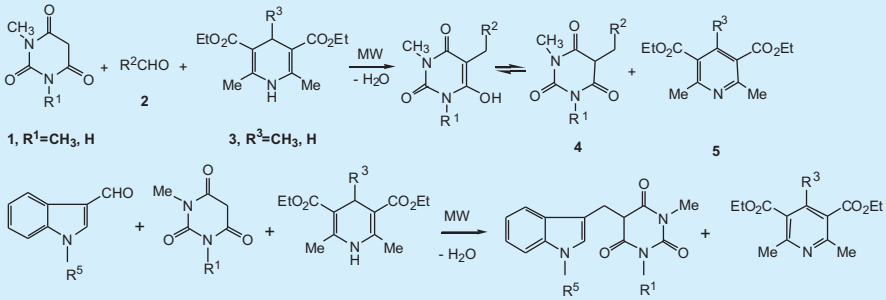
Significant Achievements:

Green approach for the synthesis of various 5-benzylated/alkylated barbituric acids

A green, atom economy and environment friendly process for the synthesis of various 5-bezylated/alkylated barbituric acids and 3-alkylated indoles. It is worth mentioning that only water is eliminated during the reaction process and, in most cases, water is used as solvent in the work-up procedure separating the products by simple filtration. The reaction also demonstrates a process of oxidative aromatization of Hantzsch 1,4-dihydropyridines (Scheme 2).



1, R^1=CH_3, H 2 3, R^3=CH_3, H 4 5

7. R^5 = Me, H 1. R^1 =Me, H 3 9a-d 5

Scheme 2

Network Projects

Development of sustainable processes for edible oils with health benefits from traditional and new resources

PI & Members:
Dr SC Nath
Dr DK Dutta
Mrs R Kotoky

Objectives:

- ✓ Screening of oilseeds for oil content and fatty acid composition.
- ✓ The present proposal aims to conduct a detailed study on the screening of new and lesser known oilseeds preferably tree borne available in different parts of the country to save a sizeable amount of foreign exchange.

Network Projects

Development of sustainable waste management technologies for chemical and allied industries (SETCA) (Nodal Laboratory: CSIR-IICT)

CSIR-NEIST: Environment Friendly Measures of Disposal and Recovery of Solid Deposits from the Strainers and Other Sources Crude Oil Pumping Stations and Pipelines-DIRESCOP)

PI & Members :
Mr S C Kalita PI
Mr J J Bora Co-PI

Member
Mr Dipankar Neog
Dr B P Baruah
Dr B K Saikia

Funding Agency:
CSIR, New Delhi

Objectives:

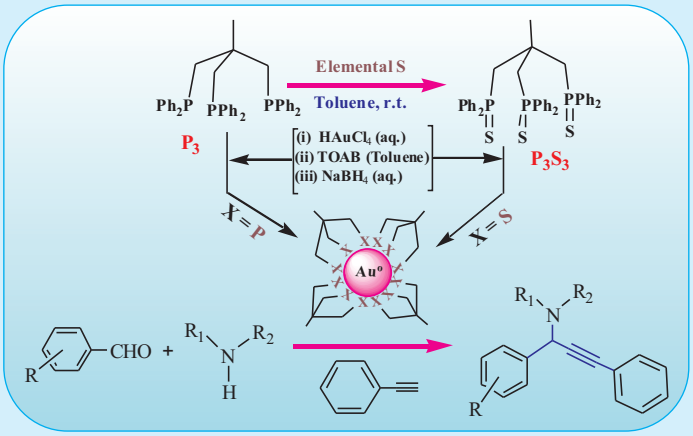
- ✓ Determination of physical and chemical properties of deposited solids of high API gravity crude oil obtained from strainers and other sources of crude oil pumping station.
- ✓ Development of process for cleaning of strainers / removal of solid deposits.
- ✓ Design and Development of suitable device for recovery of different constituents of solid deposits for commercial exploitation.

Significant Achievements:

The wax deposition mechanism is highly dependent on the rheological properties of the crude flowing in the pipelines, strainers and other sources of crude oil pumping stations. To understand the basic rheological properties, crude oil samples and solid deposit (wax) samples are collected at different locations of crude transmitting pipelines and crude storing tanks. It is observed from the Gas Chromatography (GC) results of the samples of solid deposits are dominated by heavy molecular weight carbon compounds (C-17 to C-39) and the crude samples are mixture of both light and heavy carbon compounds.

	In addition it is also to be mentioned that order is placed for the procurement of equipment and required consumables for fabrication of experimental setup. Hired manpower is also selected to carry out the project activity.
Network Projects	**Biomass of energy (BioEn) (Nodal Laboratory: CSIR-IIP)**
CSIR-NEIST: Screening of efficient algal species from North-East India for biomass culture to be utilized for biofuel/biodiesel production. **PI & Members :** Dr HP Deka Boruah, Nodal Scientist Member Dr TC Borah Dr R Saikia Dr Pinaki Sengupta **Funding Agency:** CSIR, New Delhi	**Objectives:** ✓ Selection, collection of efficient algal species from North –East India for biofuel production ✓ Culture of algal species and standardize the parameters for maximum biomass production. ✓ Mass culture production in photobioreactors and in natural condition ✓ Mass culture production for biomass and harvesting of cells for the concern laboratory for biofuel / biodiesel production. **Significant Achievements:** Media optimisation for isolation and screening of micro algae was done. Few species were screened and study of nature of growth is under progress.
Network Projects	**New Generation lubricants and additives (GENLUBE)**
PI & Members: Dr SD Baruah PI Member Dr A Borthakur Mr NC Laskar Mr A Sarmah Mr RC Bohra Mr L Phukan **Funding Agency:** CSIR, New Delhi	**Objectives:** ✓ To develop environmental friendly biodegradable base oils stock from non edible vegetable oils for industrial use. ✓ To develop epoxidized vegetable oil based high temperature lubricants **Significant achievements:** Project sanctioned recently. Initiated R&D works thereafter.
Network Projects	**Catalysts for Specialty Chemicals (CSC)**
PI & Members: Dr Dipak Kumar Dutta PI Member Dr Dilip Konwar Dr Lakshi Saikia Dr Pinaki Sengupta Dr Bibek Jyoti Borah **Funding Agency:** CSIR, New Delhi	**Objectives**: ✓ To develop Nanostructured (0.1-100 nm) (nanoparticles and nanoporous) catalysts based on metals and metal oxides and their evaluation in important industrial organic reactions. ✓ Development of cellulose templates (pores 10-30 nm) based novel nanoparticles for heterogeneous, stable, reusable catalysts for organic synthesis particularly *Green* synthesis of important drugs/drug precursors. ✓ Development of some cheaper and efficient homogeneous catalysts or catalytic processes for hydrogenation and carbon-carbon bond formation reactions for the synthesis of industrially important organic compounds based on non-precious metal (Ni, Ru etc.) complexes of hemilabile ligands. **Significant Achievements:** Multifunctional phosphine stabilized gold nanoparticles: An active catalytic system for three-component coupling reaction.

Multifuctional phosphine based ligands, 1,1,1-tris (diphenylphosphinomethyl) ethane [$CH_3C(CH_2PPh_2)_3$] [P_3] and 1,1,1-tris (diphenylphosphinomethyl) ethane trisulphide [$CH_3C(CH_2P(S)Ph_2)_3$] [P_3S_3] have been introduced to stabilize Au°-nanoparticles having small core diameter and narrow size distribution. The Au°-nanoparticles exhibit face centered cubic (fcc) lattice having different crystalline shape i.e. single crystallite stabilized by P_3 while P_3S_3 forms decahedral shapes. The synthesized Au°-nanoparticles serve as an efficient catalyst for one-pot, three-component (A^3) coupling of an aldehyde, an amine and an alkyne *via* C-H alkyne-activation to synthesize propargylamines (85 - 96%) without any additives and precaution to exclude air.



Network Projects	Natural products as affordable healthcare agents (NaPAHA)

Part A :
"Clean Technology for pulp processing"

PI & Members:
Dr MJ Bordoloi

Funding Agency:
CSIR, New Delhi

Network Projects	Environmental Research Initiative for paper and process industry (ERIPP)

PI & Members:

Dr T Goswami	PI
Dr Amrit Goswami	CoPI
Dr T C Bora	CoPI

Member
Dr P Sengupta
Dr SC Nath
Mr P Barkakati
Mr NC Gogoi
Dr HP Dekabaruah
Dr Ratul Saikia
Dr SP Saikia
Dr (Ms) S Hazarika
Dr D Kalita

(a) Objectives :
Isolation, identification, characterization and screening of suitable microbial strains from different niches against different lignocellulosic materials for their lignolytic activity and development of green biochemical/chemical process for pulp and other value added aromatics preparation.

Significant Achievements :
It is a new network project funded by CSIR for 12 FYP. The work of the project has started recently. The CSIR- NEIST is the nodal lab for this project and the participating labs are CSIR-NIIST, CSIR- CLRI, CSIR- CSMCRI, CSIR-IMTECH and CSIR- IMMT. The first Interactive meeting with all participating labs- CSIR- CLRI, CSIR- IMTECH, CSIR- NIIST, CSIR- IMMT, CSIR-NEIST and CSIR- CSMCRI was organized at CSIR- NEIST during 21-23 January 2013. Dr T Goswami, Nodal Scientist of the ERIPP project presented the overview of the project and work done by CSIR- NEIST for 2012-13. The work

Dr M R Das
Dr Pallab Pahari
Mr OP Sahu
Mr A C Kakoty
Mr D Dutta
Dr M M Bora
Mr S Borthakur
Mrs Archana Yadav
Mr T Das

Project Fellow
Ms Momona Siring
Ms Ritasree Sarma
Ms Paranjali Baruah
Ms Pallabi Duarah
Mr D J Bora
Mr Rupjyoti Hazarika
Mr P P Kalita

proposed for 2013-14 was also discussed in the meeting. The activities of other participating labs were presented separately by the PI of the participating labs. The future plan of work and possible networking areas were also discussed elaborately. Dr AK Baruwa, Former Director ASTEC and Principal NITS, Mirza, Guwahati and Dr PN Mohan Das, Former Scientist G, CSIR- NIIST chaired two session of the meeting.

Meeting in progress

(b) Clean Technology for pulp processing

Objectives:

- ✓ Collection of samples (rotten Bamboo from Jagiroad paper mill's stacking site) aseptically in sterile poly bags and isolation of strains having lignin degrading ability.
- ✓ Screening and short-listing ligninolytic strains with hypocellulolytic activities.
- ✓ Improvement of the strains and their optimization in collaboration with IMT, Chandigarh.
- ✓ Optimization of enzymes suitable for bio-pulping & development of green biochemical process.
- ✓ Application in proper substrate using bioreactor facility.

(c) 'Oxidative transformation of lignin/degraded lignin products generated from microbially treated lignocellulosic materials' for value addition

Objectives:

Development of green biochemical/chemical process for the preparation of value added aromatics such as vanillin etc from lignin/ degraded lignin generated during microbial/ green, chemical delignification of lignocellulosic materials for paper and pulp processing.

Significant Achievements :

In order to initiate the activities, black liquor that contains lignin and degraded lignin components along with different inorganics generated in the conventional Kraft Process was collected from the Jagiroad Paper Mill under HPC. After separation of the inorganics the organic components were attempted to separate through chromatographic techniques. Few components have been separated, identified and oxidative transformations of such components are in progress using green chemicals.

(d) Technology Initiatives for Utilization of Iron Oxide Waste from Titanium Processing Industries

Objectives:

- ✓ Development of iron-oxide and oxy(hydroxide) nanopowder and modification of surface properties for removal/arresting of the toxic ions, bacteria and protozoa for the water purification.
- ✓ Self-assembly noble metal and metal oxide nanoparticle onto iron-oxide and oxy(hydroxide)/clay to reduce the bacteriological contaminants of the drinking water.

Significant Achievements :

Magnetite powder as model sample of iron oxide was ground in a planetary mill and the milling time and mill rotational speed were varied. The ground products were then characterized to investigate crystallite size reduction by X-ray diffraction line broadening.

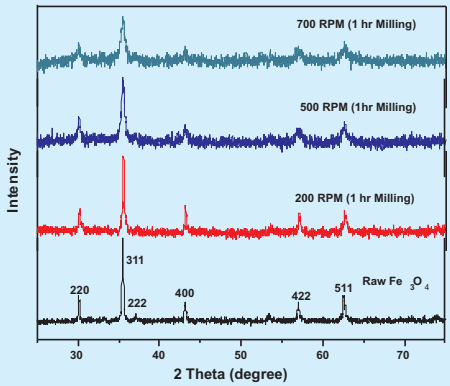


Fig. XRD pattern of Fe_3O_4 after ball milling at different RPM

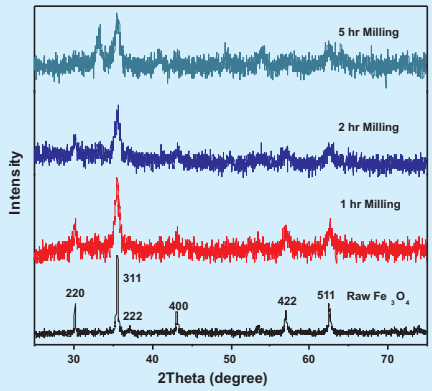


Fig. XRD pattern of Fe_3O_4 after ball milling at 700 RPM at different time interval

Network Projects

Speciality Materials Based on Engineered Clays (SPECS)

PI & Members:
Dr Dipak Kumar Dutta PI

Member
Dr Lakshi Saikia
Dr Pinaki Sengupta
Dr Bibek Jyoti Borah

Funding Agency:
CSIR, New Delhi

Objectives:

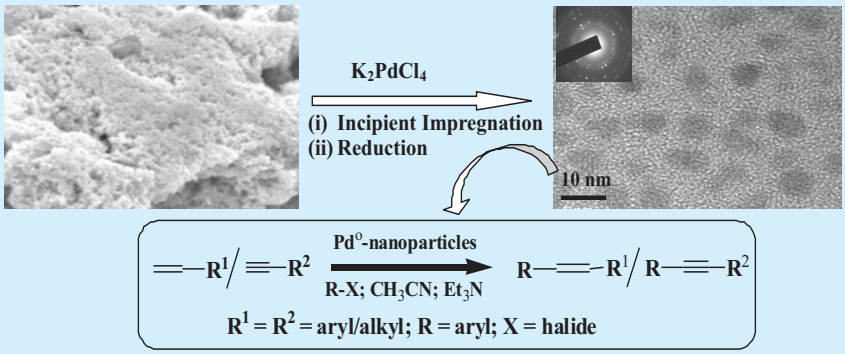
- ✓ Development of supported / intercalated / intersalated Montmorillonite clay based layered composites.
- ✓ Development of non-layered nanoporous (micro- and mesoporous) Montmorillonite clay matrix.
- ✓ Application of modified Montmorillonite clay as catalyst and catalyst supports for important industrial organic reactions such as Esterification, Alkylation, Isomerization, Diels-Alder reactions, Coupling reactions, Multi-component coupling reactions and for adsorption study.

Significant Achievements :

***In situ* stabilization of Pd°-nanoparticles into Montmorillonite Clay: Efficient heterogeneous catalysts for Heck and Sonogashira coupling reactions**

In situ generation of Pd°-nanoparticles into the nanopores of modified Montmorillonite and their catalytic performance in carbon-carbon bond formation namely Heck and Sonogashira reactions, have been carried out. The modification of Montmorillonite was carried out by activating with H_2SO_4 under controlled conditions for generating nanopores on the surface, which act as a 'Host' for Pd°-nanoparticles and was prepared by loading of K_2PdCl_4 metal precursor through incipient wetness impregnation technique followed

by reduction with hydrazine hydrate. The supported metal nanoparticles serve as efficient heterogeneous catalyst for the Heck coupling reaction in which the vinylation of aryl halides with olefins result cross-coupling products with maximum 96% isolated yield and > 99% *trans* selectivity while in the alkynylation of aryl halides with terminal alkynes i.e. in Sonogashira coupling reaction, a maximum of 94% isolated yield with 100% selectively cross-coupling products were observed. The nanocatalysts could be recycled and reused several times without significant loss of their catalytic activities.



Network Projects

Advanced Polyolefins (SPIRIT)

PI & Members:
Dr SD Baruah PI

Member
Mr A Gautam
Mr NC Laskar
Mr A Sarmah
Mr RC Bohra
Mr L Phukan

Funding Agency:
CSIR, New Delhi

Objectives:

- ✓ Development of degradable polyolefins to achieve new properties, facilitate processing and precise control of heterogeneity of polymer systems.
- ✓ Modeling and predicting structure-processing-property relationships of polyolefin copolymer systems.

Significant Achievements:
Project was sanctioned in October, 2012. Initiated R&D works thereafter.

Network Projects

North East exploration for pharmaceuticals (NEEP)

PI & Members:
Dr MJ Bordoloi PI
Dr NC Barua
Dr PK Chowdhury
Dr DK Dutta
Dr AM Das
Dr G Baishya

Funding Agency:
CSIR, New Delhi

Objectives:

- ✓ Preliminary objective of this project is to develop affordable medicines from rich resources of medicinal plants of North East India.
- ✓ A data base on traditional herbal products used by different tribes/ethnic population in the North East India.
- ✓ It will be arranged to secure IPR for such material and finally organize for transfer of technology to suitable Pharma Company.

Significant Achievements:

- The antiarthritic cream formulation developed by CSIR-NEIST has been released by central S &T minister on the occasion of CSIR foundation celebration at Vigyan Bhavan, New Delhi on 27 Sep 2012.
- The Marketing right transfer agreement of ANTI-ARTHRITIC cream to M/s Sarada Clinic Pvt. Ltd. Kolkata has been handed over by our former Director Dr P G Rao to the representative of the company.

Signing of marketing rights of transferring the herbal products "Anti Arthritis" agreement with M/s Sarada Clinic Pvt. Ltd Kolkata

Handing over of the Marketing right transfer agreement of Anti-Arthiritis cream to M/s Sarada Clinic Pvt. Ltd. Kolkata

Network Projects

Affordable cancer therapeutics (ACT) (Nodal Laboratory: CSIR-IICT)

PI & members:
Dr Dipak Prajapati PI

Member
Dr Romesh Ch Boruah
Dr P J Bhuyan
Dr Pranjal Gogoi
Dr Sanjeev Gogoi

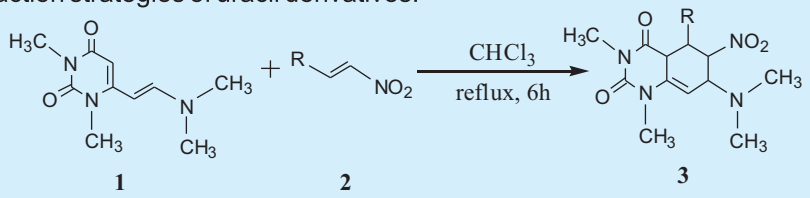
Funding Agency :
CSIR, New Delhi

Objectives :

- ✓ Synthesis of new molecules based on molecular modification of the substrates indoles, pyrimidines and steroids
- ✓ Hetero annulation of the plant based intermediates via Semi-synthesis
- ✓ Biological assay for the novel synthetic molecules.

Significant Achievements:

Multi-component reaction for the synthesis of dihydropyrido[2,3-*d*]pyrimidine-2,4-dione. A mild and efficient protocol for the synthesis of tetrahydroquinazolinedione and dihydropyrido [2,3-*d*] pyrimidine-2,4-dione templates from uracil derivatives utilizing [4+2] cycloaddition strategy in a one-pot reaction condition has been developed. A wide range of nitro alkenes (containing both electron releasing and electron withdrawing groups on the aromatic ring) smoothly undergo reaction with 6-[2-(dimethylamino)vinyl]-1,3-dimethyluracil 1 to furnish a series of tetrahydroquinazolinedione frameworks. Nitro alkenes, derived from furfural and thiophen-2-carbaldehyde also undergo cycloaddition smoothly under similar reaction conditions. It was observed in all cases that some amount of unreacted nitro alkenes and 6-[2-(dimethylamino)vinyl]-1,3-dimethyluracil always remained which could be separated by column chromatography.The method is operationally simple and follow easy work-up procedures, which fabricate a new podium to recognize cycloaddition reaction strategies of uracil derivatives.

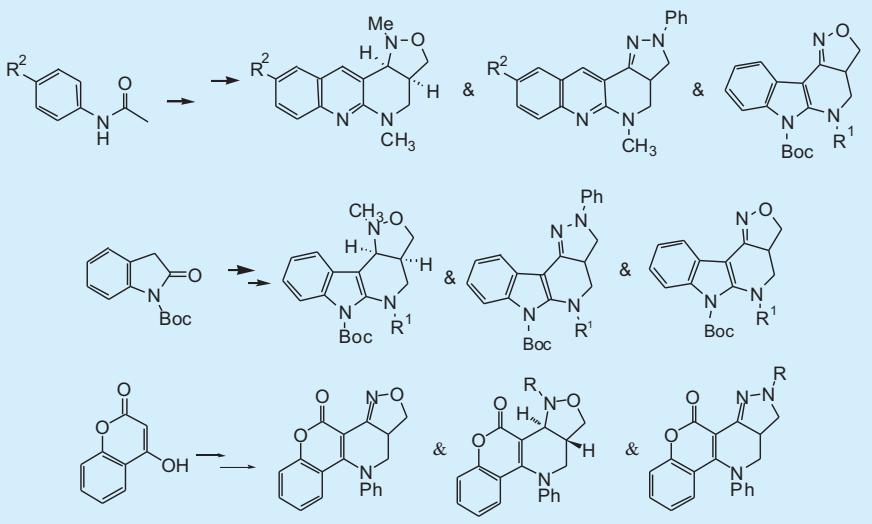


1 2 3

Scheme 1

Synthesis of annelated pyrido[2,3-*b*]-quinolines

Synthesised several novel and complex annelated pyrido[2,3-*b*]-quinolines/α-carbolines/pyrido[2,3-*c*]coumarins, respectively, from simple acetanilide, oxindole, and 4-hydroxycoumarins by exploring the intramolecular 1,3-dipolar cycloaddition reaction strategy involving nitrile oxide, nitrone, and nitrile imine as 1,3-dipoles (Scheme 1).



Scheme 1

Network Projects	CSIR advanced analytical facility for North East (CAAF-NE)
PI & Members : Dr PJ Bhuyan PI Dr LAkshi Saikia CoPI Member Dr P Kotoky Dr Raju Khan Dr PJ Saikia **Funding Agency :** CSIR, New Delhi	

Network Projects	Bioprospection of plant resources and other natural products (BioprosPR)
PI & Members: Dr SC Nath PI **Funding Agency:** CSIR, New Delhi	

Network Projects	Plant diversity-studying adaptation biology and understanding / exploiting medicinally important plants for useful bioactives (SIMPLE)
PI & Members : Dr HP Dekabaruah PI Member Dr T C Bora Dr Ratul Saikia Dr M Khongsai Dr J Kalita **Funding Agency :** CSIR, New Delhi	**Objectives:** ✓ Characterization of population dynamics and phenology in plant species in different ecosystems under natural and with respect of adaptation of species complexes under field condition. ✓ Establishment of relationship of microbial dynamics to the environment and adaptation of plants. ✓ Exploring plant diversity in different ecosystems of Assam and amplitude of adaptation to abiotic stresses in plant species across and within ecological niche(s). ✓ Studies on interaction/association among the species in relation to biotic (microbes) and abiotic components ✓ Dynamics of nutrients recycling in relation to plant performance at different ecological niches ✓ Identification of common and distinct eco-physiological response of plants in various ecological niches.

Significant Achievements:
Base line data on available resources were collected for the plant species *Abrus fruticulosus* (used in piles and used as diuretic); *Allium tuberosum* Rottl. ex Spreng (used in whooping cough); *Dracaena angustifolia* Roxb and *Justicia adhatoda* L (Leaves used in tuberculosis, bronchitis, asthma, whooping cough, liver disorders and abscess).

Network Projects	Impact of Industrial Pollution on Diversity of Bacteria and Butterflies (under INDEPTH Project)

PI & Members :
Dr BG Unni, Nodal Scientist

CoNodal Scientist
Dr Ratul Saikia,
Dr Montu Bhuyan,

Member
Dr P R Bhattacharya
Dr TC Bora
Dr HP Deka Baruah
Dr PK Baruah
Dr T Borah
Mr D Ojha

Funding Agency :
CSIR, New Delhi

Objectives:
- ✓ Genetic diversity of bacteria isolated from environmentally degraded land of Assam
- ✓ To conduct surveys to identify different level of pollutants in industrial and non-industrial areas and correlate with aerial pollutants for documenting the impact of pollutants on butterflies.
- ✓ Isolation, characterization and purification of coagulase, extracellular protein produced by *Staphylococcus basabrani* and further application studies.

Significant Achievements:
Isolation, Preservation and Screening of bacteria for degradation of hydrocarbon/heavy metals resistant and preliminary identification of extracellular protein (Coagulase) from bacterial sp. are under progress.

Network Projects	Nanotechnology: Impact on Safety, Health and Environment (NanoSHE)

PI & Members:
Dr Dipak Kumar Dutta PI

Member
Dr Lakshi Saikia
Dr Pinaki Sengupta
Dr Montu Bhuyan
Dr PR Bhattacharyya
Dr TC Bora
Dr Ratul Saikia

Funding Agency:
CSIR, New Delhi

Objectives:
- ✓ To synthesis nanoparticles of metals (Transition, Platinum and noble metals) and Metal oxides of different size fractions in the range of 0.1 – 100 nm.
- ✓ To evaluate the toxicity of the nanoparticles of metals and metal oxides of different size fractions (micro-, meso- and macro-sized) as synthesized in the range of 0.1 - 100 nm in respect of environmental aspects.
- ✓ Identification of route entry of selected nanoparticles into silkworm and its impact.

Significant Achievements :
Raw materials e.g. Montmorillonite Clay used as support for synthesis of different metal nanoparticles are collected and started their purification process.

Network Projects	COPD-TREAT "Therapeutics of chronic obstructive pulmonary disease (COPD) and related respiratory disorders"

CSIR-NEIST : Chronic Obstructive Pulmonar Disease: Study of Differential Immune response through Gene Environmental Interaction

PI & Members:
Dr BG Unni, Nodal Scientist
Dr HP Deka Baruah, Co-Nodal Scientist

Member
Dr PK Baruah
Dr T Bora Member
Mr RC Bharali
Mr D Ojha

Objectives :
To study the impact of Environmental factors and gene ((GSTT1, GSTM1, α_1–Antitrypsin, HMOX1) interaction in COPD

Significant Achievements :
The selection of the study sites, survey work and health camps near coal mines from Assam and Meghalaya have been identified (ii) The questionnaire for the health survey with all clinical, and others have been prepared after discussion with the clinical doctors and scientists.(iii) Standardization of Protocols for genes (GSTT1 &GSTM1) and other clinical parameters are being completed and for others (α_1–Antitrypsin, HMOX1) is under progress.

Network Projects

Plant – microbe and soil interaction (PMSI)

CSIR-NEIST : Role of ACC-deaminase producing PGPR on alleviation of water stress affect in pulse crops (RAWS, under PMSI)

PI & Members :

Dr Ratul Saikia PI
Dr HP Deka Baruah Co-PI
Dr TC Bora Co-PI

Funding Agency :

CSIR, New Delhi

Objectives:

- ✓ Isolation and screening of rhizobacteria for plant growth promotion with special reference to black gram (*Vigna mungo)*
- ✓ Genotyping and growth promoting traits of PGPR
- ✓ Expression of ACC-deaminase genes from PGPR
- ✓ Role of ACC-deaminase producing PGPR for plant growth promotion under water stress condition

Network Projects

Engineering of disaster mitigation and health monitoring for safe and smart built environment (EDMISSIBLE)

CSIR-NEIST : Post Disaster Management : Design and Development of Transitory Houses for Disaster Vulnerable Rural Sectors in the North Eastern Region

PI & Members :

Mr Dipankar Neog PI
Mr Deepak Basumatari Co-PI

Member
Dr Dipul Kalita
Mr JJ Bora
Mr SC Kalita
Dr P Barkakati
Dr T Goswami
Mr Sanjoy Deori

Funding Agency:
CSIR, New Delhi

Objectives :

- ✓ Design of assembled mass housing units, using locally available construction materials (major components) and metals, polymers (minor components) for their sustainability during post disaster mitigation for natural calamities like flood, earthquake, cyclone etc.
- ✓ Selection of different local materials which will be suitable for the proposed transitory housing and their processing for utilization in the proposed design.
- ✓ Detail analysis and testing of the designed housing units and their components with respect to their engineering properties, feasibility and environmental issues including health and sanitation.
- ✓ Construction of prototype units with field demonstration.

Significant Achievements :

- Setting up of basic bamboo treatment and operational facilities:

Wood Working cum Bamboo Application Machine

Bamboo Treatment Plant

- Determination of some basic mechanical properties of two bamboo species, *Bhaluka* Bamboo (*Auriculata*) and *Jati* Bamboo (*Bambusa teres*) using Universal Testing Machine.

Network Projects

Open Source Drug Discovery (OSDD) Unit funded programme:

PI & Members :

Dr D Prajapati Co-ordinator

Funding Agency:

CSIR, New Delhi

(a): Synthesis of substituted quinoxaline and quinazoline derivatives as potential anti-tuberculosis agent.

PI & Members:
Dr Pallab Pahari PI

Member
Dr Amrit Goswami
Dr Dilip Konwar

Objectives:

- ✓ Synthesis of a library of quinoxaline and quinazoline derivatives for the screening of potential anti-TB agents.
- ✓ Detailed Structure-Activity Relationship (SAR) studies of those lead compounds via linking of different known active functional groups or substituents to induce the better pharmacophoric properties

Significant Achievements:
Few quinoxaline and isoquinoline derivatives have been synthesized and submitted for biological testing.

(b): Development of new Anti-tuberculosis molecule using microbial resources of North East Gene pool.

PI & Members :

Dr Anil Kumar Singh	PI
Dr HP Dekabaruah	Co-PI
Dr TC Bora	Co-PI

Objectives:

- ✓ Screening for new efflux pump inhibitor (EPIs) from NE Gene pool.
- ✓ To target various biosynthetic pathways to check drug resistance in TB.
- ✓ Semi-synthetic approach also, if effective leads is found.

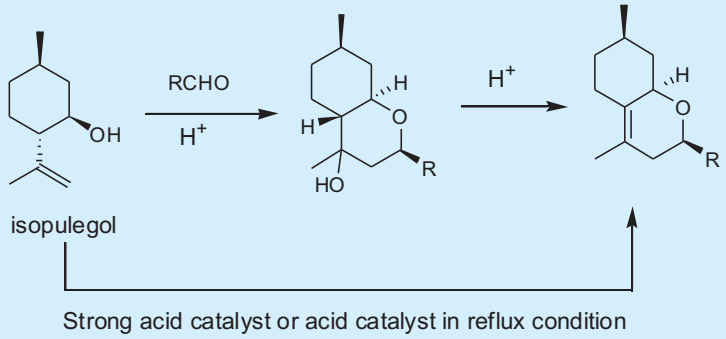
(c): Discovery of New Anti-malarials.

PI & Members:
Dr Gakul Baishya PI

Objectives:

- ✓ Development of new methods towards C-C bond forming reactions and application to scaffold synthesis (trioxane) taking into account the green chemistry principles. Development of new synthetic methods for molecular fragment synthesis

Significant Achievements:
Intermediate compounds for the synthesis of trioxane derivatives have been synthesized



(d): Synthesis of new vitamin D analogues and related compounds as novel class of anti-TB agent.

PI & Members :

Dr Pranjal gogoi	PI
Dr R C Boruah	CoPI

Objectives:

- ✓ Development of new synthetic methods for molecular fragment synthesis
- ✓ Synthesis of molecular fragments for the construction of vitamin D analogues and related molecular libraries
- ✓ Development of new methods towards C-C forming reactions and application to scaffold synthesis taking into account the green chemistry principles
- ✓ Synthesis of vitamin D analogues and related molecular libraries for TB

Significant Achievements:
A ligand-free Suzuki-Miyaura cross-coupling reaction have been developed for the construction of C-C bond. The method has been published as "legend-free Suzuki-cross-coupling reactions: application to β-halo-α, β-unsaturated aldehydes" by Pranjal Gogoi, Pranjal Bezboruah, Romesh C Boruah in Eur J Org Chem 2013 (in web DOI 10.1002/ejoc.201300491).

A wide range of electronically varied boronic acids were efficiently coupled with structurally different β-halo-α, β-unsaturated aldehydes. This protocol was extended to direct one-pot synthesis of polycyclic aromatic hydrocarbon via Suzuki-Miyaura cross-coupling /aldol condensation cascade reaction under microwave irridation. Out of these synthesized compounds, 11 compounds for the antitubercular activity screening have been submitted to CSIR-IICT, Hyderabad. Some of the screened compounds showed moderate antitubercular activities.

(e): development of noval steroidal antimycobacterial compounds.

Objectives:
- ✓ Development of new synthetic methods for the synthesis of library of heterosteroids for the screening of anti-TB activity
- ✓ Detailed Structure-Activity Relationship (SAR) studies of the lead compounds

PI & Members :
Dr Sanjib Gogoi PI
Dr R C Boruah CoPI

Significant Achievements:
Twenty nine steroidal and nonsteroidal samples synthesised using new methodologies for the biological screening at CSIR-IICT, Hyderabad. Some of the submitted compounds showed moderate anti-tubercular activities when they were screened against *Mycobacterium smegmatis*.

Network Projects

Probing the Changing Atmosphere and its Impact in Indo-Ganetic Plains (IGP) And Himalayan Regions [AIM-IGPHim]

PI & Members :
Dr BP Baruah PC
Dr Prasenjit Saikia Activity Leader

Member
Dr B K Saikia

Funding Agency :
CSIR, New Delhi

Objectives:
- ✓ Chemical characterization of Aerosol and their seasonal variability.
- ✓ Development of emission inventories of trace gas and aerosol.
- ✓ Source apportionment study for aerosol.
- ✓ Capacity building activities to strengthen the scientific through national and international collaboration.

Significant Achievements:
- Collection of literature from 1994-2013.
- Procurement of Instruments (weather monitoring station)
- Identification of major source of aerosol and selection of sites for samples collection.
- Determination of different evolved gases (CO, CO_2, SO_2, H_2S, C_xH_y, NO_2) during the pyrolysis process of NER coal.

Network Projects

Development of novel leather products based on ethnic designs of northeast

PI & Members :
Dr HB Singh

Coordinator
Mr D Chandramouli,
CSIR-CLRI

Objectives :
Establishment of a Resource Hub Centre for Ethnic designs and development of novel products

Significant Achievements:
Developed 45 various novel products based on local fabrics and designs of northeast (lady's bag, purse, card holder, file folder, air bag, travelers' bag, half coat, etc.)

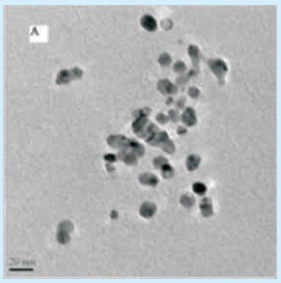
(IV) Progress of Inhouse, Grant-in-aid and Consultancy Projects

Agro Technology

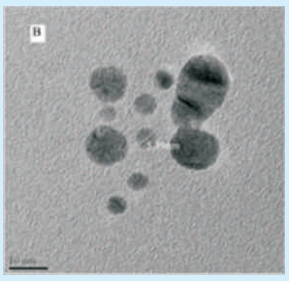
MLP	Bioprospection and assessment of genetic diversity of medicinal, aromatic and economic plants of NE India for industrial and socio-economic development
A. Bioprospection of medicinal, aromatic and economic plants of NE India for industrial and socio-economic development **B.** Assessment of genetic diversity in a few important ethno-medicinal and endemic species from North East India in exploratory manner using molecular markers. **Funding Agency:** CSIR, New Delhi	

MLP	Bioprospecting & chemical investigation of medicinal, aromatic & edible plants of Arunachal Pradesh & Manipur
Funding Agency: CSIR, New Delhi Development of agro-technology & chemical investigation of selected medicinal, aromatic and edible plant of Arunachal Pradesh	**Objectives :** ✓ To introduce various medicinal, aromatic and edible plants. ✓ To developed new/better strain of medicinal/ aromatic plants. ✓ Development of agro technology for commercial cultivation. ✓ Chemical investigation of unexplored medicinal, aromatic and wild edible plant of Arunachal Pradesh. ✓ Evaluation of antioxidant activities, phenolic content, flavonoids content of selected medicinal/edible plant and parts thereof. ✓ Evaluation of nutraceuticals and mineral content of selective medicinal/edible plant species. ✓ To generate knowledge, enhance the value of knowledge and its application for agro based industrial development in the rural sector. ✓ To generate employment opportunities for socio economic uplift in the rural sector. **Significant Achievements:** ● ***In*-situ biosynthesis of Ag, Au and bimetallic nanoparticles using *Piper pedicellatum* C.DC-Green chemistry approach:** The synthesis of silver (Ag), gold (Au) and bimetallic Ag-Au nanoparticles using *Piper pedicellatum* C.DC leaf extract was demonstrated. The rapid formation of stable Ag and Au nanoparticle has been found using *Piper pedicellatum* C.DC leaf extract in aqueous medium at normal atmospheric condition. Competitive reduction of Au^{3+} and Ag^{+} ions present simultaneously in solution during exposure to Piper pedicellatum C.DC leaf extract leads to the synthesis of bimetallic Ag–Au nanoparticles in solution. Transmission electron microscopy (TEM) analysis revealed that the Ag nanoparticle predominantly form

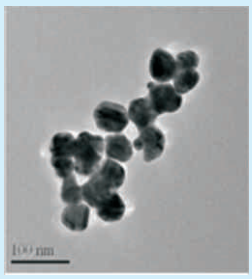
spherical in shape with the size range of 2.0±0.5–30.0±1.2 nm and in case of Au nanoparticles the particles are spherical in shape along with few particles of the shape like triangular, hexagonal, pentagonal are also observed. The particles size range was 2.0±0.3-40.0±1.4 nm. The chemical constituents, viz. catechin, gallic acid, courmaric acid and protocatechuic acid of the leaf extract were identified which may act as a reducing, stabilizing and capping agent. The formation of pure metallic and bimetallic nanoparticles are possibly facilitated by flavonoids, phenolic acids and other such constituents present in the *Piper pedicellatum* C.DC leaf extract.



Ag nanoparticles



Au nanoparticles



Bimetallic Ag-Au nanoparticles

- **Green synthesis of Ag nanoparticles using *Piper pedicellatum* C.DC fruits and its photocatalytic activity.** Synthesis of silver (Ag) nanoparticles was done by using *Piper pedicellatum* C.DC fruits extract in aqueous medium was reported. Transmission electron microscopy (TEM) analysis shows that the Ag nanoparticles predominantly formed spherical in shape with size range 3.0 ± 0.5 - 30.3 ± 1.6 nm. The results show that Ag nanoparticles have suitable photocatalytic activity for the degradation of Methyl red dye.
- **Biosynthesis of Gold (Au) nanoparticles by using *Gymnocladus assamicus* pods extracts**:
  The Au-nanoparticles were synthesized by using plant extracts. It is a green process for synthesis of nanoparticles. The shape controlling role of Au nanoparticles was observed in presence of different concentration of CTAB. Significant result was found in this experiment. From the result it was found that the shape of Au nanoparticles becomes spherical along with a few other geometry nanoparticles. The size range was only 10-37 nm only.
- *Zenthoxylum alatum* and *Pimenta dioica* both are essential oil bearing plants. Germplasm of both the species are kept in NEIST Branch Itanagar farm. For quick multiplication through tender shoots of both the species an experiment was conducted “Effect of rooting on different and various concentration of growth hormone (IAA, IBA and NAA; 50 ppm, 100 ppm and 200ppm)”. The minerals i.e. K, Na, Ca, Fe, Cu, Mg, Mn, P, N, Pb, Mo and As were evaluated for sixteen edible plants of Arunachal Pradesh.
- An approach has been taken to increase the oil content of BLI-ARUN strain of lemon grass through chemical mutation breeding technique. About 25-35% increase of essential oil content has been achieved having 1.6-1.8% of essential oil.

- About 153 kg of fresh Litsea seeds were collected from Sagalee, Papum Pare dist. and the seed was sent the NEIST Jorhat for further analysis.
- Following 3 articles were published in Souviner of 1st Krishi Expo & Kisan Mela -2012 held during 12-14 December 2012 at IG Park Itanagar
  - ❖ "Aromatic plants and its cultivation towards sustainable development of Arunachal Pradesh" authored by Budhen C. Baruah, Jayanta Bora and Chandan Tamuly, pp.78-84.
  - ❖ "Vermicompost-An aspect for sustainable farm Management" authored by Budhen C. Baruah, pp.42-47.
  - ❖ "Edible mushroom and its production" authored by Budhen C. Baruah, pp.95-100.
- A chapter "Cultivation of aromatic plant towards the sustainable development of Arunachal Pradesh" authored by B.C. Baruah, Chandan Tamuly, Jayanta Bora and Sanjeev Saikia was published in a book " Natural Essential Oils-Fragrances and Flavours edited by Akhil Baruah and S.C. Nath, Aavishkar Publishers, Jaipur-302003 (Raj.) India, pp.362-369.

Prospecting of local bio-resources of northeast India with special reference to Manipur

PI & Members:
Dr HB Singh

Objectives:

- ✓ Proper identification and record of economically viable and significant species mainly plants, animals and microbes
- ✓ Survey, documentation and identification of insect pathogenic resources of Manipur
- ✓ Development of suitable technology based on local knowledge and scientific validation
- ✓ Application of these technologies for sustainable development and economic prosperity of the region

GAP

Biotech Intervention on Selected Medicinal and Aromatic Plants of NER for their Effective Utilization

PI & Members:

Dr P R Bhattacharya	PI
Dr S C Nath	Co-PI
Dr M Barthakur	Co-PI
Dr B S Bhaou	Co-PI
Dr Gakul Baishya	Co-PI

Collaborator
Dr Chandana Barua
Dr Iswar Chandra Barua
Dr M Ahmed

Funding Agency :
DBT, New Delhi

Objectives:

- ✓ To work out the taxonomy of the germplasm of the four medicinal and aromatic plants.
- ✓ To investigate bioactive phytochemical ingredients of selected species for an effective utilization of these unique resources.
- ✓ To evaluate pharmacological activity of the plant extracts and their various fractions.
- ✓ To assess the drug isolated for potential adverse eefects on metabolic system.
- ✓ To develop technology of good agricultural practices, mass multiplication and post-harvest management.

Significant Achievements:

Extraction of two active extracts from *Clerodendrum indicum* (whole plant-CL):

- Ethanol Extract [code no. NST-GB-CL-I]
  → Found to be highly active for HCl-ethanol and Indomethacin-induced ulcer model in rats.
  → Phytochemical analysis and determination of the quercetin and gallic acid contents in this extract by HPLC method.
- 50% ethanol in water extract [NDT-GB-CL-II]
  → bio-evaluation is under investigation.

GAP	Exploration & Utilization of wild edible plants consumed by ST people of Arunachal Pradesh for socio economic development of the state.

PI & Members:
Chandan Tamuly PI
Jayanta Bora Co-PI

Objectives:

- ✓ Prioritsation of wild edible plants used by Nyishi tribe of Arunachal Pradesh having medicinal and nutritional properties.
- ✓ Evaluation of nutraceutical of the selected plants for value addition.
- ✓ Prioritization of potential plant species for mass cultivation to enhance alternative livelihood option of tribal community for socio economic development.
- ✓ Awareness programme regarding promotion, sustainable utilization and nutritional value of selected edible plant through mass cultivation particularly on shifting cultivation affected area to conservation of biodiversity and socio-economic development of the tribal people.
- ✓ Selection of a few plant species for maximum income generation through market linkage of the tribal people of the state.

Significant Achievements:

- Survey, collection and identification of wild edible plant is going on.
- Selected a few wild edible plant species for value addition.
- Nutraceuticals were evaluated for three selected plant.

Biological Sciences

MLP	Bioprofiling and bio-prospecting microorganisms, plants and insects from North East gene pool and their application potentials

Funding Agency:
CSIR, New Delhi

GAP	Exploration and Screening of Bacterial Diversity in North-East India and Its Potential Application in Biocontrol

PI & Members:
Dr Ratul Saikia PI
Dr TC Bora Co-PI

Funding Agency :
ICAR, New Delhi

Objectives:

- ✓ Collection of environmental samples from different habitat of North-East States of India
- ✓ Isolation, purification and preservation of bacteria
- ✓ Bacterial data base development for future uses
- ✓ Screening of bacterial isolates for biocontrol
- ✓ Characterization ***of potential isolates and diversity analysis***

Significant Achievements:

Genetic and functional diversity of bacteria isolated from extreme environment, Tawang, Arunachal Pradesh. We have isolated 150 nos. of bacteria and 70 nos. of *Streptomyces* from soil of Tawang. Out of the 150 bacterial isolates, 27 recorded as gram positive and 83 as gram negative. These bacterial isolates showed variation in morphological and biochemical characters. Moreover, 11 isolates showed strong antibacterial activity and 2 showed antifungal activities against the test pathogens. 16S rDNA-RFLP analysis of antimicrobial potential bacteria exhibited high degree of genetic variation among the isolates. Some isolates found to positive in protease and amylase production. 15% of the *Streptomyces* isolates produced bioactive metabolite found to active against the pathogens, *viz., Fusarium oxysporum* f. sp. *ciceri* (Foc), *Fusarium semitectum* (Fs), *Rhizoctonia solani.*

Multilevel diversity analysis of draught tolerant fluorescence pseudomonads associated with green gram rhizosphere. Twenty two

draught tolerant fluorescent pseudomonads were isolated from green gram rhizospheric soil using supplementation of different concentration of polyethylene glycol (PEG) to the growth media. The isolates were screened for their different PGPR traits as well as antagonistic activity against different plant pathogens. Out of 20 isolates, *Pseudomonas* isolate fps14 have the activity to produce the draught responsive enzyme ACC deaminase. PCR amplification results 700 bp product size of *acdS* gene. The isolates were found to be prominent in phosphate solubilization, siderophore production as well as the production of plant growth promoting hormone, IAA. *In vitro* study of fps14 isolates in green gram plant revealed increase in root length of 10-20% and dry weight of 15 to 30% in comparison to the positive controls under water stress condition. Greater activity of stress-related enzymes catalase and peroxidase in bacterized plant under water stress when compared to untreated plants. Latter fps14 was identified as *Pseudomonas aeruginosa* through 16S rDNA sequencing analysis. Genetic diversity among these fluorescent pseudomonads was analyzed through 16S rDNA-RFLP, BOX – PCR and ERIC–PCR fingerprinting with respect to four reference strains of *Pseudomonas fluorescens* NCIM 2099^{T}, *P. aeruginosa* MTCC 2582^{T}, *P. aureofaciens* NCIM 2026^{T}, and *P. syringae* MTCC 673^{T}. Genotypic analysis revealed huge genetic diversity among the draught tolerant isolates with different PGPR traits (Fig.).

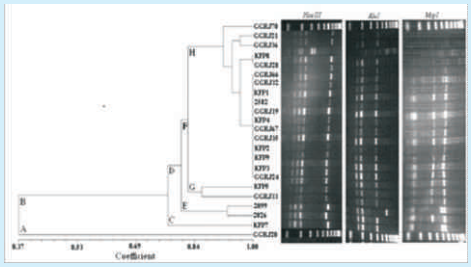


Fig.*Combined dendrogram of antagonistic potential fluorescent pseudomonads isolates based on cluster analysis of 16S rDNA-RFLP products with restriction endonuclease HaeIII, AluI and MspI using the UPGMA algorithm and the Jaccard coefficient.*

GAP

Survey Isolation and Preliminary Characterization of Microbial Populations of Southern Brahmaputra Corridor of Assam

PI & Members :
Dr BG Unni PI
Dr SB Wann Member

Funding Agency:
DST, New Delhi

Objective :
Survey, Isolation,Identification and characterization of microbes from Soil samples from different locations from the Southern Brahmaputra Corridor of Assam

Significant Achievements:

Molecular identification of *Fusarium oxysporum*, a wilt causing pathogen of tomato isolated from Assam, North East India based on Internal Transcribed Spacer ITS

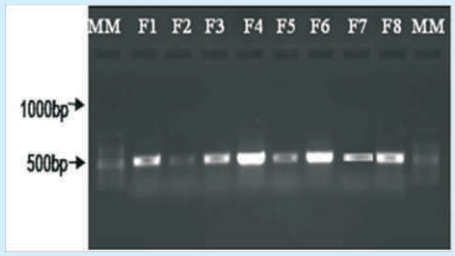


Fig.*:Amplification of conserved ribosomal regions of Fusarium spp. using the primers ITS-1 and ITS-4. 'MM' – 100bp DNA ladder; 'F1 – F8' – Fusarium isolates*

Fusarium oxysporum which causes wilt is a serious pathogen. *Fusarium* isolates were isolated from Assam located in North East region of India. Morphological identification of *Fusarium* isolates was done using conidial and hyphal structures. Molecular identification of *Fusarium* cultures were carried out based on conserved ribosomal internal transcribed spacer (ITS) region.

Amplified the ITS regions between the small nuclear 18S rDNA and large nuclear 28S rDNA, including 5.8S rDNA using universal primer pairs ITS1 (5′-TCCGTAGGTGAACCTGCGG-3′) and ITS4 (5′-TCCTCCGCTTATTGATATGC-3′) (White et al., 1990). Further, characterization using random amplified polymorphic DNA (RAPD) was carried out to observe the relatedness among these isolates. The ITS nucleotide sequences for each isolate were then compared to those in the public domain databases NCBI (National Center for Biotechnology information; www.ncbi.nih.gov) using Basic Local Alignment Search Tool for Nucleotide Sequences (BLASTN). Alignment of ITS DNA sequences was done using Clustal_W program (Thompson et al. 1994). Phylogenetic tree was created using CLC Sequence Viewer Version 6.3 based on UPGMA (unweighted pair group method for arithmetic analysis). The confidence of the branching was estimated by bootstrap analysis. It was concluded that molecular profiling using ITS, is an indispensable method for identification studies.

GAP

Creation of Bioinformatics infrastructure Facility for the Promotion of Biology Teaching through Bioinformatics

PI & Members
Dr RL Bezbaruah PI
Dr R Saikia CoPI

Funding Agency :
DBT, New Delhi

Objectives :

- ✓ To serve bioinformatics and computational facility to researcher in relation to wet laboratory experiment.
- ✓ To conduct training and workshop for promoting bioinformatics application in biological research and development.
- ✓ To provide basic and core Bioinformatics knowledge for PG and UG student coming from different academic Institution in India
- ✓ To strengthen the Human Resource Development in the field of Bioinformatics.

Significant Achievements:

The Bioinformatics Infrastructure Facility (BIF) at Biotechnology Division, CSIR-NEIST, Jorhat was established on 2nd February, 2008 under the Biotechnology Information System Network (BTISnet) scheme of the Department of Biotechnology, Govt. of India to promote innovation in biology teaching through Bioinformatics. With the goal to facilitate and expose students and researchers from different academic institution of North-East India this centre has successfully serving a vital role in the field of Bioinformatics teaching. The centre is profoundly devoted in R&D work with a great intensity to medicinal chemistry, Computer Aided Drug Design and microbial genomics data analysis.

GAP

Development of formulations of microbial bioinoculants with plant growth promoting and biocontrol activities for application in rice cultivation in Manipur and Assam

PI & Members :
CSIR-NEIST
Dr HP Deka Boruah PI

Member
Dr N Saikia (Retd.)
Dr M Khongsai

Manipur University
Dr D Nigthousam PI

Funding Agency :
DBT, New Delhi

Objectives :

- ✓ Revalidation of PGP-BCA strains available with the investigators
- ✓ Optimization of fermentation/mass production for selected BCA/PGP strains.
- ✓ Development of formulation of microbial consortia of selected strains and asessment of their efficacy under pot and field trials.
- ✓ Optimization of formulation and delivery methods; registration and patenting, if feasible.

Significant Achievements:

Strains were screened having the PGPR potential in this programme. A strain showing biodegradative potential and other beneficial activities, namely *Pseudomonas aeruginosa* Strain N002 was put to whole genome

sequencing. Here, we report the draft genome sequence of crude oil-degrading *Pseudomonas aeruginosa* strain N002, isolated from a crude oil-polluted soil sample from Geleky, Assam, India. Multiple genes potentially involved in crude oil degradation were identified. Different biochemical pathways involved in different metabolism being analysed.

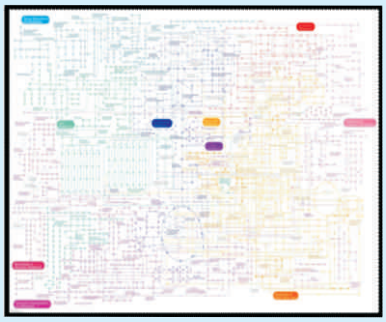


Fig.: An overview of metabolism and transport in Pseudomonas aeruginosa N002

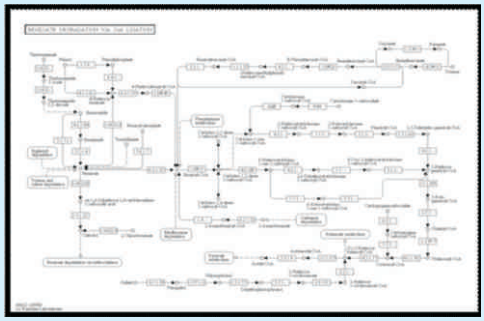


Fig.: Benzoate Degradation mechanism in Pseudomonas aeruginosa N002

GAP

Application of carbon sequestration in the terrestrial ecosystem of Assam for long term sustainability

PI & Members :
Dr HP Deka Boruah PI
Dr Neelima Saikia Co-PI (Retd)

Funding Agency :
DST, New Delhi

Objectives :

- ✓ Implications of carbon sequestration in anthropogenically degraded land
  - Baseline data generation of carbon pool in ecologically degraded /restored land.
  - Contribution of plant species to C budget in such soil.
  - Assessment of plant ecotype study for optimization of carbon sequestration in ecologically degraded soil.
- ✓ Assessment of C sequestration in forest ecosystems
  - Establishment of relationship of atmospheric CO_2, understory plant cover plant C and soil C in riparian forest areas.
  - Documentation of plant species for carbon sequestration ability in forest ecosystems.
  - Studies of forest species for CO_2 partitioning and C sequestration efficacy at functional eco- physiological levels.

Significant Achievements:

Model suitable for assessment of aboveground biomass was validated. The equation proposed by Hedl *et al.* (2009) was used to determine the tree basal area.

$$\text{Basal Area} = (3.1416 \times (\text{dbh}/2)^2)/(144)$$

$$\text{Basal Area (dbh in cm)} = 0.00007854 \times \text{dbh}^2 \quad (1)$$

The model $Y = 42.69-12.800(D)+1.242(D^2)$ was used to estimate the aboveground biomass in the three forests. Trees were grouped into eight dbh classes i.e., >10-30 cm, 30-50 cm, 50-70 cm, 70-90 cm, 90-110 cm, 110-130 cm, 130-150 cm and >150 cm, and the density and aboveground biomass distribution under each diameter at breast height class were analyzed. The soil and aboveground carbon stocks for three forests of Assam- Jiadhal, Damra and Gibbon, of Indo Burma Mega Biodiversity hot spots were assessed to determine its nature of carbon sink and sequestration potential. We found that soil of Jiadhal was sandy type while Damra and Gibbon were clay type. The average soil carbon stock in the three layers of soil were 55.8 t ha^{-1}, 52.6 t ha^{-1} and 51.3 t ha^{-1} for Damra; 68.7

t ha^{-1}, 53.6 t ha^{-1} and 52.3 t ha^{-1} for Gibbon and 27.2 t ha^{-1}, 25.2 t ha^{-1} and 23.4 t ha^{-1} for Jiadhal. Similarly, the aboveground tree biomass carbon was 169.09 t ha^{-1}, 524.48 t ha^{-1} and 121.86 t ha^{-1}. The average moisture content was 19.20-23.59 % for Damra and for Jiadhal and Gibbon, the moisture content were 23.72 %, 20.12 % and 19.02 %.

New Observations: It was found that there was degradation in all the three forests and there is marked difference between the density of trees in the three forests. The forests showed less density in tree species. Damra forest is dominated by *Tectona grandis* and Jiadhal by *Acacia catechu* which is 5 to 15 years old. Gibbon forest is dominated by *Dipterocarpus macrocarpus.* The other plant species found in the sanctuary are *Garcinia* sp., *Terminalia mycocarpa*, *Artocarpus chaplasha, Mesua ferrea, Lagerstromia speciosa, Michelia champaca* and several species of bamboo and ferns.

GAP

Genetic diversity of antimicrobial agents producing Streptomyces isolated from protected forest area of Assam and Arunachal Pradesh

PI & Members :

Dr Ratul Saikia	PI
Dr TC Bora	Co-PI
Dr MJ Bordoloi	Co-PI

Funding Agency :
DBT, New Delhi

Objective:

- ✓ Genetic diversity of *Streptomyces* spp.
- ✓ Chemical profiling of antimicrobial metabolites.
- ✓ Selection of most efficient strain to control phytopathogen.

Significant Achievements:

Phenotypic characterization of Streptomyces strains

Antimicrobial positive *Streptomyces* strains were observed under light microscope for acid-fastness and Gram-staining properties. Morphological characters were observed on CSPY agar plate. Physiological criteria such as the ability to degrade casein and tyrosine as substrates by various *Streptomyces* strains were used for genus confirmation. The utilization of different carbon sources and production of melanin pigment and utilization of urea were studied so as to characterize species level classification.

Based on antimicrobial activity total 33 strains putatively *Streptomyces* spp. was selected from CSPY agar plates. Optimal growth temperature for the strains was recorded as 25 °C, growth can occur below 6°C, no growth recording at 35 °C or above. Most of these strains show typical morphology of Streptomyces, they had branched and non-fragmented substrate mycelia, abundant aerial hyphae and short or long spore chains with or without pigmentation. All the colonies of the strains were slow growing, aerobic, glabrous or chalky, heaped with substrate mycelia of colors and possessed an earthy smell. The strains were acid-fast negative and gram positive, degraded the substrates casein, however, degradation of tyrosine was variable according to each isolate. Microscopically, it was revealed that the spore chain morphology differed depending on the species, showing straight and flexuous forms, hooks, open loops and coils.

Based on the aerial mycelium colour, the strains could be grouped into - grey and white. Different colours of mycelia were also observed, the shades light brown and ivory colour being the predominant. Few of them had substrate mycelia in violet, purple or red-violet. Utilization of several carbohydrates varied according to each strain. Maximum, i.e. 11 nos. of strains had capacity to utilize L-arabinose, followed by (8 strains) sucrose, D-mannitol, raffinose and L-rhamnose. Only two strains were able to use D-fructose as carbon source. Majority of the strains (22 out of 33) could degrade urea, and 13 nos. of strains could produce diffusible pigments in the surrounding medium.