recent Biotechnological Applications in India",

by ENVIS Centre on Environmental Biotechnology supported by Ministry of Environment Forest and Climate Change (MoEF & CC), GoI to be published (2016).

ABSTRACT

Biomining is defined as the technologies that utilize microbial community for the extraction of metals from its ore or wastes and facilitate a greener recovery. Extraction of manganese by biomining is now a thing of the present and not just a hypothesis, as it was few decades back. The severe industrial importance of manganese has led to augmented global production of manganese in the last few years which has led to a decrease in the amount of high grade ores. It has also resulted in pollution of both terrestrial and aquatic ecosystems due to the generation of massive amounts of manganese containing wastes. Therefore, biomining is now being employed to recover manganese low grade ores and solid mining wastes which serve a dual purpose of both resource recycling and bioremediation. Manganese bio recovery can be accomplished by a wide range of bacterial and fungal strains capable of growing under diverse environmental conditions. They solubilise manganese by direct and indirect mechanisms thereby aiding its recovery. Bacterial solubilisation is mainly carried out by direct mechanism which involves the direct contact of the cell with the metal. However fungal solubilisation is mostly correlated with indirect mechanism which does not require direct contact of the cells with metal particles and involves solubilisation by the help of bio generated metabolites that mainly includes

organic acids. Many enzymes like Muilticopper oxidase, Manganese reductase and Peptidyl-prolyl-cis-trans isomerise have been linked to manganese solubilisation. The present scenario of commercial manganese recovery through booming is very encouraging and this technology holds immense potential for future metal recovery and bioremediation endeavours.

5. Paper Presented In Seminar

- Inaugurations talk on bioremediation, Seminar on Bioremediation-28th March 2015.
- Bio mineral processing of low grade ores and industrial wastes, workshop on microbiology in the development of sustainable technologies-26th July 2015.
- The role of microorganisms and their significance in treatment of mine and industrial waste for metal recovery at International Symposium on solid wastes from industries, rural and urban settlements – issues, challenges and management, 23rd-25th sep 2015,Bhubaneswar.(Invited Talk), Chaired a Session.
- Importance of low-cost bioleaching technologies for the extraction of metals from low-grade ores and wastes L.B.Sukla and T. Subbaiah, International conference on recent advances in biosciences and application of engineering in production of biopharmaceuticals, 14th -16th Dec 2015, KL university.

6. Papers Communicated

- Molecular cloning and expression of lipase and its application for biodiesel production, Bio resource Technology.

Papers are regularly referred in many of the important reviews. (https://scholar.google.co.in/citations?user=SaflpMUAAAAJ&hl=en)