University of Pune

University with Potential for Excellence

Phase II - Proposal

Coordinator

Prof. W.N. Gade

Director, BCUD, University of Pune

Focus Area : Biotechnology and Novel Materials

Area I – Biotechnology :

Molecular Characterization of Organisms for Therapeutic Applications

Area II – Biotechnology & Novel Materials

a) ***Nanomaterials and nanobiotechnology***

b) Novel Materials for Energy Harvesting

Holistic Development

Area I - Health & Social Sciences

Focus : Translational research in health of women and children

Area II – Social Sciences

a) ***Centre for Social Sciences and Humanities***

b) ***Determinants of Health in Maharashtra: Assessing theory, policy and practice***

Area III – Biodiversity

Capacity Building Programme in Biodiversity Assessment of Western Maharashtra

Area IV – Infrastructure Development

Central Instrument Facility, Hostel, Scientist Complex

Focus Area : *Biotechnology and Novel Materials*

I. (a) Biotechnology

Molecular Characterization of Organisms for Therapeutic Applications

The focus of phase I of UPE was Biotchnology. The emphasis is on Human Resource Development in Biotechnology and cutting edge research in frontier areas of Biotechnology. Thus the focus was:

- Manpower Development Programme.
- Development of interactive programmes and infrastructure.
- Research and Development Programme (R and D).

The first two objectives led to the establishment in 2002 of Institute of Bioinformatics and Biotechnology (IBB) and have been elucidated in detail in the UPE phase -I report submitted to UGC, New Delhi. The on-going R and D program which we intend to carry forward in UPE-phase II will be an extension/continuation of the phase-I programme.

In UPE phase-I, the University had initiated research programs in the focus areas of diabetes, malaria, viral diseases, herbal drugs and biomaterials, bioactive molecules etc. The departments of university *viz.*, Dept of Microbiology, IBB, Biotechnology etc., already have a collection of microbes which are known to be pathogenic to plants and animals and their spread thus needs to be controlled using various therapies. There are also microbes which can be used for bioremediation as well as for obtaining therapeutically important molecules. Research work has been carried out in the areas of bio-surfactants and bio-emulsifiers wherein novel compounds such as glycolipids, proteins and peptides from *Acinetobacter* sp.; *Streptomyces sp., Yarrowia* sp and other novel marine microbes have been purified and characterized for their antimicrobial and biofilm disrupting activities. A self-assembling protein is being studied for its immobilization property and the ability to form emulsions. Research in the area of animal and plant biotechnology related to human health is also being undertaken.

Objectives :

Based on the data obtained during phase-I, further work will be carried out in the phase-II. The main objectives being:

- Molecular characterization of novel organisms including microbes, animals and plants and evaluation of their potential for recovery of therapeutic molecules.
- Potential of these organisms for improving the environment will also be evaluated.

Microbes for Therapeutic Potential

Microorganisms isolated from various environments have been shown to produce novel bio-surfactants exhibiting strong antimicrobial activity and thus can act as therapeutic agent(s). Some of the other organisms, apart from the ones mentioned above, which can be exploited for therapeutic use are actinomycetes which have the ability to produce metabolites having antimycotic property e.g., it is known to produce a compound that is active against dermatophytes with a greater potency than griseofulvin. Lactic acid bacilli produce antifungals which can be used as a bio-preservative. Similarly species of microorganisms such as *Acinetobacter* spp. produce superoxide dismutases which can be used as a therapeutic agent. Bacteriophage can be used for in vitro management of biofilms against hospital isolates and some endophytes are known to produce novel secondary metabolites.

Biofilm formation is affected by various factors such as lectins, EPS, Quorum sensing, e-DNA and genetic determinants. Controlling biofilm formation is an important aspect in clinical study. e-DNA is contributed by natural cell death during growth and autolysin mediated cell death, which serves as primary reservoir for enrichment of biofilms and spread of genetic traits. Lectins, EPS and e-DNA mediate adhesion and hence can be used for controlling biofilms. Similarly the genetic studies on genes involved in the process of biofilm formation will help in assessing efficient drug targets. Hence, lectins involved in adherence to the biotic surfaces will be selected for the study. *Acinetobacter* spp. has been reported to be present ubiquitously in nature. *Acinetobacter baumannii* has gained importance in medicine since it exhibits plasmid mediated multiple drug resistance with an additional property of biofim formation with the adhesion being mediated by lectin interaction.

Many sp. of streptomyces have been isolated and characterized. These will be used for obtaining antibacterial and fungal compounds both for improving the human health and also for treating the plant diseases.

Microorganisms for improving Environment:

Some of the bacterial sp like pseudomonas, klebsiella, exegobacteria, serratia etc. have been reported to be quite efficient in bioremediation of heavy metals as well

as recovery of precious metals from electronic waste. Molecular level mechanism of these processes will be studied with genomic / proteomic approach.

- **Isolation and Characterization of novel bioactive siderophores from endophytic microorganisms**

Iron is an essential growth element for all living organisms. Under iron-limiting conditions plant growth promoting endophytes produce low-molecular-weight compounds called siderophores to competitively acquire ferric ion. Hence novel siderophores will be isolated and characterized from endophytic microorganisms from *Dioscorea* spp and other medicinal and crop plants such as *Helianthus annus, Phoenix sylvestris, Datura stramonium, Sesamum indicum*

- **Isolation, Characterization and Whole Genome Sequencing of Bacteriophages and its Therapeutic Applications**

The antibiotic resistant profiles of Acinetobacter isolated from various hospitals in India were found to have plasmid encoded multiple drug resistance (Pardesi, 2009). Hence, use of phages against such multiple drug resistant microbes may be the efficient way to treat its infections. Phages can be isolated from environment or sewage water. The isolated phages need to be purified and characterized. Their antimicrobial activity should be studied. Whole genome sequencing is the next logical step to understand the intricacies of the phage life cycle. Whole genome sequence will help development of phage gene based antimicrobials (Liu et. al., 2004). They have many advantages over whole phage preparations such as they do not induce resistance and toxic shock. Besides, phages can be used for the following applications such as Phage display (Coates and Hu, 2007), Phage based pathogen detection (Pettya et. al., 2007), Engineered Phages for biofilm disruption (Lu and Collins, 2007), Employing Lysogenic Phages for targeted delivery of antimicrobial genes (Westwater et. al., 2003) and Antimicrobial drug discovery (Liu et. al., 2004).

- **Molecular characterization of virulence factors contributing to the pathogenicity of *Acinetobacter spp.* for therapeutic management of infections**

There are very few reports on virulence of *Acinetobacter* spp. from the Indian sub continent. Lectin production by *Acinetobacter* spp. plays a role in colonization of upper respiratory tract and is thus an important virulence property (Patil *et al*, 2001). Preliminary studies have been carried out in our laboratory with clinical isolates of *Acinetobacter* spp. to be used in the proposed study. Phospholipase C activity in *Acinetobacter* spp. and its role in virulence has been studied (Purandare *et al*, 2009). Investigations in our laboratory have also reported importance of

biofilm in pathogenicity of *Acinetobacter* spp. (Sahu *et al*, 2010; Iyer *et al*, 2010). The focus of the proposed study would be to characterize the bacterial factors that contribute to pathogenicity of *Acinetobacter* spp. Screening and characterization of various virulence factors produced by *Acinetobacter* spp. would be done using phenotypic screening methods. The involvement of these factors in bacterial colonization and/ or invasion and/or survival in host system will be evaluated. Molecular Characterization of virulence factors produced by *Acinetobacter* spp. would also be done to compare the genetic diversity of the virulence genes in *Acinetobacter* spp.

Therapeutic potential of medicinal plants like *Phoenix sylvestris*, *Lantana* spp. and *Barleria* spp. for antidiabetic, antioxidant, anticancer and antiinflammatory activities will be undertaken. The active principles of the plants and its endophytes will be isolated and characterized.

Eulophia species surfaced with prominence from a neutraceutical point of view for its rejuvenating effect, anti fatigue, anti-cancer and aphrodisiac properties. Out of 210 known *Eulophia* species, seven are known from Maharashtra. *Eulophia ochreata* L. is one of dominant species found to be growing in various places of Western Ghats of Maharashtra and hence will be investigated for its molecular characterization and therapeutic application. *Eulophia* are extensively utilized by the tribals as food and medicine. The indiscriminate utilization of these plants from the forest made them rare. Medicinal properties of these plants are not well documented and requires scientific authentication, which would lead to identification of newer sources of drugs for modern society.

Epigenetics for therapeutic potential

It has been documented that epigenetics plays a crucial role in establishing phenotypes and in modulating genotypes to influence phenotypes during development, stress and physiological processes. It leaves a heritable imprint which can be sensitive to environmental changes and influence health and well being of a person. A large number of life style diseases, cancers (more than 50 % of cancers), imprinted diseases and illnesses where predisposition to the disease has a genetic component are all set in by changes in DNA methylation which plays an important role in chromatin remodeling. Modulators of DNA methylation machinery and DNA methylation as well as chromatin reprogramming promise to have tremendous, but hitherto unexplored potential for therapeutic aspects. These modulators will be investigated for novel anti-diabetic and anti-cancer applications.

In this project it is proposed

- To identify and isolate novel molecule from plant (medicinal plants with known modulatory activities) and microbes which can modulate epigenetic pathways in organisms.
- To identify the molecular genetic mechanisms which govern both the biosysnthesis and activity.
- Molecular and genome wide characterization using DNA sequencing and metabolomics and whole genomics to explore the possibility of understanding and manipulating the biosynthetic pathways and mechanisms of action

Bioremediation

Also the biodegradation potential of the microbes such as *Yarrowia lipolytica, Acinetobacter,* klebsella, etc with some novel fungi and plants will be studied with respect to degradation of toxic compounds such as halogenated compounds , synthetic textile dyes and heavy metals since the rivers in the Pune region are often loaded with industrial effluents from paints, dyes, paper and pulp industries. Toxic heavy metals such lead, chromium (VI), arsenic are some of the metals that would detoxified using microbial and plant systems. Department of Biotechnology is engaged in understanding the mechanism of bioremediation at molecular level using genomic / proteomic approach. Large number of bacterial sp are being isolated from contaminated sites and their potential for bioremediation will be evaluated.

Bioactive molecules:

The department of chemistry (DoC) and Deparment of Biotechnology will play a pivotal role in this area. With the expertise available in the isolation of bio-active compounds from micro-organisms. These include antibatrical, antifungal and therapeutic compounds. The compounds will be separated with the help of preperative HPLC techniques. Bio-assays will be undertaken with highly purified compounds. If possible, derivatization of molecules will be undertaken to characterize the molecules and study of their bio-assays. The structures of bio-active compounds will be determined with the help of analytical and spectroscopic instruments such as LC-MS and high resolution (300/400/500 MHz) NMR spectroscopy.

Bioinformatics in therapeutic potential

Relevant inputs from the Bioinformatics centre will be required for database development such as

- Development of database to archive primary data of micro-organisms and plants
- Nature of data:
  - Phenotypic
  - Molecular
- Database of bioactive compounds
- Development of web portal and server for data submission, archival (intra-net based) and dissemination (public domain)
- Analysis of data:
  - Sequences analysis viz. comparative & phylogenetic analysis
  - Structure analysis viz. protein structure prediction & molecular modeling
  - Co-relation of sequence-structure-function relationships
  - Analysis of high-throughput sequencing data using comparative genomics techniques
  - Characterization and analysis of metabolic pathways

Expertise available:

The available expertise and the Departments involved are given below. The relevant publications are listed in Annexure-I

a.	Institute of Bioinformatics and Biotechnology :	Prof. B.A.Chopade Dr. A. Ravi Kumar Dr. S. Zinjarde
b.	Dept. of Microbiology:	Prof B.A.Chopade Prof. B.P.Kapadnis Dr. R. L. Deopurkar Dr. Karishma Pardesi
c.	Dept. of Botany :	Prof. S.D. Deokule Dr. N. Malpathak
d.	Dept. of Zoology :	Prof. D.D. Deobagkar

	Mr. Kedar Ahire Dr. Richa Ashama
e. Dept. of Biotechnology :	Prof. W.N.Gade
f. Bioinformatics Centre	Dr. U. Kulkarni-Kale
	Dr. Sangeeta Sawant
g. Dept. of Chemistry :	Prof. D. D. Dhavale Dr. M. Nikalje Dr. P. D. Lokhande Dr. Kodam Dr. M.V.Kulkarni

Methodology and Outcome

a. Microorganisms will be isolated from novel ecological niches and identified using morphological, biochemical and molecular tools. Isolation of bacteriophages against *Acinetobacter* and other hospital associated bacterial pathogens and their molecular characterization will be undertaken.

b. The selected plants will also be identified using conventional methodology. Compounds from the selected plants and microbes will be purified, characterized, structure-function activity elucidated and they will also be evaluated for their therapeutic potential. For this, purification will be done using solvent extractions, followed by standard chromatographic methods. The choice of methodology will be determined by the type of compound undergoing purification. The bioactive component will be characterized using biochemical and physico-chemical methods such as UV-Visible, IR spectroscopy, GC, HPLC, LC-MS and Multi-dimentional NMR. Evaluation of the bioactive compound will be undertaken using relevant bioassays

c. Molecular characterization and vesicle mediated gene transfer in planktonic and biofilms of *Acinetobacter* spp includes isolation and purification of outer membrane vesicles. Confirmation and determination of size will done by transmission electron microscopy

d. Plants will be multiplied by using conventional method as well as biotechnologicaltechniques. Potential bioactive compounds will be isolated from

invivo and *invitro* system purified, characterized and tested for anti-inflammatory activity *in-vivo* and *in-vitro.*

Deliverables

1. Identification and characterization of genes responsible for biofilms formation in *Acinetobacter* spp.
2. Isolation and characterization of novel lectins from *Acinetobacter* spp.
3. Isolation, characterization and genome sequencing of novel bacteriophages.
4. Discovery and molecular characterization of the novel microorganisms from environment.
5. Novel biomolecules with biofilm disrupting ability.
6. Process/Product patents on novel compounds.
7. Possible lead identification for modulation of cancer, life style diseases
8. Purification, characterization and evaluation of pancreatic amylase inhibitors from known Ayurvedic anti-diabetic, anti-oxidant and anticancer plants.
9. Understanding the molecular mechanism of bioremediation of heavy matels by bacteria using genomics/proteomic approach.
10. Structure determination of bio-active compounds using highly sophisticated instrumentation facility such as LC-MS and NMR.
11. Bioremediation potential of *Yarrowia lipolytica* for toxic halogenated compounds.
12. Detoxification of heavy metals and synthetic dyes by *Yarrowia lipolytica*, and other metal tolerant fungi and metal resistant bacteria such as *Acinetobacter* spp.

Related Publications

Anti-diabetic

1. Ponnusamy S, Zinjarde S., Bhargava S., Kumar AR (2011) Potent alpha-amylase inhibitory activity of Indian Ayurvedic medicinal plants. BMC Complementary and Alternative Medicine doi:10, 1186/1472-6882-11-5.
2. Ponnusamy S., Ravindran R., Zinjarde S., Bhargava S., Kumar A.R. (2010) Evaluation of traditional Indian anti-diabetic medicinal plants for Human Pancreatic Amylase inhibitory effect in vitro. Evidence Based Complementary and Alternative Medicine (doi:10.1155/2011/515647).
3. Bhat M., Zinjarde S.S., Bhargava S.Y., Kumar A.R., Joshi B.N. (2008) Antidiabetic Indian Plants: a Good Source of Potent Amylase Inhibitors. Evidence based Complementary & Alternative Medicine doi:10.1093/ecam/nen040
4. Sanap, S.P., Ghosh, S., Jabgunde, A.M., Pinjari, R.V., Gejji, S.P., Singh, S., Chopade, B.A., and Dhavale, D.D. (2010) Synthesis, computational study and glycosidase inhibitory activity of polyhydroxylated conidine alkaloids—a bicyclic iminosugar. Organic and Biomolecular Chemistry8: 3307-3315.
5. Pawar, V.U., Ghosh, S., Chopade, B. A., and Shinde, V., (2010) Design and synthesis of harzialactone analogues : promising anticancer agents. Bioorganic and Medicinal Chemistry Letters 20 (24): Pages 7243-7245.
6. Decolorization and degradation of Disperse Blue 79 and Acid Orange 10, by Bacillus fusiformis KMK5 isolated from the textile dye contaminated soil. Kolekar Y. M, Pawar S. P, Gawai K. R, Lokhande P. D, Shouche Y. S, Kodam K. M. Bioresour Technol. 2008 Dec; 99 (18):8999-9003. Epub 2008 Jun 17.
7. Chromate reduction by Burkholderia cepacia MCMB-821 isolated from pristine habitat of alkaline Crater Lake, Revati Wani, Kodam K. M., Gawai K.R. and Prashant K. Dhakephalkar, *Appl. Microbiol. Biotechnol.* 57,627-632, 2007.

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potential drug targets. Journal of Bioinformatics and Sequence Analysis. 1(3): 41-45.

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11. Bankar A.V., Joshi B.S, Kumar A.R., Zinjarde S.S. (2010) Banana peel extract mediated novel route for the synthesis of silver nanoparticles. Colloids and Surfaces A: Physicochemical & Engineering Aspects 368:58-63.
12. Bankar A.V., Joshi B.S, Kumar A.R., Zinjarde S.S. (2010) Banana peel extract mediated synthesis of gold nanoparticles. Colloids & Surfaces B: Biointerfaces 80:45–50.
13. Dusane D.H., Matkar, P., Venugopalan V.P., Kumar A.R., Zinjarde S.S. (2011) Cross species induction of antimicrobial compounds, biosurfactants and quorum-sensing inhibitors in tropical marine epibiotic bacteria by pathogens and biofouling microorganisms. Current Microbiology (DOI 10.1007/s00284-010-9812-1).
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15. Amin, M., and Kapadnis, B.P. (2005). Heat stable antimicrobial activity of *Allium ascalonicum* against bacteria and fungi. *Indian Journal of Experimental Biology* 43: 751-754.
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Bioemulsifier/ Biosurfactants

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BUDGET ESTIMATES: SUMMARY

A. Equipment:

Item	**Cost (Rs in crores)**
Inductively coupled plazma spectrometer (ICPS)	0.60
Ultracentrifuge	0.40
Total (A)	**1.00**

B. Recurring:

Item	**Yearly Budget Rs. (in crores)**					**Rs. (in crores)**
	1st	2nd	3rd	4th	5th	Total
Project Assistans (6)	0.08	0.08	0.08	0.08	0.08	0.40
Chemicals and Consumables	0.50	0.50	0.50	0.50	0.40	2.40
Contingency and Travel	0.04	0.04	0.04	0.04	0.04	0.20
Total (B)	**0.62**	**0.62**	**0.62**	**0.62**	**0.52**	**3.00**
Grand total (A+B)						**4.00**

Area II – Biotechnology & Novel Materials

Focus Area II – a: Nanomaterials and Nanobiotechnology

Synthesis, characterization and applications of novel nanomaterials for potential application in medicine and biotechnology

Objectives

- Microbial synthesis of nanomaterials
- Chemical synthesis of nanobiomaterials (core shell, quantum dots, etc)
- Synthesis and characterization of novel bionanomaterials of metals, semiconductor quantum dots, their composites and magnetic nanoparticles
- Optical properties will be studied by UV visible spepctroscopy
- Nature of binding will be studied by FTIRStructural properties will be studied by XRD, SEM and TEMMagnetic particles of $CoFe_2O_4$ will be prepared. Their optical, structural and magnetic properties will be studied
- These will be explored for design and development of sensors, detection techniques, drug delivery systems, vaccines, etc.

Departments

Biotechnology

Zoology (CAS-UGC)

IBB (UPE)

Chemistry

Faculty Members Involved

Dr. W. N. Gade (Biotechnology)

Dr. Deepti Deobagkar (Zoology)

Dr. Kedar Ahire (Zoology)

Dr. Suvidya Ranade (Chemistry)

Dr. Satyavati Joshi (Chemistry)

Dr. B.A. Chopade (IBB)

Dr. Ameeta Ravikumar(IBB)

Dr. Smita Zinzarde (IBB)

Work done so far :

During the First Phase of UPE, capabalities have been developed to use microbial systems to produce nanomaterials. Characterization is being carried out in collaboration with NCL, Pune.

Bacterial, fungal and actinomycetes are being used for the production of Quantam Dots, sulfides and matel oxides mainly as Gold, Silver or Plantinum nanoparticals. *Ecoli* has been used for production of copper nanoparticels. Silver nanoparticels are used as antibacterials agenst. Alloys (nanoparticels) of silver and titanium are used in dental treatment.

Advantages of Microbial nanoparticels:

Nanoparticels from microbial systems are –

a) Water soluable

b) Biocompatible

c) Protein capted

Hence, these can be used in drug delivery and then other biomedical applications.

Background Work

- Microbial and biological synthesis : novel approaches
- Characterization of biologically synthesized nanomaterials
- Use of nanomaterials for therapeutic purposes
- Use of DNA and other biomaterials as capping agent –DNA CdS nanoparticles – functionalisation of silver@ silica core shell particles and attachment of antibodies
- Use of surface plasmon resonance for detection of antigen antibody interaction

- Detection of microbes – using core shell particles The nanoparticles which are synthesized and characterized will be used for the study the interaction with DNA.
- Initially interaction with ss DNA and ds DNA will be studied using U.V visible spectroscopy.
- Commercially available dsDNA having base changes will be used for developing the detection system.
- Finally the human DNA having base changes will be taken for study. Spectroscopic or pH based method will be used for this.
- Emphasis will be on use of these nanomaterials for biomedical applications.

Expertise:-

- The evolution of Ag nanoparticles by photochemical reduction method and the effect of biotin on their UV-Visible absorption spectrum and ATR-FTIR were studied. Surface modification studies were carried out on chemically reduced Ag nanoparticles.
- The effect of (EGTA) in stabilizing different shapes of silver nanoparticles have been examined by electronic absorption spectroscopy and transmission electron microscopy.
- An end-to-end assembly of spherical Ag nanoparticles were prepared in the presence of biotin to form long fiberlike microstructures.
- Prefunctionalized polyoxometalate, capped Au nanoparticles were synthesized successfully in DMF. A novel method for transferring Au nanoparticles from DMF solution into non-polar organic solvent cyclohexane was developed.
- Biomodified CdS and Ag@CdS nanoparticles were synthesized using L-cysteine as a capping agent in the colloidal state. The role of pH on the size and structure of CdS nanoparticles was investigated in detail. As well as CdS nanoparticles stabilized by L-cysteine were doped with varying silver concentrations and thereby its emission study was done in detail.
- Surface properties CdS and Ag–CdS nanoparticles were studied by X-ray photoelectron spectroscopy (XPS).
- The group has experts in biochemistry, microbiology, molecular biology and genetics, zoology, bioinformatics and biotechnology.
- The University has scientists with expertise on nanoscience, sensors, physics chemistry, material sciences,electronics, etc. These would be complemented as and when required.

- In the recent years, work on the syntheses and applications of novel bio-inspired nanomaterials using microorganisms and their products as well as with the agricultural waste material is being conducted..

Methodology

1. Novel green methods for the synthesis of a variety of nanoparticles would be developed using bacterial and fungal systems.
2. The nanoparticles obtained will be characterized.
3. The mechanisms by which the synthesis occurs would be investigated.
4. Depending on the type of nanoparticle formed, applications in the following fields would be studied

    a. development of sensors

    b. as antimicrobial agents

    c. Photoluminescence studies will be done to develop a fluorescent probe

    d. Drug delivery and protein separation so the possibility will be explored for using these magnetic nanoparticles for biomedical applications

Deliverables

- Understanding the chemical and biological processes involved in nanomaterial synthesis.
- Generation of novel nanobiomaterials with novel properties and innovative applications.
- Translation of this technology in design of vaccines, drug delivery systems, detection technology. Novel ‘green synthesis’ methods would be developed using microorganisms and plants.
- Applications of these for therapeutic purposes would be studied.
- Advanced diagnostics and biosensors,
- Targeted drug delivery and smart drugs,
- Immuno- isolation therapies,
- Visualization of molecules inside the cells,
- Novel biosynthetic approaches.
- Toxicity studies will be carried out.

- **Time line : Phase wise program**

    - Phase 1 : Synthesis of materials 1-3rd year
    - Phase 2 : Characterisation- chemical, physical, biological 2-4th year
    - Phase 3 : Development of Applications 3-5th year
    - Phase 4 : Publications patenting, translation research

Budget : Total 1 Crore

Recurring		
Consumables	Rs 0.10 crores per year	0.50 crores
Contingency	Rs 0.008 crores per year	0.04 crores
Travel	Rs 0.002 crores per year	0.01 crores
JRF/Project assistants Three		0.27 crores
Non recurring		
Equipment		**0.18 crores**
Cold refrigerated Centrifuge		0.11 crores
Nanodrop spectrophotometer		0.05 crores
Microfuge (two)		0.02 crores
Total		**1.0 crore**
Overheads		as admissible

Publications in the area of nanobiotechnology

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8. Bankar A.V., Joshi B.S., Kumar A.R., Zinjarde S.S. (2010) Banana peel extract mediated novel route for the synthesis of palladium nanoparticles. **Materials Letters** 64:1951-1953.

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11. Effect of ethylene glycol-bis (2-aminoethylether)-N,N,N,N-tetraacetic acid (EGTA) on the growth, stabilization and morphology of silver nanoparticles" S.Hegde, S.S.Joshi, S.Kapoor, T.Mukherjee **Coll. Surf. A**, 280, 116,2006

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19. Rautaray, D., Bansal, V., Bharade, A., Ahire, K., Sanyal, A., Ahmed, A. and Sastry, M. (2005) Fungus mediated biosynthesis of silica and titania nanoparticles. Journal of Materials Chemistry, 15:2583-2589.

Area II – Biotechnology & Novel Materials

Focus Area II –*b) Novel Materials for Energy Harvesting*

Aim:

Development of Novel materials for applications in (a) Direct alcohol Fuel cell (b) Rainbow solar cell (c) CZTS based thin film solar cells (d) Dye sensitized solar cells (e) Gas Storage and (f) Supercapacitors for energy storage devices.

Participating Departments :

- Physics: UGC-CAS Phase IV (2005-10), DST-FIST level 2 Phase II (2007-2012)
- Chemistry: UGC-CAS Phase III currently ongoing, DST-FIST Phase III ongoing
- School of Energy Studies

(a) Materials for alcohol fuel cell and solid oxide fuel cell

(i) Development of novel composite materials based on graphene oxide and reduced graphene oxide, MWCNTs, TiO_2, metal alloy nanoparticles and polyaniline conducting polymer materials and membrane based on Polybenzimidazole (PBI) Poly(ethylene oxide)

Participating faculty:

Name	Department	Expertise based on the published work
Dr. Anjali Athavale	Chemistry	• Conducting polymers. • perovskites materials for SOFCs and gas sensor applications
Dr. Santosh Haram	Chemistry	• MWCNTs, Graphene, Pt-based novel materials for fuel cell and sensor applications. • Electrochemical techniques
Prof. Anjali Kshirsagar	Physics	• Band structure methods for bulk and nano structures to understand the electronic structure and related properties • Effect of doping metal impurities in semiconductors in bulk and cluster
Dr. Subhash Pingale	Chemistry	• Electrostatic based computational Theory

Dr. Geeta Sharma	Chemistry	• Nano and mesoporous metals by □-radiolysis and surfactant assisted synthesis • LINAC
Dr. Vaishali Shinde	Chemistry	• Synthetic organic chemist. • Preparation of Polymeric materials
Dr. Pragati Thakur	Chemistry	• Synthesis of TiO_2 –MWCNTS based materials for the adsorption and catalysis.

Background and Hypothesis:

Energy is one of the important concerns of the 21st century. Advances in the science and technology have focused on finding new alternatives approaches to improve energy production, such as conversion of sunlight to electricity or conversion of bio-fuel directly into electricity. Development of fuel cells is one such mandate. Fuel cells have known since the time of Faraday i.e. middle of 19th century and have gained great attention during 1960s because of developments in the space technology by NASA. Fuel cell is a galvanic cell (like torch cell), where the fuel (e.g.H_2) and O_2 (e.g. air) is pumped at respective electrodes separated by a membrane, which leads to the conversion of chemical energy into the electricity, without limits of Carnot cycle. Thus, the fuel cells deliver practical efficiency over 60% which is ca.5 times higher than conventional internal combustion engines. Different architecture and fuels have been developed for these devices. Among them, alcohols and more specifically methanol is safer and cheaper and easily available as a bi-product from sugarcane industry and thus preferred over H_2. The fuel cell in which alcohols are used directly as a fuel is called direct alcohol fuel cells (DAFCs). Methanol oxidation is a six-electron transfer reaction that follows the scheme:

$$CH_3OH + H_2O \xrightarrow{Pt} CO_2 + 6H^+ + 6e^-$$

This reaction has a thermodynamic potential of 0.04 V vs. standard hydrogen electrode (SHE) and can approach a power output as high as pure hydrogen-based fuel cells. The further development in the field is however have been limited by (1) CO poisoning of the electro-catalyst which is normally platinum impregnated carbon and (2) The conventional Nafion® membrane used here "leaks" the fuel between two compartments. Thus, the further development in this field is pivoted on fundamental research in finding out "holy" support/catalyst composites which will enhances the CO tolerance and stable polymer membrane material which will permeable to only H^+ and stable at over 100^0C. The most prominent strategies have been (1) use of bi-metallic alloy nanoparticle catalysts (2) use of conducting metal oxides with conducting polymers carbon nanotubes and more recent graphane based materials as a support and (3) use of alternative acid-base membrane materials. So far, these

efforts have been isolated in nature word wide and to crack the problem the collecting efforts by a single group having all the necessary expertise is desirable.

With this background of information and moreover based on "collective expertise" gain in UPE phase I (CNQS), we set following collective objectives in developing Novel materials for the direct alcohol Fuel cell applications.

Objectives:

- To develop novel composite materials supports, based on graphene oxide and reduced graphene oxide, MWCNTs, TiO_2 and polyaniline conducting polymer based materials.
- To develop the active metal parts, based on Pt, Pd, Ru Au and Pb alloys nanoparticles and having mesoporous morphology.
- To develop proton exchange membrane materials based on composites of Polybenzimidazole (PBI) and Poly (2-acrylamido-2-methyl-1-propanesulfonic acid) with inorganic additives.
- To develop pervoskite based cathode materials to facilitate O_2 reduction reaction in DAFCs and solid metal oxide (SOFCs) fuel cells.
- To model metal nanoparticles of Au/Ag/Pd/Pt on or near a single or double graphene (oxide) sheet using super-cell approach, to determine the relaxed geometry and the electronic structure and related quantities like density of states, charge density, conduction near the sheet etc and to predict suitable combination for application in fuel cells.

(i) Methodology to Prepare Novel Anode materials

- **To prepare graphene and MWCNTs based materials:**
  - Chemical method: The graphene oxide will be prepared by exfoliation of graphite by chemical method. The resultant product will be co-reduced in presence of metal salts using hydrazine hydrate or □-radiolysis to give graphene/metal composites.
  - CVD method: MWCNTs will be prepared by CVD method and functionalized with chemical methods. The composites with metals will be prepared by □-radiolysis.
  - Surfactant template method: Amphiphilic surfactants, will be mixed with graphane and MWCNTs which will lead to their self organization as hemimicelles on the nanotube surface. These coated MWCNTs/graphene

will be treated with metal salts will be subject to γ-radiolysis to formed metal NPs decorated MWCNTs/graphene.

- **To prepare conducting polymer based novel composites:**
  - Single step method- The metal/ MWCNTs would be mixed in monomer solution in acidic medium. This mixture would be used for electro polymerization, forming the composite film on electrode like glassy carbon or carbon paper.
  - Double step method- The metal/ MWCNTs would be dispersed in ethanol and Nafion. This mixture would be casted on the surface of the electrode, dried up and will use for electropolymerization with monomer in acidic solution to obtain a thin film of polyaniline nonofibers.
  - Monomers – Aniline, pyrrole, and their substituted derivatives or co-polymers.
  - Metals – Pt, Rh, Ag etc.
  - Oxides- TiO_2, ZnO, CuO
- **To prepare TiO_2 MWCNTs nano-composites**
  - TiO_2 nanoparticles will be prepared by sol-gel, and solvothermal and microemulaion methods.
  - TiO_2-MWCNTs composites will be prepared by impregnation method.

(ii) Methodology to Prepare Novel Proton Exchange Membrane (PEM) Materials:

- polybenzimidazole and Poly (2-acrylamido-2-methyl-1-propanesulfonic acid)(PAMPS) based polymers will be prepared by synthetic organic chemistry routes.
- These will be impregnated with TiO_2 particles, silicotungstic acid, phosphotungstic acid, zirconium phosphate/phosphonate to elevate the ionic conductivity.

(iii) Methodology to Prepare Novel Cathode materials for SOFCs:

- Material of focus will be Perovskite, Ruddlesden – Popper type materials and ordered double perovkites viz. $LaMnO_3$, $LaFeO_3$, $LaNiO_3$. A site – La, Sr, Pr, Ag and B site ion - Ce, Co, Fe, Cu.
- These will be prepared by solid state, Pechini , Co-precipitation, solvothermal and microwave assisted methods.

(iv) Methodologies for the Characterization of Materials:

- Material characterization will be done by XRD, TEM, SEM, BET, Raman, and far-infraread spectroscopy
- The alcohol oxidation reactions and O_2 reduction reactions on so developed anode and cathode materials respectively will be accomplished by voltammetry and electrochemical impedance spectroscopy techniques.

(v) Methodology for the computational Modeling:

- Density functional based psuedopotential approach with plane wave basis set will be employed to find the electronic structure and related properties. A supercell with about 100-200 atoms per unit cell will be used. We will be using VASP or BigDFT package for the calculations.
- To determine conductivity across the contact, Landuer approach will be used. Improvement in the band gap is expected by using the self-interaction correction (SIC) which crops up as a result of local density or generalized gradient approximation. Programs will be modified to incorporate SIC.

Expected outcome/deliverables

- Well characterized formulations of composite anode and cathode materials for the direct alcohol fuel cell based applications. Validated materials with respect to kinetic parameters will be delivered.
- Novel composites of organic and in-organic membrane materials will be deliverable.
- It is expected that the understanding of electronic structure in comparison with the experimental results will help in identifying better combination of materials for the fuel cell applications.
- Holistic deliverables such as trained manpower and course content in this field will be sought.

Phase wise program

First phase (year 1-2): Preparation and characterization of all the above mentioned materials will be undertaken. Appointment of JRF, training for using the software, review of literature and initiation of the calculations will be carried out

Second Phase (year 2-3) Formulation of the composites electrodes and characterization by various spectroscopic techniques will be done in the second phase. Implementation of the calculations for graphene, graphene oxide, optimization for

size of supercell and other computational parameters are expected. Understanding the results of electronic structure of graphene/graphene oxide/reduced grapheme oxide. Incorporation of SIC corrections will be also initiated in this phase.

Third Phase: (year 3-4) investigation of modified electrodes by voltammetry and electrochemical impedance spectroscopy will be done in the third phase. metal nanoparticles near the graphene based structures will be studied and results for different metal particles will be compared to identify the best combination.

Fourth phase: (year 4-5) Analysis of results, comparison of theory with the experiments and report writing.

Representative Publications to support the claims

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2. Fabrication, Characterization and Electrochemical Performance of Single Strand Carbon Fiber Prepared by Catalytic Chemical Vapor Decomposition Method, V.S. Joshi, S.P. Gokhale, K.R. Patil, S.K. Haram, Electrochimica Acta **55,** 2022 (2010)
3. Filling and coating of multi walled carbon nanotubes with silver by DC electrophoresis, Kanchan M. Samant, Vijay R. Chaudhari, Sudhir Kapoor, Santosh K. Haram, Carbon, 2126 (2007)
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13. "Electronic structure of GaN codoped with Mn and Cr, Nandan Tandon, G.P. Das, and Anjali Kshirsagar Phys. Rev. B **77**, 205206 (2008)

14. Passivation of CdTe clusters : A first principle study, Somesh K. Bhattacharya and Anjali Kshirsagar Eur. Phys. J. D **48**, 355 (2008)

15. How cationic gold clusters respond to a single sulfur atom, Hagos W.Ghebriel and Anjali Kshirsagar J. Chem. Phys. **127**, 224708 (2007)

(b) Identification of semiconductor quantum dots based Novel Materials for rainbow solar cells

Participating faculty:

Name	**Department**	**Expertise based on the published work**
Prof. Shailaja Mahamuni	Physics	• Investigation of "high quality" quantum dots in terms of surface defects, size and shape dispersion photo-luminescence, linear and nonlinear optical techniques • Will provide nonmonotonic electron energy levels as a function of size and role of surface defects in ferromagnetic ordering of nanocrystals

Dr. Santosh Haram	Chemistry	• Experience in the field of voltammetry on semiconductor quantum dots • will provide band structure parameters, viz. quasi-particle gap, conduction and valance band edges with respect to vacuum
Prof. Anjali Kshirsagar	Physics	• Band structure methods for bulk and nano structures to understand the electronic structure and related properties • Effect of doping metal impurities in semiconductor clusters will be studied as a function of size and shape of clusters

Objective of the work :

- To study semiconductor quantum dots by optical spectroscopies including Raman Spectroscopy to find out the conditions under which they are more suitable for photovoltaic conversion. A process of multiexciton generation in quantum dots will be especially examined. The phenomenon of multiple exciton generation would be of great potential to increase the solar cell efficiency beyond the thermodynamic limits.
- Use of semiconductor quantum dot arrays to improve the photovoltaic conversion efficiency by virtue of different forbidden gap and hence absorption in different spectral regime.
- Study of excitonic effects in semiconductor quantum dots by theoretical approach to understand the experimental results

Expected outcome

a) Coherent picture of charge carrier relaxation in quantum dots and nanostructures would be vivid from our work. Such knowledge is essential for possible use of quantum dots for photovoltaic conversion.

b) A process involving production of uniform absorbing layer on solar cell to enhance the photovoltaic conversion efficiency will be developed.

c) Theoretical understanding of the excitonic effects using time-dependent density functional theory will be able to predict a better materials for solar cell with good efficiency.

Phase wise breakup for the work

In first phase (years 1-2), semiconductor quantum dots of varying sizes and shapes, with very less size dispersion in each category, will be synthesized. Necessary programs will either be procured or developed for exciton calculations.

In second phase (years 3-4), voltammetric characterization will be done on dispersions of semiconductor Q-dots. Band structure parameters will be evaluated. Photoluminescence and optical absorption studies will provide band gap information. Theoretical calculations will also provide complimentary data.

In the third phase (years 4-5), the experimental and theoretical results will be compared and suitable materials will be identified.

Representative Publications to support the claims

1. Shaukatali N. Inamdar, Pravin P. Ingole, and Santosh K. Haram, ChemPhysChem.**9**, 2574 (2008)

2. Santosh K. Haram, Bernadette M. Quinn and Allen J. Bard,J. Am. Chem. Soc.**123,** 8860 (2001)

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4. Ferromagnetism in ZnO Nanocrystals: Doping and Surface Chemistry. D. Y. Inamdar, A. D. Lad, A.K. Pathak, I. Dubenko, N. Ali, and ShailajaMahamuni, J. Phys. Chem. C. **114**, 1451(2010)

5. Effect of ZnS Shell Formation on the Confined Energy Levels of ZnSe Quantum Dots. Amit D. Lad and Shailaja Mahamuni, Phys.Rev. B **78**, 125421 (2008).

6. Synthesis and Studies of Cu2O Quantum Particles Kavita Borgohain, Norio Murase, and Shailaja Mahamuni, J.Appl.Phys. **92**, 1292 (2002)

7. Quantum Size Effects in CuO Nanoparticles K. Borgohain, J.B. Singh, M.V. Rama Rao, T. Shripathi, and Shailaja Mahamuni, Phys. Rev.B **61**, 11093 (2000)

8. Doped Cage-like Structure of Cd_9S_9, Prajakta Deodhar and Anjali Kshirsagar, AIP Conference Proceedings **1276**, 425 (2010)

9. Transferable orthogonal tight-binding parameters for ZnS and CdS, Somesh Kr Bhattacharya, Prajakta A. Deodhar, Ranjani Viswanatha and AnjaliKshirsagar, J. Phys.: Condens. Matter **22**, 295304 (2010)

10. Passivation of CdTe clusters : A first principle study, Somesh K. Bhattacharya and Anjali Kshirsagar, Eur. Phys. J. D **48**, 355 (2008)

11. Ab initio calculations of the structural and electronic properties of CdTe clusters, Somesh K. Bhattacharya and Anjali Kshirsagar, Phys. Rev. B **75**, 035402 (2007).

(c) State-of-the-art Cu_2ZnSnS_4 (CZTS) based thin film solar cell with maximum possible efficiency and low cost

Participating faculty:

Name	Department	Expertise based on the published work
Sandesh Jadkar	Physics	• experience on the development of solar cells using nanocrystalline silicon • HWCVD process and PECVD process for synthesis of nanocrystalline silicon material
S. V. Ghaisas	School of Energy Studies	• Simulations of different processes including catalysis, fracture, growth • ab-initio calculations of nanostructures using density functional theory.
Suresh Gosavi	Physics	• Lithography and pattern transfer • Development of Micro photosensors and lead free thermistor using photoimagable thick film technology • Synthesis of metal and semiconductors nanostructures using chemical and biological route.

Objectives of the work:

- Establishment of multi-chamber, multi-target RF sputtering unit
- Synthesis and characterization of p-type Cu_2ZnSnS_4 (CZTS) thin films by RF sputtering system in H_2S partial pressure in argon
- Synthesis and characterization of n-type ZnS thin films by RF sputtering system/chemical bath deposition

- State-of-the-art CZTS based thin film solar cell with maximum possible efficiency

Methodology to be followed :

A multi-chamber/multi-target radio frequency (RF) sputtering deposition technique is proposed to design, fabricate, and commission for the synthesis of p-type CZTS thin films. The synthesis of CZTS thin films will be done by the co-sputtering of Cu, Zn, Sn with H_2S partial pressure in Argon. The H_2S reacts with metals during sputtering to produce final CZTS films. Using multi-chamber/multi-target RF sputtering it possible not only to load or unload the substrates into the process chamber without breaking the vacuum, but also to increase the repeatability of the experimentation. Various process parameters during the deposition decide the growth of CZTS films. It is therefore propose to undertake extensive study of influence of these process parameters on synthesis of p-type CZTS films, film properties and structure. These parameters will be optimized to get the device quality p-type CZTS films at higher deposition rates and at low substrate temperature. The effect of process parameters will be studied for structural, electrical, and opto-electronic properties using various techniques such as dark and photoconductivity measurement, Hall measurement, UV-Visible spectroscopy, Fourier Transform Infra Red (FTIR) spectroscopy, Low angle X-ray diffraction (XRD) spectroscopy, Raman spectroscopy, Scanning Electron Microscopy (SEM), Scanning Tunneling Microscopy (STM), Transmission Electron Microscopy (TEM) etc. Simultaneously, synthesis of n-type ZnS thin films by RF sputtering system/chemical bath deposition will be carried out. Attempt will be made to prepare device quality ZnS films with desired properties. These films will be studied for structural, electrical, and opto-electronic properties using various techniques mentioned above. An important evolution of p-type CZTS and n-type ZnS films would be carried out by fabricating **single junction solar cell** structures entirely deposited by RF sputtering/chemical bath deposition.

Expected outcome :

The important fallout of proposed work in Novel Materials for Energy Harvesting in UPE Phase II will be the development and establishment of the highly sophisticated multi-chamber/multi-target radio frequency (RF) sputtering deposition technique and fabrication of single junction CZTS thin films based solar cell structures entirely by RF sputtering deposition system-***an attempt which is totally new.*** The success of these attempts have a strong implication towards technology as the RF sputtering deposition is rather simple and less expensive than the conventional techniques and can be scaled up for large area depositions. The schematic of proposed solar cell is shown in figure 1.

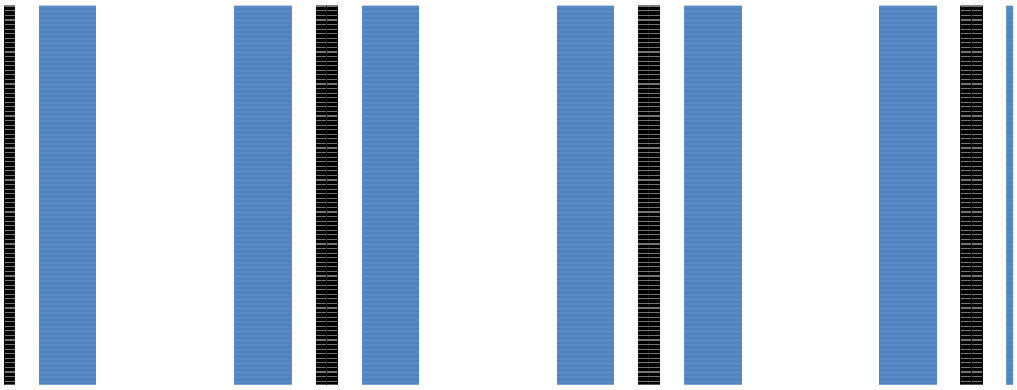


Figure 1: Schematic of proposed single junction CZTS based solar cell structures

Phase wise breakup for the work:

Phase I (Year 1): Establishment of multi-chamber, multi-target RF sputtering unit and synthesis and characterization of p-type Cu_2ZnSnS_4 (CZTS) thin films in H_2S partial pressure in argon

Phase II (years 2 & 3): Synthesis and characterization of n-type ZnS thin films by RF sputtering system/chemical bath deposition

Phase III (years 4 & 5): State-of-the-art CZTS based thin film solar cell with maximum possible efficiency

Representative Publications to support the claims

1. Role of Argon in HW-CVD deposited hydrogenated nanocrystalline silicon (nc-Si:H) thin films Nabeel A. Bakr, Adinath M. Funde, Vaishali S. Waman, Tushar S. Salve, S. P. Gokhale and Sandesh R. Jadkar Thin Solid Films (In Press, Accepted Manuscript, and available online 24 February 2011)
2. Influence of deposition pressure on structural, optical and electrical properties of nc-Si:H films deposited by HW-CVD N. A. Bakr, A. M. Funde, V. S. Waman, M. M. Kamble, R. R. Hawaldar, D. P. Amalnerkar, V. G. Sathe, S. W. Gosavi, and S. R. Jadkar Journal of Physics and Chemistry of Solids (Accepted for publication) (2010)
3. Determination of the optical parameters of a-Si:H thin films deposited by HW-CVD technique using transmission spectrum only Nabeel A. Bakr, Adinath M.

Funde, Vaishali S. Waman, M. M. Kamble and Sandesh R. Jadkar Pramana: Journal of Physics (Accepted for publication) (2010)

4. Observation of Photoconductivity in Sn doped ZnO nanowires and their Photo-Enhanced Field Emission behaviour J. S. Farid, M. A. More, S. R. Jadkar, K. R. Patil, P. Vijayamohanan and D. S. Joag Journal of Physical Chemistry C 114, 3843 (2010)

5. Influence of argon flow on deposition of hydrogenated nanocrystalline silicon (nc-Si:H) films by plasma chemical vapour deposition A. M. Funde, Nabeel Ali Bakr, D. K. Kamble, R. R. Hawaldar, D. P. Amalnerkar and S. R. Jadkar Journal of Nano Research 5, 185 (2009)

6. Optical properties of zinc selenide clusters from first-principles calculations Sachin P. Nanavati, V. Sundararajan, Shailaja Mahamuni, Vijay Kumar, and S. V. Ghaisas Phys. Rev. B 80, 245417 (2009)

7. Ab-initio Calculation for the Study of Nano Scale Silicon-based Structure Sudip Chakraborty, G. Shashidhar and S. V Ghaisas Solid State Phenomena 139, 113 (2008)

8. Structure and Energetics of Silicon clusters adsorbed on Au (111) Surface: A first principles study Sudip Chakraborty, S.V.Ghaisas and Chiranjib Majumder International Journal of Nanotechnology 7, 833 (2010)

9. Qunatum Confinement effect in pristine and oxygen covered silicon nanocrystals with surface states Sudip Chakraborty, Subhash V Ghaisas, Ch Rajesh, Shailaja Mahamuni Accepted in Journal of Computational and Theoretical Nanoscience

10. A Micro/Nano Photoconductor G.G. Umarji, S.W. Gosavi, U.P.Mulik and D.P.Amalnerkar **PATENT** (2010), Application no 1561/MUM/ 2010

11. Study on I-V characteristics of *lead free* NTC thick film thermistor for self heating applicationShweta Jagtap, Sunit Rane, Suresh Gosavi, and Dinesh Amalnerkar *Microelectronic Engineerin* In Press, Accepted Manuscript, Available online 31 August 2010

12. Study of microstructure, impedance and dc electrical properties of RuO_2 based screen printed 'green' NTC thermisters Shweta Jagtap, Sunit Rane, Rohini Aiyer, Suresh Gosavi, Dinesh Amalnerkar, Current Applied Physics 10, 1156 (2010)

13. An investigation on TiO_2–ZnO based thick film '*solar blind*', photo-conductor for 'green' electronics Govinda Lakhotia, Govind Umarji, Shweta Jagtap, Sunit Rane, Uttamrao Mulik, Dinesh Amalnerka and Suresh W. Gosavi J. Mat. Sci. and Engg. B. 168, 66 (**2010)**

As it is evident from the literature survey that the CZTS based thin film solar cell photovoltaic devices are expected to come up in the market in the big way. If the single junction solar cells made by the RF sputtering method are found to be better than those obtained from the glow discharge technique in terms of stability and performance, then there is a scope for large scale utilization of this material in the photovoltaic industry. It is with this contention the present project attempts to explore the feasible of synthesis of single junction solar cell structures with conversion efficiency than what has been realized by the conventional techniques. The significance of the success of these attempts have a strong implication towards technology as the RF sputtering method is fairly simple and less expensive than the other methods and can be scaled up for large area depositions.

(c) Development of Novel Dye molecules and oxide nanoparticles for the Dye Sensitized (Gratzel) Solar Cells

Participating faculty:

Name	Department	Expertise based on the published work
Dr. Habib Pathan	Physics	• Synthesis of materials useful for Fabrication and development of 2^{nd} and 3^{rd} generation solar cells
Dr. Sunita Salunke-Gawali	Chemistry	• Synthesis and characterization of metal complexes
Dr. Shrikrishna Sartale	Physics	• Synthesis of nanocrystalline metal and metal oxides
Dr.Subhash Pingale	Chemistry	• *Ab initio* theoretical calculations on the molecular electronic properties and their structure-property relationship
Prof. Shailaja Mahamuni	Physics	•
Satyavati Joshi	Chemistry	• Synthesis of TiO2 nanoparticles by electrochemical and polyol method • Synthesis of flower-like ZnO nanostructures by aqueous solution route and ZnO nanobeads by aqueous polymer thermolysis method

Objectives:

- Synthesis of different dyes
- Synthesis of TiO2, its composites and ZnO nanoparticles and characterization of synthesized samples by UV-DRS, Powder XRD, FTIR, TG-DTA, SEM and TEM
- Deposition of meso-porous nanocrystalline metal oxides viz. TiO_2, CeO_2, etc. Immobilization of dye with specific particle size on Metal oxide electrode and approach to develop Dye Sensitized Solar Cells (DSSC) for energy harvesting
- Theoretical study on electron transfer which is the basis for potential application of dye-sensitized solar cells
- Study of opt0electronic properties employing Density Functional Theory (DFT) and quantum mechanical (QM) methods

Methodology to be followed :

For Dye:

- Synthesis of the ligands 4, 4'-dialkylated-2, 2'-bipyridine ligands will be carried out using, 4, 4'-dimethyl-2, 2'-bipyridine, Butyl lithium or lithium di-isopropyl amide solutions, with various n-alkyl bromides. The characterization of the ligands as well as the amphiphilic metal complexes will be done by single crystal X-ray structure, FTIR, ^{1}HNMR, Elemental Analysis etc studies.
- Compositions and thermodynamic parameter would be further obtained from thermal methods such as TGA, DSC and DTA. Electrochemical behaviour will be studied by Cyclic Voltammetry, and magnetic behaviors will be studied by EPR and variable temperature magnetic measurements.
- The morphology of the various nanoaggregates formed in different solvents will be studied by microscopy techniques such as SEM, TEM, and AFM. Particle size in solution will be determined by DLS (Dynamic Light Scattering) and cryo-SEM.

For metal oxide matrix:

Synthesis of nanocrystalline metal oxides using chemical approach. The characterization of the nanocrystalline metal oxides by X-ray diffraction, UV-Vis spectroscopy, Scanning Electron Microscopy, Tunneling Electron Microscopy etc. Synthesis of nanomaterials by Sol Gel, Electrochemical or Sonochemical synthetic methodologies as per the requirement.

Theoretical study:

- Molecular properties of the present dyes will be studied by using *ab initio* quantum chemical methods.
- Their Structure-property relationship will be explored with the above methods and novel dyes will be suggested for dye-sensitized photovoltaic cells by optimizing structure-property parameters.

Expected outcome :

- Synthesis of TiO2, its composites and ZnO nanoparticles to satisfy following factors for efficient light harvesting and conversion : (i) Very high surface area of nanostructured oxides for dye adsorption, (ii) Efficient injection of electrons from excited dye to conduction band of TiO2 should be done and (iii) Transport of charge carriers should take place with a minimized recombination loss of electrons.
- Development Novel Dye Molecule to achieve better conduction.
- DSSC with moderate price with considerable efficiency.
- Optoelectronic propertied of the dye molecules in dye-sensitized solar cells will be explored.
- Based on these properties novel dye molecules will be suggested for better efficiency of the cell

Phase wise breakup for the work:

Year 1-3: Synthesis of required materials/dyes useful for DSSC

4-5: Fabrication and development of DSSCs and studies employing theoretical calculations.

Representative Publications to support the claims

1. "An effective use of nanocrystalline CdO thin films in dye-sensitized solar cells", R.S. Mane, H. M. Pathan, C.D. Lokhande, S. –H. Han, Solar Energy **80**, 185 (2006). Included in Science Direct TOP25 Hottest Articles
2. "Nanocrystalline TiO2/ZnO Thin Films: Fabrication and Application to Dye-Sensitized Solar Cells", R. S. Mane, W. J. Lee, H. M. Pathan, S. –H. Han, J. Phys. Chem. B **109**, 24254 (2005)
3. "Magnetic and Mössbauer investigation of photomagnetic Prussian Blue analogue $Na_{0.45}Co[Fe(CN)_6]_{0.79}\cdot 3.4H_2O$: relaxation of the thermally quenched

state, dehydration effect on the thermal hysteresis loop" S. Gawali-Salunke, I. Maurin, K. Boukheddaden, E. Codjovi, K. Hashimoto, H. Tokoro, S. Ohkoshi, F. Varret , The Journal of Physial Chemistry B **109**, 8251 (2005)

4. "Metal-Complexes as Ligands To Generate Asymmetric Homo- and Heterodinuclear MAIIIMBII Species: A Magneto-Structural and Spectroscopic Comparison of Imidazole-N Versus Pyridine-N" Biplab Biswas, Sunita Salunke-Gawali, Thomas Weyhermüller, Vinzenz Bachler, Eckhard Bill and Phalguni Chaudhuri , Inorg. Chem. **49**, 626 (2010)

5. Scanning tunneling microscopy study of growth of Pt nanoclusters on thin film Al_2O_3/NiAl(100)" S. D. Sartale, H. W. Shiu, M. H. Ten, J. Y. Huang and M.-F Luo , "Surface Science **600,** 4978 (2006)

6. "Chemical and electrochemical synthesis of nanosized TiO_2 anatase for large area photon conversion," B. R. Sankapal, S.D. Sartale, M. Ch. Lux-Steiner and A. Ennaoui, Comptes Rendus Chimie, **9**, 702 (2006)

7. Room temperature synthesis of compact TiO_2 thin films for 3-D solar cells by chemical arrested route" R.S. Mane, Yun Hee Hwang, C.D. Lokhande, S.D. Sartale and Sung-Hwan Han, Applied Surface Science, **246,** 271 (2005)

8. "Electrostatic insights into molecular hydration process: A case study of crown ethers", S. S. Pingale, S. R. Gadre and L. J. Bartolotti, J. Phys. Chem. A **102**, 9987 (1998)

9. "Polarization-corrected electrostatic potential for probing cation-binding patterns of molecules: I. Saturated hydrocarbons", S. R. Gadre and S. S. Pingale, J. Am. Chem. Soc. **120**, 7056 (1998)

10. "Polarization-corrected molecular electrostatic potential for the cation binding problem" S. S. Pingale and S. R. Gadre, Chem. Phys. Letter **340**, 604 (2001). "Ab initio study of substituent effect on molecular p-conjugation", S. S. Pingale, Proceedings of ICEP (2010) (Accepted for publication).

11. Polymerized organic–inorganic synthesis of nanocrystalline zinc oxide Prajakta R. Patil, Satyawati S. Joshi Materials Chemistry and Physics **105,** 354 (2007)

12. Low temperature pH dependent synthesis of flower-like ZnO nanostructures with enhanced photocatalytic activity Mukta V. Vaishampayana, Imtiaz S. Mulla, Satyawati S. Joshi, Material Research Bulletin accepted **2010**

(e) Development of viable gas storage materials

Participating faculty:

Name	Department	Expertise based on the published work
Dr. S. B. Waghmode	Chemistry	• Synthesis of micro- and meso-porous silica materials and their characterization
Dr. A.S. Kumbhar	Chemistry	• Synthesis of coordination compounds for applications in biological chemistry, catalysis and gas adsorption studies • Use of bipyridineglycoluril as a building block for several metallosupramolecular synthons resulting in diverse self-assembled networks forming channels encapsulating solvent, anions, and gas molecules
Dr. K.M. Kodam	Chemistry	• bioremediation, degradation of different pollutants
Dr. Geeta Sharma	Chemistry	• Nano and mesoporous metals by □-radiolysis and surfactant assisted synthesis • LINAC

Objectives :

- Study of various novel materials for gas storage (hydrogen, carbon dioxide, oxygen, methane)
- Synthesis of various metallosupramolecular networks of transition metal complexes and mesoporous silica nanotubes
- Synthesis of liquid crystalline noble metal mesophase materials and nanomaterials by green route

Methodology to be followed :

- Coordination complexes of individual polypyridyl, benzenedicarboxylate and tetrazolate ligands as well as mixed ligands will be synthesized and thoroughly characterized structurally. The permanent porosity of these complexes will be confirmed by gas adsorption measurements.

- Mesoporous silica nanoparticles will be synthesized by reacting tetraethyl orthosilicate with a template hexadecyltrimethylammonium bromide (CTAB). Template will be removed by washing with a solvent or calcination at appropriate temperature. Optimization of synthesis conditions will be studied. Noble metals such as Pt, Pd, Pt-Pd (appropriate metals salts) will be loaded by wet impregnation and green process. Different noble nano particles will be synthesized by green route using plant extracts.
- Giant direct hexagonal mesophases will be made by a quaternary system (water, surfactant, co-surfactant, and oil) using "nanoreactors" to synthesize structured nanomaterials in the aqueous and oil phases. These swollen mesophases (SLC) will be doped with a large amount of metal salts of various types. These doped samples will be exposed to fast radiolytic reduction by gamma/ electron beam irradiation. The hydrated electrons and the reducing radicals produced during the radiolysis.
- These synthesized materials will be thoroughly characterized by various techniques such as low angle XRD, SEM, TEM, elemental analysis, TGA, DSC and DTA, FTIR, NMR, UV-vis, BET-surface area, ESI-MS, Time Resolved Fluorescence, Steady State Fluorescence, Cyclic voltammetry etc. The adsorption of gases such as hydrogen, methane, carbon dioxide and nitrogen shall be studied.

Expected outcome:

The synthesis and thorough characterization of materials will give insight to design promising gases storage material(s). This study will help to develop a viable hydrogen gas storage material(s), which will be tested for other gases too. Along with this work training of manpower will also be done. This study will result in publications/patents in high impact journals in collaboration.

Phase-wise plan:

Phase	**Activity**
I	Procurement of equipments, chemicals and project staff
II	Synthesis and characterization of materials
III	Synthesis and characterization of materials; Catalytic activity study
IV	Catalytic activity study; Optimization of conditions
V	Correlation of data and writing reports and manuscripts

Representative Publications to support the claims

Sr. No.	Title of paper	Authors	Journal details	Impact Factor (2009)	Citations Scopus
1	Stabilization of acyclic water tetramer in a Copper(II) malonate framework structure	M.S.Deshpande, **A.S.Kumbhar**, C.Nather	Dalton Trans. 2010, 39, 9146–9152.	4.10	0
2	H-bond directed open-Framework of bis(bipyridine-glycoluril)phosphatocobalt(III) with solvent accessible void space	Deshpande, M. S.; **Avinash S.Kumbhar** Puranik, V. G.	CrystEngComm. 2008, 10,1520-1523	4.20	6
3	Hydrogen Bonding-Directed Metallosupramolecular Structural Motifs Based on a Peripheral Urea Fused Bipyridine Tecton	Deshpande, M. S.; **Avinash S.Kumbhar** Puranik, V. G.	Cryst. Growth Des.; 2008, 8, 1952-1960.	4.16	6
4	Supramolecular Self-assembled Ruthenium-Polypyridyl Framework Encapsulating Discrete Water Cluster	MS.Deshpande, **A S.Kumbhar** Vedavati G. Puranik and K. Selvaraj	Cryst.Growth & Design, 2006, 6, 743-748	4.16	24

1 Isopropylation of benzene with 2-propanol over AFI aluminophosphate molecular sieves substituted with alkaline earth metal Suresh B. Waghmode, S.K. Saha, Y. Kubota and Y. Sugi *Journal of Catalysis, 228 (2004) 192.*

2 Physicochemical investigations of the basicity of the cation exchanged ETS-10 molecular sieves Suresh B. Waghmode, R.Vetrivel, S.G. Hegde, C.S. Gopinath and S. Sivasanker *Journal of Physical Chemistry B, 107 (2003) 8517.*

3 Physicochemical investigations of the basicity of the cation exchanged ETS-10 molecular sieves Suresh B. Waghmode, R.Vetrivel, S.G. Hegde, C.S. Gopinath and S. Sivasanker *Journal of Physical Chemistry B, 107 (2003) 8517.*

4 Influence of the nature of the exchanged ion on n-hexane aromatization activity of Pt-ETS-10 Suresh B. Waghmode, T.K. Das, R. Vetrivel and S. Sivasanker *Journal of Catalysis 185 (1999) 265.*

5. Decolorization and degradation of Disperse Blue 79 and Acid Orange 10, by B*acillus fusiformis* KMK5 isolated from the textile dye contaminated soil, Yogesh M. Kolekar , Shrikant P. Pawar, Kachru R. Gawai, Pradeep D. Lokhande, Yogesh S. Shouche, Kisan M. Kodam, Bioresource Technology 99, 8999 (2008)

6. **Highly Swollen Liquid Crystals as New Reactors for the Synthesis of Nanomaterials,** Surendran, G.; Tokumoto, M. S.; Pena dos Santos, E.; Remita, H.; Ramos, L.; Kooyman, P. J.; Santilli, C. V.; Bourgaux, C.; Dieudonne, P.; Prouzet, E.; *Chem. Mater. 17* 1505 (2005)

7. **Existence and Stability of New Nanoreactors: Highly Swollen Hexagonal Liquid Crystals** Pena dos Santos, E.; Tokumoto, M. S.; Surendran, G.;

Remita, H.; Bourgaux, C.; Dieudonne, P.; Prouzet, E.; Ramos, L.; *Langmuir 21*, 4362 (2005)

8. From self assembly of Platinum nanoparticles to nanostructured materials. Geetarani Surendran, Gabriela Apolstolescu, Myriam Tokumoto, Eric Prouzet, Lawrence Ramos, Patricia Beaunier, Patricia Kooyman, Arnaud Etcheberry, Hynd Remita, *Small* **1**, 964 (2005)

9. Synthesis of Porous Platinum Nanoballs Geetarani Surendran**,** Laurence Ramos, Brigitte Pansu, Eric Prouzet, Patricia Beaunier, Hynd Remita, *Chem. Mater.***19**, 5045 (2007)

(f) Synthesis of Grephene and MWCNTs based nanocomposite materials and fabrication of supercapacitor array for energy storage applications

Participating faculty:

Name	Department	Expertise based on the published work
Suresh Gosavi	Physics	• Lithography and pattern transfer • Development of Micro photosensors and lead free thermistor using photoimagable thick film technology • Synthesis of metal and semiconductors nanostructures using chemical and biological route.
Dr. Santosh Haram	Chemistry	• MWCNTs, Graphene, Pt-based novel materials for fuel cell and sensor applications. • Electrochemical techniques
Sandesh Jadkar	Physics	• experience on the development of solar cells using nanocrystalline silicon • HWCVD process and PECVD process for synthesis of nanocrystalline silicon material
S. V. Ghaisas	School of Energy Studies	• Simulations of different processes including catalysis, fracture, growth • ab-initio calculations of nanostructures using density functional theory.

Objectives of the work:

- To prepared graphene and MWCNTs based modified electrodes for super capacitance applications.
- Development of Electrode materials based on Graphene and its composites (Electrode decoration with nanostructures).
- Cyclic Voltametric studies for its capacitor behavior studies.
- Fabrication of capacitor array using photolithographic technique.
- Comparative studies with Nickel metal hybrid batteries.
- Theoretical calculation using Greens function approach for the working of such capacitors.

Methodology to be followed

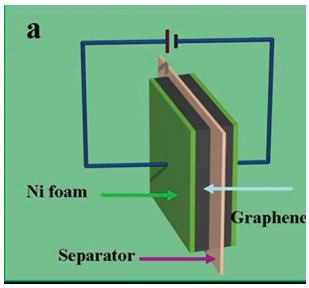
Development of renewable energy production and hybrid electric power generation and storage has been attracting much attention since end of last century. Lot of efforts have been made in the development of lithium ion and secondary batteries. Supercapacitors have shown more potential for exhibiting faster and higher power capacity, long life wide thermal operating range and low maintenance cost. However they suffer from low energy density.

In the present study we will mainly focus on development of ultracapacitors based on grapheme/MWCNTs and its derivatives and composites. It is observed that energy densities can be substantially increase using graphene as a separating layer.

Following methodology will be used for this development.

1. Synthesis of graphene/MWCNTs and its derivatives using chemical and CVD method.
2. Structural characterization using, XRD, Raman, Cyclic Voltammetry, and Capacitance measurements.
3. Fabrication and testing of capacitors and arrays.
4. Understanding of working mechanism using theoretical calculation, Green function method.
5. Temperature dependence studies on the power density, energy density and specific capacitance.

Schematic showing the device.



Expected outcome

An array of super capacitor bank, using synthesized grephene based nanocomposites material with following specifications.

1. Specific capacitance of between 200 F/g and 300F/g
2. Power density of ~10 kW/kg
3. Energy density of 80-90 Wh/kg (For lithium ion batteries it is 120-170 Wh/kg Lead acid 20-30 Wh/kg)
4. Current density of 1A/g

This specification will match with national and international scenario.

Phase wise breakup for the work

- In first phase dispersions of graphene oxide, reduced graphene oxide and MWCNTs will be prepared by chemical and CVD method.
- In the second phase, modified electrodes prepared by these novel materials will be characterized by Raman spectroscopy and electrochemical methods.
- Simultaneously, fabrication process parameters for capacitor will be optimized and test device will be fabricated. In the first and second phase
- Design and theoretical calculation using Green function for understanding of the working of these capacitors.
- Third phase will be dedicated for Array fabrication and testing on the optimized material.

Relevant publications:

1. Electrodics of methanol oxidation on Pt-f-multiwalled carbon nanotube composite, prepared by g-radiolysis Kanchan M. Samant, Vrushali S. Joshi ,

Geeta Sharmaa, Sudhir Kapoor, Santosh K. Haram*, Electrochemica Acta, (2011), in Press

2. Fabrication, Characterization and Electrochemical Performance of Single Strand Carbon Fiber Prepared by Catalytic Chemical Vapor Decomposition Method, V.S. Joshi, S.P. Gokhale, K.R. Patil, S.K. Haram*, Electrochimica Acta 55 (2010), 2022- 2028

3. Filling and coating of multi walled carbon nanotubes with silver by DC electrophoresis, Kanchan M. Samant, Vijay R. Chaudhari, Sudhir Kapoor, Santosh K. Haram*, Carbon, (2007), 2126..

4. **PATENTS:** "A Micro/Nano Photoconductor" (2010) Application no 1561/MUM/ 2010 G.G. Umarji, S.W. Gosavi, U.P.Mulik and D.P.Amalnerkar

5. Shweta Jagtap, Sunit Rane, Suresh Gosavi, and Dinesh Amalnerkar, "Study on I-V characteristics of lead free NTC thick film thermistor for self heating application", *Microelectronic Engineering, In Press, Accepted Manuscript, Available online 31 August 2010*

6. Shweta Jagtap, Sunit Rane, Rohini Aiyer, Suresh Gosavi, Dinesh Amalnerkar, "Study of microstructure, impedance and dc electrical properties of RuO_2 based screen printed 'green' NTC thermisters", Current Applied Physics**.** *, Vol. 10, Issue 2, (2010) 1156-1163*

7. Govinda Lakhotia, Govind Umarji, Shweta Jagtap, Sunit Rane, Uttamrao Mulik, Dinesh Amalnerka and Suresh W. Gosavi**,** "An investigation on TiO_2–ZnO based thick film '*solar blind*', photo-conductor for 'green' electronics", J. Mat. Sci. and Engg. B. *1-3, 15 April 2010, pp 66-70*1.

8. Observation of Photoconductivity in Sn doped ZnO nanowires and their Photo-Enhanced Field Emission behaviour J. S. Farid, M. A. More, S. R. Jadkar, K. R. Patil, P. Vijayamohanan and D. S. Joag Journal of Physical Chemistry C 114 (2010) 3843

9. Influence of argon flow on deposition of hydrogenated nanocrystalline silicon (nc-Si:H) films by plasma chemical vapour deposition A. M. Funde, Nabeel Ali Bakr, D. K. Kamble, R. R. Hawaldar, D. P. Amalnerkar and S. R. Jadkar Journal of Nano Research 5 (2009) 185-191

10. Si quantum dots for solar cell fabrication M. Ficcadentia, N. Pinto, L. Morresi, R. Murri, L. Serenelli, M. Tucci, M. Falconieri, A. Krasilnikov Sytchkova, M. L. Grilli, A. Mittiga, M. Izzi, L. Pirozzi and S. R. Jadkar Materials Science and Engineering B, 159-160 (2009) 66-69

11. Influence of hydrogen dilution on structural, electrical and optical properties of hydrogenated nanocrystalline silicon (nc-Si:H) thin films

prepared by plasma enhanced chemical vapour deposition (PE-CVD) A. M. Funde, N. A. Bakr, D. K. Kamble, R. R. Hawaldar, D. P. Amalnerkar and S. R. Jadkar Solar Energy Materials and Solar Cells 92 (2008)1217-1223

12. Deposition of hydrogenated amorphous silicon (a-Si:H) films by hot-wire chemical vapor deposition (HW-CVD) method: Role of substrate temperature S. R. Jadkar, J. V. Sali, A. M. Funde, P. B. Vidyasagar R. R. Hawaldar and D. P. Amalnerkar Solar Energy Materials and Solar Cells 91 714-720 (2007)

13. Optical properties of zinc selenide clusters from first-principles calculations, Sachin P. Nanavati, V. Sundararajan1, Shailaja Mahamuni, Vijay Kumar, and S. V. Ghaisas, Phys. Rev. B 80, 245417 (2009)

14. "Ab-initio Calculation for the Study of Nano Scale Silicon-based Structure" Sudip Chakraborty, G. Shashidhar and S. V Ghaisas, Solid State Phenomena Vol. 139 (2008) pp 113-118.

15. "Structure and Energetics of Silicon clusters adsorbed on Au (111) Surface: A first principles study" Sudip Chakraborty, S. V. Ghaisas and Chiranjib Majumder, International Journal of Nanotechnology 2010 Vol. 7, No.9/10/11/12 pp. 833 - 842

16. Qunatum Confinement effect in pristine and oxygen covered silicon nanocrystals with surfacestates". Sudip Chakraborty, Subhash V Ghaisas, Ch Rajesh, Shailaja Mahamuni, accepted in Journal of Computational and Theretical Nanoscience.

BUDGET ESTIMATES: SUMMARY

1. Non-Recurring

Item	Amount (in crores)
Mask Aligner and optical lithography set up with wire bonder	0.65
High performance Computing Facility	0.25
RF sputtering Unit (Multiple target/ multi-chamber)	0.50
Gas Analyzer	0.25
Potentiostat/Galvanostat	0.15
TOTAL	**1.80**

2. Recurring

	Amount (in crores)
Project Assistant 5@Rs. 15,000 pm	0.45
Contingency and consumables	0.25
TOTAL	**0.70**

Total A+B Rs. 2.50 Crores

Justification for Equipment and recurring expenditure:

The faculty is involved in research in the above areas and has published work in high impact factor journals and citations as evidenced. The faculty has also received funding from the other agencies such as UGC, CSIR, DAE, ISRO, DRDO, Pune University etc. The Department also collaborates extensively with other institutes and industries. We have made a class 10000 clean room facility which can be used for lithography and microfluidics. Based on the available synthesis and characterization facilities and computational resources, some essential facilities and equipments are identified by the faculty that are required to be procured under the UPE programme in phase II.

1. Mask Aligner and Wire Bonder (Lithography Facility)

In the Departments of Physics and Electronic Science and Schools of Energy Studies and Basic Medical Science, faculty members are working on the following research problems :

- Solar Cell Fabrication (Silicon based, Organic, flexible)
- Polymer based Microfluidics and Nanofluidics Devices
- Thin Film Transistor
- Field Emitter Array
- Silicon Bulk and Surface Micromachining
- Photoimagable thick film technology for thermister fabrication.

The Basic requirement for the fabrication of micro-nano size devices is state of the art clean room facility with photolithography setup. Through DST Nano Unit we have established Class 10000 clean room facility (25 Lakh) and Electron beam lithography machine (30 lakh) for master mask fabrication. Mask aligner is equipment used to align and transfer the mask pattern on the substrate, with uniform UV exposure (dose in mj/cm^2) over the 4" x 4" area. Multi level device fabrication can only be done with Mask aligner exposure system. After successful fabrication of these devices (10 -100 microns size), one has to do the inter connections for their practical use. The wire used is typically of diameter of 3-5 mils. Thermosonic gold wire bonder will be essential for this purpose.

2. High Performance Computing Facility :

Material modeling is an area being persuaded extensively in the Departments of Physics and Chemistry, Center for Modeling and simulation and Interdisciplinary School of Scientific Computing. The high performance computing (HPC) facilities need to be established to cater to the need of these groups. HPC facilities were established under UPE phase I two times, since computers need to be upgraded almost every 2-3 years. Currently we are using both shared memory architecture as well as clusters. Dual /quad core machine are connected using infiniband in one of the clusters bought under UPE grant. Various computing paradigms will be used in the second phase. Computational research and engineering will increasingly make use of faster computers and networks. A total of Rs. 50 Lakhs is therefore asked to cater to this requirement.

Computational Research will help in interpreting experimental results, in designing of novel materials and also to understand the underlying basic processes.

3. RF sputtering Unit

For the fabrication of thin film based CZTS solar cell, control layer simultaneous deposition of Cu, Zn, Sn, without exposing to atmosphere condition is necessary.

Multiple target/ Multi-chamber system with load lock arrangement is therefore required.

4. Gas Analyzer

Once the porous materials are prepared, it is necessary to guage the gas absorption capacity of the materials for various gases under study. A gas analyzer (with necessary detectors) is therefore essential for this work.

5. Potentiostat/Galvanostat

For the synthesis of graphane using electrochemical method, galvanostate is required. This decorated graphane material will be used for super capacitor energy storage devices. Also CZTS based solar cell will be electrochemically deposited using galvanostate system. For the accurate control on the properties of one of the layer in CZTS solar cells, particularly Sn, potentiostate/galvanostate is necessary. Also for the sulforization ot is essential.

6. X-Ray Powder diffractometer :

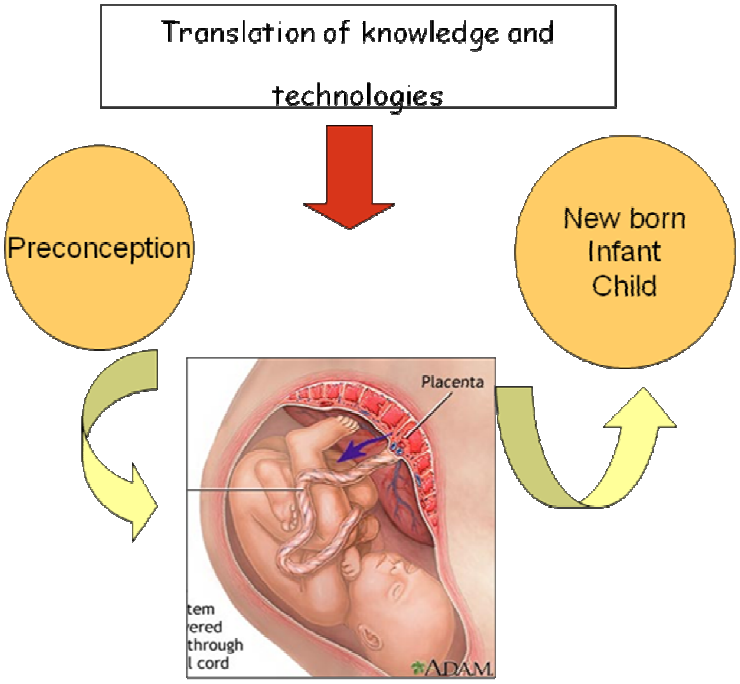
The trust of research in novel materials for energy harvesting is to prepare oxides, chalcogenides, Si and carbon based materials and their composites. The X-ray powder diffractometer is an important piece of equipment, mainly used for the characterization of these crystalline solids. At the moment, there is one diffractometer procured under first phase of UPE. This solo facility is extensively used 24x7 by about 100 associates and students. So, there is a big gap between the demand and supply of instrument time. Besides we only have the basic piece of equipment, supporting JCPDS data base files and crystallographic fitting software is not available. At present we are using Point detector Scintillation counter SOL-XE energy dispersive. We propose to upgrade our system with the following new detector LynxEye Detector High Speed Detector (Approx 45,000 Euro = INR 27,50,000/-). This is high speed detector which will give better data quality and more number of samples can be run every day. At present we do not have data analysis software and PDF2 database. Data Analysis Software DIFFRACplus TOPAS Software , ICDD & ICSD Database and PDF2, licence with Stress and Strain measurements (Approx 15,000 Euro = INR 9,50,000/-)

7. Dispersive micro-Raman Spectrometer :

Besides chalcogenides and oxide based materials, many associates are currently involved and also propose to work on carbon nanotubes, graphene, diamond and Si and organic polymer based materials. To characterize this class of materials, there is no substitute for Raman spectrometer. Currently Raman spectrometer is not available in the campus. Therefore, it is strongly proposed to procure this machine from UPE second phase. Most of the samples will be in the form of opaque solids, with quantities in micrograms. Therefore, it is proposed to procure high-end dispersive MicroRaman facility.

Area II : Health and Social Sciences

Focus : Translational research in health of women and children



Project Investigators :

Dr Anita Kar, School of Health Sciences

Dr Nilima Rajurkar, Chemistry department and Environmental Science department

Dr Suvidya Ranade, Chemistry department

Dr Aarti Nagarkar, School of Health Sciences

Dr. S.M.(Raja) Dixit, Co-ordinator, CSSH

Dr Suhas Palshikar, Member, Coordination Committee, CSSH

Dr Sharmila Rege, Member, Coordination Committee, CSSH

1.0 Goal and Vision of the programme

This programme area will focus on the health and wellbeing of women and children. A healthy woman is a healthy mother and her child will be a productive citizen of the country, contributing to the overall development of the nation. The programme will be cross-disciplinary and aim at translating existing or new knowledge and technologies from gender studies, public health, biochemistry and genetics for the improvement of women and child health especially those from the disadvantaged strata of society. In the long term, it is envisioned that this programme will evolve into an important translational research centre on women and child health, conducting application –oriented work, be it development of policies and programmes, or development of contextualized laboratory diagnostics and measures that can be used for impacting the health of women and children of this country.

1.1 Participating departments, faculty and faculty specializations

Dr Anita Kar, School of Health Sciences; Human genetics and public health

Dr Nilima Rajurkar, Chemistry department and Environmental Science department; Analytical and Radio chemistry

Dr Suvidya Ranade, Chemistry department; Human genetics and biochemistry

Dr Aarti Nagarkar School of Health Sciences; Social epidemiology

Dr. S.M.(Raja) Dixit, Co-ordinator, CSSH

Dr Suhas Palshikar, Member, Coordination Committee, CSSH

Dr Sharmila Rege, Member, Coordination Committee, CSSH

1.2 Theoretical rationale of the programme

The programme will centre on access to health services for women, examination of existing and current women and child health policies and measuring plasma levels of micronutrients. A major thrust areas in the programme will be focus public health genetics, an area which is currently non-existent in the country, primarily due to non-availability of evidence based data. The public health genetics component will aim at describing the epidemiology of two specific rare disorders, and a model for the delivery of genetic counseling services to the population level. The programme is illustrated in Box 1.

The theoretical rationale for this programme is as follows :

1. Access to health care is the primary determinant of positive pregnancy outcomes and healthy infants. The CHSS will examine the role of social inequity in access to health resources with the objective of developing policy recommendations and community based interventional modules.
2. Nutrition, especially micronutrients are important determinants of maternal and child health. The Chemistry and Environmental science departments will investigate trace element concentrations (with a focus on iodine and iron) in pregnant women and children using AAS and RIA techniques and relate them to pregnancy outcome and child health.
3. Genetic disorders remain a neglected area in the Indian public health sector. The chemistry department will undertake mutation analysis of patients afflicted with the Cornelia de Lange syndrome.
4. The School of Health Sciences will explore the issue of public health genetics through construction of epidemiological and mutational databases for hemophilia and use them as models to determine a route for delivering genetic counseling to the population level.
5. The Centre for Social Sciences and Humanities will explore the social determinants of health that is the conditions in which people are born, grow, live, work and age, and the structural drivers of those conditions, that is the distribution of power, money and resources as determinants influencing policy decisions.

1.3 Aims and Objectives of the programme

Reproductive and child health programme and policy analysis	To undertake the policy analysis of the RCH programme using evaluative framework based on equity, efficiency and satisfaction to design community based intervention module.
Iodine	To determine the level of iodine concentration in pregnant women and children and their relationship to birth and developmental defects.
Trace element	To determine the trace elements in blood samples (with specific emphasis on iron, zinc and selenium) of women and children and their relationship to general health.
Rare disease/mutation data	To develop the mutational data on developmental disorders related to Cornelia de Lange syndrome and the Retinits pigmentosa in Western Maharashtra region.
Genetic	To describe the epidemiology and develop mutational databases for hemophilia

Counseling	To develop a model for uptake of genetic counseling and measure its impact
Centre for Social Sciences and Humanities	Social gradient in reproductive, occupational and mental health, assisted reproductive technologies and assessing global and local movements for health equity

1.4 Project Deliverables

Reproductive and child health programme and policy analysis	**Iodine**	**Trace element**	**Rare disease /mutation data**	**Genetic counseling**	**Social Gradients**
Policy recommendations and community based intervention modules Comprehensive index to assess the RCH programme at district and sub district level Framework for analysing social inequalities on health	Understanding the prevalence of iodine deficiency in the target population and its relationship to birth outcomes and child development Public awareness for IDD	Correlation between Trace element and health care Will help in achieving hemoglobin level 12 by 2012 Awareness among the public about iron deficiency anemia and other nutrient deficiencies	Generation of mutational data in Indian patients especially from Western Maharashtra region for developmental disorders like CDLS and retinitis pigmentosa	A validated genetic counseling module for hemophilia Mutation database for patients from Maharashtra Epidemiological data on trends of the disorder	Policy implications and practice

1.6 Budget (for five years)

Budget head	Year I	Year II	Year III	Year IV	Year V	Total (Rs.) Lacs
Non-recurring Equipment						
Scintillation Counter, Gel documentation system	10.0					**10.0**
Recurring						
(i) Salary **Junior Research Fellow (6)** Rs.15,000x12 x5yrs **Project Assistant (3)** Rs.12,000x12x 2yrs	10.8 4.32	10.8 4.32	10.8	10.8	10.8	54.0 08.64
Hiring services (of field and Research staff on monthly /hourly basis)	4.0	4.0	4.0	4.0	4.0	20.0
Chemicals and consumables	2.70	2.70	2.20	2.20	2.20	12.00
Field work and Travel TA/DA for JRF , RA and PI,Co-PI, other project personnel	3.80	3.80	2.40	3.35	2.01	15.36
Books and Journals	2.0	2.0	2.0	2.0	2.0	10.0
Contingency Stationary, postage, communication charges, Honorarium to Experts/consultants	1.4	1.4	1.4	1.4	1.4	7.0
Workshop/Seminar Dissemination Workshops/ Printing /Publication of material	2.0	2.0	2.0	3.50	3.50	13.0
TOTAL	41.02	31.02	24.80	27.25	27.60	**150.0**

PROJECT I
Access to care: Analysis of programmes and policies

PI : Dr Aarti Nagarkar
School of Health Sciences

Rationale:

Paradigm shifts in 1997 has shifted focus of health services from maternal and child health to emphasize the reproductive and child health (RCH). RCH is a service package, which is geared towards an improvement in the quality of life with aim to achieve reduction in infant and maternal mortality. National Commission on Population (NCP) document has shown Maharashtra as one of the better performing state on the basis of RCH indicators namely utilization of antenatal care, contraception use, institutional deliveries, reduction in birth order 3and more, child-women ratio, marriages before 18 years and complete immunization. In the same document 12 districts of Maharashtra are considered as high performing while remaining 18 are high-middle performing districts. However there exists variation within district and between districts. There are many reasons for such variation; from overall development to recruitment of health staff, or community acceptance. Since, RCH package is an important tool to reduce maternal and neonatal/infant mortality, services offered should be acceptable to the communities and adapted to the local setting. Therefore, policy analysis of the said package at the level of district and sub-district is necessary. Such research would help in making evidence based and locale specific recommendations for further improvement.

The proposed research primarily aims to undertake the policy analysis of the existing RCH programme and provide recommendations. The process of policy analysis involves several other steps, first to understand the intra and inter district variation in functioning of RCH programme using secondary data. This would be followed by exploring the reasons and pathways of present disparities at district and sub-district level. Analysis of the accessibility issue with reference to inequalities based on gender, caste, class and ethnicity will be explored. One more dimension to policy analysis can be added by exploring the experiences and perspectives of auxiliary nurse midwives (ANM), medical officers and other stakeholders in the content and quality of maternal and child health care in rural Maharashtra.

Aim

To undertake the policy analysis of the RCH programme using evaluative framework based on equity, efficiency and satisfaction to design community based intervention module.

Objectives

1. To study the intra and inter district variation in functioning of RCH programme

2. To explore the reasons for variation in performance at inter-intra district level
3. To explore the pathways of social inequity in access to health resources in selected districts
4. To study the perspectives of health care providers and other stakeholders on RCH policy in selected districts
5. To develop evidence based, locale specific intervention modules based on existing policy

Methodology

First stage:

Study proposed to make use of existing secondary data sources as well as primary data. First objective will make extensive use of secondary data available at district and sub-district level. Data based on pre-decided indicators would be collected and analysed to understand the current situation. This will be followed by selection of better and low performing districts based on the findings of secondary analysis. Talukas/ subdistricts will also be graded based on their performance.

Second stage

In the second phase a sub sample of low performing districts and tehsils will be selected for further research. Each selected district and tehsil will be visited by research team. Combination of qualitative tools and techniques will be used to understand the reasons for low performance from all stakeholders. Data will be collected mainly by use of focus group discussions and key informant interviews.

Third stage

At this stage, community beneficiaries and stakeholders will be contacted at tehsil level to understand the issues of accessibility, acceptance and what are the mechanisms through which the hindering factors surface in the phenomena. Data will make use of qualitative techniques which include projective techniques, rapid rural appraisal techniques as well as indepth interviews of selected case studies.

At the same time health personnel at district to village level will be contacted and focus group sessions will be arranged to understand their perspective on the performance of the district.

Fourth stage

Qualitative data analysis collected at stage two and three, supported by the secondary data will be used to make specific recommendation. Intervention modules will be prepared based on each recommendation. The modules will be discussed with all stakeholders to assess feasibility. At the same time, dissemination of the results will be arranged at each district level for health personnel.

Project Deliverables

1. Policy recommendations and community based intervention modules
2. Comprehensive index to assess the RCH programme at district and sub district level
3. Framework for analysing social inequalities on health

Studies on iodine deficiency disorder

PI : Prof.(Mrs.) N.S.Rajurkar
Department of Chemistry and Department of Environmental Science

Background

Iodine is an essential trace element and is of much interest in nutritional research. It is essential for the production of the hormones in the thyroid gland. However, deficiency or excess of iodine can cause disorders, commonly known as iodine disorders. The safe and adequate intake of iodine is in the range of 50-200 $\mu g.d^{-1.}$ Iodine deficiency disorders can cause a spectrum of disorders like mental retardation and stunted growth in children, hair loss and other effects in adults. In a recent survey it has been reported that, in India, out of 324 districts surveyed, 264 have been found to be endemic for iodine deficiency disorders (IDD). There are several cases of goiter reported in Maharastra. Children and pregnant women are found to be more susceptible to IDD. Hence it is thought of interest to take up this project for Women and Child Health.

Aim and Objective

To determine the level of iodine concentration in pregnant women and children and their relationship to birth and developmental defects.

Methodology for iodine estimation in blood plasma

Blood sample collection from hospitals / by arranging health camps

Radioimmunoassay technique will be used for iodine estimation. The procedure is as follows:

- Known amount of the test sample + labelled antigen into the micro-titre wells
- Incubate → allow the reaction to reach completion
- Decant & wash contents of the well → removes all unbound antigens
- Radioactivity remaining in the Micro-titre wells measured by a Scintillation counter
- Intensity of radioactivity is inversely correlated with the concentration of antigens in the test sample

RIA Kits from Board of Research and Isotope Technology will be used

- BRIA MAG 3 RIA kit for total triiodothyronine T3 magnetic particle separation system
- BRIA MAG 4 RIA kit for total thyroxine
- T4IRMAK-9 RIA kit for human throid stimulating harmone hTSH

Outcome of the work

- Understanding the prevalence of iodine deficiency in the target population and its relationship to birth outcomes and child development.
- Public awareness for IDD

The above work will be carried out at Department of Chemistry which has a recognized lab for radiochemistry

PROJECT III

Trace element studies in women and children

PI : Prof.(Mrs.) N.S.Rajurkar
Department of Chemistry and Department of Environmental Science

Background

Anemia is a result of wide variety of causes that can be isolated, but more often coexists. The most significant contributor of anemia is iron deficiency and it is generally assumed that 50 % of the cases are due to iron deficiency and is one of the common nutritional deficiencies in the world affecting the absorption and metabolism of other antioxidant minerals including copper and selenium. According to the world health report 2002 iron deficiency was identified as one of the 10 leading risk factors for disease, disability and death in the world . Thus global public health problem affects both developing and developed countries with major consequences for human health as well as social and economic development. Though it occurs at all stages of life cycle, it is found to be more prevalent in women of all ages and children. Hence, it is thought of interest to undertake the project on trace element analysis in blood samples with special reference to iron.

Aim and Objective

To determine the trace elements in blood samples (with specific emphasis on iron, zinc and selenium) of women and children and their relationship to general health.

Methodology

- Collection of blood samples from hospitals/health cmp
- Acid digestion of blood

- Trace element estimation by AAS/ICPAES/Nano-colorimeter
- Hemoglobin will be estimated by CMG method.

Outcome of the work

- Correlation between Trace element and health care
- Will help in achieving hemoglobin level 12 by 2012
- Awareness among the public about iron deficiency anemia and other nutrient deficiencies

The above work will be carried out at Department of Environmental Science

Expertise

Prof. Rajurkar is working in the fied of Radiochemistry and trace element research from last 25 years and has published no.of research papers in the international journal of repute. Some of the significant publications in the area of health science are listed below.

1. Studies on the production and quality assurance of miniature I-125 radioactive source suitable for the treatment of ocular and prostate cancers. S.K.Saxena,A.Shanta,**N.S.Rajurkar** and M.A.Majali,
   Appl. Radiat. Isot. 64,441 (2006).

2. Studies on the adsorption of I-125 on metallic pellets for their potential application for the diagnosis of osteoporesis. S.K.Saxena,
   N.S.Rajurkar,M.A.Majali,A.Shanta,A.Dashand M.Venkatesh
   BARC News letter 223,180,2006

3. Selective preconcentration and determination of iodine species in milk samples using polymer inclusion sorbent. Preeti Bhagat, A.K. Pandey, R. Acharya, A.G.CNair, **N.S. Rajurkar**, A.V.R Reddy
   Talanta, 71,1226,(2007)
4. Determination of Iodine in food products by epithermal Neutron Activation A nalysis. R. Acharya, A.G.C. Nair, A.V.R. Reddy, Preeti Bhagat, **N.S. Rajurkar**, D. Parthasarathi.
   BARC News Letter 297,201,2008

5. Molecular iodine selective membrane for iodate determination in salt samples: Chemical amplification and preconcentration P R. Bhagat, A.K. Pandey, R. Acharya, V. Natrajan, **N.S.Rajurkar** and A.V.R. Reddy.
   Analytical and Bioanalytical Chemistry, 391, 1081 , 2008

6. Estimation of iodine in food, food products and salt using ENAA P R. Bhagat, R. Acharya, A.G.C.Nair, A.K. Pandey, N.S.Rajurkar and A.V.R. Reddy.
   Food Chemistry 115, 706, 2009

7. Biochemical assessment of iodine deficiency disorder by urinary iodine analysis of children from age group of 2-15 years. N.S.Rajurkar, S.F. Patiland N.H. Zatakia
Asian J. of Chem. Environ. Res. 2, 47, 2009

National conferences : 6 International conferences :3

Receient of best paper/young scientist awards : 3

PROJECT IV

Molecular studies on Developmental disorders and retinitis pigmentosa

Dr Suvidya Ranade
Department of Chemistry

Objective: To develop the mutational data on developmental disorders similar to Cornelia de Lange syndrome and Retinitis pigmentosa in Western Maharashtra region.

Expertise:

Mutational analysis of genetic disorders:

I have been working in the area of mutational analysis of genetic disorders. The study has been done on mutational analysis of beta globin gene in case of beta thalassemia patients from Western Maharashtra region. The specific region of gene was amplified using ARMS PCR. The biochemical studies have been done on beta thalassemia to study pattern of disease in Western Maharashtra region.

Nucleotide sequence analysis:

The nucleotide sequence analysis of S.flexneri 1a has been done partially; two complete gene sequences were obtained and deposited in the NCBI genbank.

Biological Database analysis:

Using the complete genome sequence of Enteropathogen like S flexneri, S dysenteriae the Simple sequence repeats were found out with help of softwares. The distribution and analysis of SSR was correlated with virulence. Recently the SSR analysis was done for the genes responsible for Cornelia de Lange syndrome. The comparison amongst the 3 genes was used to predict the more susceptible gene for mutation accumulation.

Bionanotechnology:

Recently the study has been initiated on interaction of gold nanoparticles with nucleic acid. The GNPs were chemically synthesized and the spectral studies were

done to study interactions with nucleotide bases, ssDNA and ds DNA. The other techniques like IR spectra, XRD, TEM were used to study the interaction further.

1. Pattern of hemoglobinopathies in Western Maharashtra.**S.S.Ambekar (Ranade**), M.A.Phadke, G.D.Mokashi, M.P.Bankar, V.A.Khedkar, V.Venkat, D.G.Basutkar. Indian Pediatrics, 38, May 17; 2001:530-534.
2. Prevalence and heterogeneity of beta thalassemia mutations in Western Maharashtra population a Hospital based study. **S.S.Ambekar (Ranade**), M.A.Phadke, D.N.Balpande, G.D.Mokashi, M.P.Bankar, V.A.Khedkar, P.S.Gambhir, P.M.Bulakh, D.G.Basutkar. International Journal of Human Genetics, 1(3); 2001:219-223.
3. **Suvidya Ranade**, Ashraf Hussaini, PS Khandekar, DN Deobagkar, DD Deobagkar Nucleotide sequence analysis of S.flexneri 1a a common Indian isolate,. IJCB, **Indian Journal of Clinical Biochemistry, 2009 / 24 (2) 142-149**
4. Simple sequence repeats in different genome sequences of *Shigella* and comparison with high AT and GC rich genomes. Hossani Ashraf, **Ranade Suvidya**, Ghosh Indira, Khandekar Pramod. DNA Sequence, 19(3); 2008 Jun: 167-176.
5. Simple Sequence Repeats in CdLS causing genes: Distribution and Comparison Mr. Shailesh Bajaj[1], Dr. Suvidya Ranade[2], Dr. Prakash Gambhir[3] **communicated to j biomedical informatics Jan 2011.**
6. "Interaction of DNA bases (cytosine and thymine), ss-DNA and ds-DNA with gold nanoparticles" Borse shubhangi D, Suvidya Ranade and Joshi Satyawati S.*, Department of Chemistry, University of Pune, Ganeshkhind, Pune -411 007, India **To be communicated**
7. Molecular studies on NIPBL in the Indian cases of Cornelia de Lange syndrome. Suvidya Ranade, Shailesh Bajaj, Dr. Prakash Gambhir. **To be communicated**

Background:

The study on CDLS on Indian patient is the on going work being carried out under DST funded project. The hotspot region of the gene NIPBL is being studied using PCR primers and using CSGE for identification of heteroduplexed DNA. The polymorphism in this gene in patients and control has been identified for the first time. We are screening the gene for the presence of mutations. The work will be extended to study the different regions /exons of the genes responsible for developmental disorders similar to CDLS.

The work on Retinitis Pigmentosa has been done in Indian patients by Prof M Dikshit (a retired senior faculty of chemistry department.).The 5^{th} exon of the Rhodopsin gene has been screened for the presence of mutations. Pedigree study has been carried out. The work will be extended by studying the remaining exons 1-4 of this gene for the mutations.

Methodology:

- The diagnosed cases of developmental disorders related to CDLS sand RB will be taken with the involvement of a paediatrician and a ophthalmologist.
- The family history and the clinical details will be taken. Pedigree analysis will be done.
- Mutational analysis in the hot spot region using specific PCR primers for each NIPBL/related gene and RB gene will be done.
- Mutational data in Indian patients will be generated. The study group will include the children and their parents' along with the controls.
- Genotype phenotype comparison will be done for both the disorders.
- Distribution of SSR in the genes responsible for the CDLS and the retinitis pigmentosa (available at NCBI database)will be studied to identify the mutation prone region

Outcome and deliverables:

Generation of mutational data in Indian patients especially from Western Maharashtra region for developmental disorders similar to CDLS and retinitis pigmentosa

PROJECT : V

Public health genetics programme using hemophilia as a model

PI : Dr Anita Kar
School of Health Sciences

Rationale :

As the name implies, genetic disorders occur due to gene dysfunction. They present during the neonatal and pediatric periods as severely painful and incurable disorders of children. A review of existing literature shows that India has a significant amount of data on the genetic basis of common disorders. However, the data on the epidemiology of these conditions is significantly lacking, primarily since these conditions are rare and have very low population prevalence. Rare diseases present as a methodological challenge to epidemiologists since standard methods cannot be used to extract epidemiological information. Rare disease registries provide a method for capturing data which can then be used for describing the epidemiology of the disorders. There are no established protocols for genetic counseling at the population level. While laboratory data can provide knowledge on prevalence of various types of mutations, health systems research forms the primary operational tool for translation of information so as to reach the population.

This research will use hemophilia as a model system. Hemophilia occurs due to a dysfunction in the coagulation factor gene, Factor VIII (hemophilia A) or Factor IX (hemophilia B). Patients have frequent hemorrhagic episodes, which with progressive age and sub-optimal treatment, results in severe arthropathy of joints, especially knee

joints. The goal of a public health genetics programme is to (a) prevent the birth of individuals afflicted with genetic disorders and (b) aim at providing the best available treatment for existing patients.

This project will address (a) that is identifying a strategy to provide genetic counseling at the population level.

Background work done :

The focus of the Principal Investigator's research is to develop a model for preventive genetics that is research into the prevention of genetic disorders through population-based genetic counselling offered through public health support, as well as developing strategies for support for existing patients. Using hemophilia as a model, a rare disease registry which records 16-year data on hemophilia for diagnosed cases in this state has been developed, and has been used to describe the epidemiology of the disorder in the state of Maharashtra. The prevalence and risk factors for disability in hemophilia have been reported and genetic studies have been undertaken to understand the prevalence trends of this disorder. A bibliography of hemophilia research in India has been constructed, that lists all articles published in this field from India between 1990 and 2010 (to be available shortly at www.anitakar.com). An ongoing study, the first of its kind from the developing world, is measuring the pattern of bleeding, its cause, treatment decisions and the cost of treatment through analysis of 600 weeks of bleeding data obtained through a prospective patient follow up

Selected publications :

1. Kar A A bibliographic analysis of hemophilia research in India and its utility in providing data for prevention and care (Ind J Comm Med, in press)

2. Kar A (2010) Factors influencing haemophilia prevalence estimates from the volunteer supervised Indian registry at Maharashtra ***Haemophilia*** *16, 952–954*

3. Kar A and Potnis Lele M (2004) Haemophilia data collection in developing countries: example of the haemophilia database of Maharashtra. ***Haemophilia***; 10:301-304.

4. Potnis-Lele,M and Kar,A (2001): Descriptive epidemiology of hemophilia in Maharashtra, India ***Hemophilia*** 7 **:**561-567

5. Kar, A, Mirkazermi R, Singh P, Potnis-Lele M, Lohade S, Lalwani A and Shah A S Disability in Indian patients with haemophilia ***Haemophilia*** (2007), 13, 398–404

6. Potnis-Lele M and Kar A (2006) Prenatal diagnosis of hemophilia A ***J. Genetics Screening and Health*** : 1 25-32

7. Kar, A and Potnis-Lele,M (2003) Impact of family history on family size in patients attending a hemophilia clinic in Pune, India ***Int J Epid*** 32: 316-320.

Objectives of the proposed research :

1. To describe the epidemiology and develop mutational databases for hemophilia
2. To develop a model for uptake of genetic counseling and measure its impact

Methodology for objective 1 :

1. A Maharashtra Hemophilia Network will be established and after a network meeting, data will be collected from the seven hemophilia chapters in the state of Maharashtra. The data will be on : Personal identifiers, name of HTC/ hospital, type of factor deficiency, severity, date of birth, age at diagnosis, age at registration, place of residence, patients occupation, income, family income, family history, date of last contact with the HTC. Using only personal identifiers, the data will be checked for duplications, and duplicate entries will be removed. After coding of the data, the entire data will be compiled and analyzed for prevalence trends, annual case registrations, ratio of HA to HB, age at diagnosis, age at registration.

Methodology for objective 2 :

Methods for analysis of the inversion 22 and inversion 1 mutation will be standardized. Mutation and gene deletions will be done by exon scanning, using reported primers. CSGE will be used to detect mutations and these exons will be sequenced.

3. Using focus group discussion, the pre and post counseling information will be developed. Methods to inform families with hemophilia about risk to female relatives and the available options will be developed.

4. Using the communication modules, families will be invited for mutation analysis and carrier detection. Mutation will be analyzed in the patient and then offered to female relatives at risk.

4. Since the University does not have clearance to do pre-natal sex determination tests, in case there is need of ante-natal testing, the woman will be appropriately referred.

5. The number of patients and female relative tested will be determined by the end of the project.

Project deliverables :

The project should lead to some fundamental tools in the field of hemophilia genetics, viz.,

1. A genetic counseling module for hemophilia which will be validated by
    - data on the number of at risk women who have been sensitized about their carrier status
    - data on number of women volunteering for mutation screening
2. Mutation database
3. Epidemiological data

Phase wise programme

All objectives will run concurrently

Project VI –

Social Determinants of Health in Maharashtra: Assessing Theory, Policy and Practice

Prof. Suhas Palshikar, Dept of Political Sciences

Prof.Dr. S.M.(Raja) Dixit, Interdisciplinary School of Social Scviences

Dr Sharmila Rege, Head of Women Studies

Rationale:

The Commission on Social Determinants of Health (CSDH) was set up by the World Health Organization in 2005 to support action on the social determinants of health to improve overall population health, improve the distribution of health, and to reduce disadvantage due to poor health. It published its final report 'Closing The Gap in a Generation: Health Equity through Action on the Social determinants of Health' in 2008. This landmark document underlined the challenges for health equity and calls for careful study and of social conditions before policies are drawn up and implemented.

The social determinants of health that is the conditions in which people are born, grow, live, work and age, and the structural drivers of those conditions, that is the distribution of power, money and resources are now recognised as important sites for policy intervention.High medical costs, the impersonality of technology-intensive

specialty medicine and the difficulty in accessing curative primary care which constitute a crisis for health and medicine require qualitative exploration.

While social science research on public health is being increasingly acknowledged by medical scientists and public health specialists , the precise nature of academic exchange and collaboration needs to be worked out through interdisciplinary research projects and joint curriculum development Programmes. This proposal develops upon the qualitative research and policy analysis undertaken by faculty members in sociology, anthropology, women's studies ,political science on reproductive health and sexuality, occupational health, birth markets and sex ratios, medical pluralism and mental health. Building upon the expertise and critical significance of themes the following maybe outlined as areas having potential for developing excellence through research and curriculum development programmes.

1. Social Gradient in reproductive, Occupational and Mental health

Research projects would focus on health outcomes as linked to position in social hierarchies, described by income, occupation and education, caste, by ethnic group or by gender They would explore in particular the social gradient in health (intersection of inequalities) and implications of the same for policy and programmes. Thus review of policy initiatives and communities at global, national and state levels and local practices would be an important constituent of research.

2. Social Gradient in Assisted Reproductive Technologies

Research would focus on myth of 'miracle cures for infertility and sex determination' by focusing on the social and economic context in which technologies are developed. The social and individual costs of ARTs particularly in a transitional health system and the social gradient in surrogacy and neo-eugenics are important themes to be explored.

3. Critically Assessing Global and Local Movements for Health Equity

In Maharashtra, there have been several social movements, civil society interventions and self help initiatives that have suggested alternative models by building an integrated understanding of

- Health determinants
- Health care system.
- Health care ideology

These initiatives have often been spearheaded by comparatively small groups of activists with some professional training in health or related fields. They have formed networks of concerned activists, have often used media and judiciary to press for policy changes and have often succeeded in creating awareness or sometimes even bringing about policy change on key health issues. These initiatives need to be documented the alternative health care initiatives suggested by them critically assessed.

4. Opening new grounds for a dialogue between a self-critical medicine and social sciences

A set of historical studies on cholera, post-traumatic stress disorder, ischemic heart disease, and under-nutrition in contemporary India have cleared new grounds for a dialogue between a self-critical medicine and the new social sciences . They have suggested that public health focus olarge-scale preventive programmes has resulted in the underdevelopment of primary care in the curative mode and this deficit in curative care is targeted by the new corporate hospitals that adopt as standard an expensive and inappropriate form of tertiary care that is marketed globally. Doctors trained in a tertiary setting are ill-equipped to provide appropriate medical care in any other context.

Area II : Interdisciplinary Programme in Social Sciences and Humanities under the holistic development

This proposal is based on the work done under the first phase of the UPE, wide consultations among faculty members and feedback received from the UPE Review Committee (Feb. 2010) and the UPE Committee (Jan. 2011). The UPE Review Committee's Report states the following about CSSH:

"Given the constraints of funds and time, the work done by this Centre is impressive. The Centre was a later entry into this programme and has been given 1.2 crores as financial support. The overall work is in the right direction fulfilling some of the objectives of UPE. It is necessary to continue providing support to the Centre to provide excellence in teaching and research."

In the UPE second phase we propose to have an **Interdisciplinary Programme in Social Sciences and Humanities** which will be conducted through the **Centre for Social Sciences and Humanities (CSSH).** In the University's UPE Second Phase Proposal it is specifically stated that **under the holistic development we propose to support the CSSH**. The following logic informs the choice of the focus area for the second phase:

- Continuation and expansion of the work done in the first phase;
- Inclusion of concerns of all disciplines of Social Sciences and Humanities; and
- Most importantly, crucial areas requiring inputs from Social Sciences for public policy making for moving towards just and inclusive social orders.

For bringing out the **close connection between UPE Phase I and Phase II**, let us first have **a look on the history of the CSSH very briefly**.

Introduction :

The University of Pune has been committed to ensure the balanced development of all disciplines. On being identified as **University with Potential for Excellence**, the University, as per the guidelines of the UGC, put in place the systems to define the thrust areas of research and teaching. These included Bio-informatics, Biotechnology, Simulation and Modelling and Sensor Studies. To ensure **balanced development and fair access to opportunities for achieving excellence across the disciplines**, the University established the Centre for Social Sciences (CSS) in the year 2003-04, which is, from 2007-08, known as Centre for Social Sciences and Humanities (CSSH) as per the recommendation of the Review Committee.

Aims and Objectives :

The original aims and objectives of the CSSH in the UPE Phase I were as follows :

- To enhance the standards of teaching and research in Social Sciences and Humanities;
- To systematically encourage Interdisciplinary research in identified areas;
- To initiate multiple pathways for achieving excellence;
- To respect and appreciate plural methodologies for meaningful investigations;
- To facilitate better quality research through infrastructure;
- To develop sustainable intellectual resources;
- To push capacity building.

Governance :

The CSSH is headed by the co-ordinator nominated by the Vice-Chancellor of the University from the senior academicians from Social Sciences and Humanities Departments. To help and advise him especially in policy-matters, there is a five-member CSSH Co-ordination Committee appointed by the Vice-Chancellor. Considering the interdisciplinary thrust of the CSSH activities, the Office of the CSSH was shifted to the Interdisciplinary School (IDS) in Humanities and Social Sciences and the CSSH Co-ordinatorship was assigned to the Head of the IDS from 15th June 2009 onwards. The CSSH does not have a separate administrative staff, but is presently functioning through the administrative infrastructure of the IDS.

CSSH Co-ordinators (2003-10) :

1. Dr. Sadanand More, Professor and Head, Department of Philosophy (2003-4 to July 2006)
2. Dr. Suhas Palshikar, Professor and Head, Department of Politics and Public Administration (July 2006 to 14th June 2009)
3. Dr. S. M. alias Raja Dixit, Professor and Head, Interdisciplinary School (IDS), (Humanities and Social Sciences) (Since 15th June 2009)

CSSH Co-ordination Committee (since 15th July 2009) :

1. Dr. S. M. alias Raja Dixit, Professor and Head, IDS(HSS) and Co-ordinator, CHSS, (Chairman),
2. Dr. Suhas Palshikar, Professor, Department of Politics and Public Administration and former Co-ordinator, CSSH,
3. Dr. Shrikant Paranjpe, Professor, Department of Defense and Strategic Studies,
4. Dr. Aniket Jaware, Professor, Department of English,

5. Dr. Sharmila Rege, Director, Krantijyoti Savitribai Phule Women's Study Centre.

Work done (2003-04 to 31st Dec. 2010) :

The UPE funding of Rs. 1.20 crores provided by the UGC was utilized mainly in the five areas of activities from 2003-04 to 2007-08 : Research, Building intellectual resources, Support for academic interactions, Capacity Building and Infrastructure development. The reports of that work were sent to the University and the UGC from time to time. After the first phase of the UPE funding was over, the CSSH activities continued because of the encouragement from the University authorities and the valuable financial support of Rs. 60,00,000 from the 'University Fund'.

The CSSH provided support to the following Departments/Centres for various activities :

1. Anthropology
2. Centre for Performing Arts
3. Centre for Advanced Study in Sanskrit
4. Defence and Strategic Studies
5. Economics
6. English
7. Foreign Languages
8. Hindi
9. History
10. Interdisciplinary School (Humanities and Social Sciences)
11. Journalism
12. Krantijyoti Savitribai Phule Women's Studies Centre
13. Marathi
14. Pali
15. Philosophy
16. Political Science
17. Psychology
18. Sanskrit and Prakrit Languages
19. Sociology

Let us have just a glimpse at the CSSH activities and achievements mainly during the UPE Phase I :

- The CSSH **Website** (http://cssh.unipune.ernet.in/) was launched.
- The **Statistical Package for Social Sciences (SPSS)**, internationally renowned and used software for quantitative analyses in the Social Sciences, which was installed in 2007, was made available to the Social Science

Departments. SPSS, for example, is extensively used at the Department of Political Science and it is also taught to the students at the Department of Anthropology.

- The CSSH supported **research** by faculty members **involving interdisciplinary areas and methodologies**. More than 20 research projects were supported, seventeen of which are now available in printed form. The pre-submission peer-review workshops were conducted by all researchers involved in this activity. **Marathi translation** of Kamala Bhasin's book 'Understanding Gender' has also been made available in the printed form. The compilation of **Dictionaries and Bibliographies** in Sanskrit, Pali, Foreign Languages Sections are also the academic activities worth mentioning.

Number of projects supported	**20**
Number of projects completed and published as peer-reviewed occasional papers	**17**
Papers based on these projects published in reputed journals such as E.P.W.	**06**
Translation published (which is now available in the book form also)	**01**

Related Publications

In the first phase of UPE, the CSSH supported many research projects and brought out publications in the focus areas. The list is given below for reference :

1. A Study of Maths in Pandharpur
2. Assessment of Nutritional Status of Some Tribal Groups of Maharashtra
3. Can microcredit be an effective strategy for gender mainstreaming?
4. Challenges to the Indian Society and Culture in the Age of Globalization
5. Devadasi Practice / 'Sacred Prostitution' in Contemporary Maharashtra (Foregrounding Caste in Analyzing Prostitution)
6. German Perception of the Indian Workplace : A Study in Intercultural Understanding
7. Intergenerational Occupational Mobility across Caste Groups : A Study of Pune City.
8. Maharashtra in the 19th Century : Literature and Thinking on Science in Marathi

9. Mahatma Gandhi and Martin Buber on the Juish Question : Revisiting a Controversy
10. Marathas in Orissa, 1751-1803
11. Marathi translation of Kamala Bhasin's book 'Understanding Gender'
12. Paraskar Grihya Paddhati of Vasudeva Dikshit (Edited with introduction)
13. Religion of Warli : A study from the perspective of Philosophical Anthropology
14. Studies in Political Leadership : A case study of candidates in Nagpur Municipal Corporation Election
15. Sutrapaths in Mahanubhav Literature and Brahmasutras of Badarayana : A comparative Study
16. Towards understanding the Gendered Character of Seva : A Case study of 'Samtol', 'Samvadini' and 'Jijamata Dal' of Dnyana Prabodhini
17. Tracing the Deserted (In collaboration with SOPPECOM)
18. Understanding Cultural Marginality : A Case study of Brass Bands in Pune.

- The CSSH aims at creating **durable intellectual resources** for future researches in the form of **documentation and digitization**. Massive documentation on Social Movements and socio-cultural and intellectual life of Maharashtra has been done. The necessary funding has been given to many Departments for this purpose and the Departments have done remarkable work in this area.

Name of the Department	**Documentation/Degitization**
Interdisciplinary School (Humanities and Social Sciences)	• *Dinmitra*, (Ed. Mukundrao Patil) (Dec. 1918 to Oct. 1952) (File No.s 9 to 45 : Tarawadi Archives). • *Magowa*, (Ed. Sudhir Bedekar), all issues (April 1972 to Jan. 1976). • *Tatparya* (Ed. Sudhir Bedekar), all issues, (April 1978 to March1987). • *Satyashodhak Marxwadi* (Ed. Comrade Sharad Patil) (March 1987 to July 1992 and 2001). • *Dnyanodayachi Pahili Shambhar Varshe* (Ed. Dr. B.P. Hiwale), 1942. • Documentation pertaining to the

	nomadic tribe *Dawari Gosavi.* • Many articles from *Navabharat, Samaj Prabodhan Patrika,* etc. • About 35 interviews related to the *Brass Band Culture* in Pune. • Some documents from *Ra.Na. Chavan Collection*, Wai. • Some old letters by eminent persons from *M.S. Dixit Collection.* • Old photographs (1913-17), *Akkalkot* Princely State.
Department of Sociology	• History of Sociology, • Employment Gurantee Scheme, • Human Rights Violations.
The Women's Study Centre	• Print and Music Cultures of Ambedkarite Calendar, • 6th Dec. Mahaparinirvan Diwas, • Nomadic Tribes engaged in Begging : A gender perspective on Nath Panthi Dawari Gosavi • 'Hindola' (Film on Desertion)
Department of Political Science	'Political Parties and Social Movements'
Department of Philosophy	Digitization of its Journals : • 'Indian Philosophical Quarterly', • 'Paramarsha' (Marathi), and • 'Paramarsha' (Hindi).

- The CSSH supported many **academic activities such as Seminars, Workshops, Lectures, 'Gharana Sammelans'** etc. Activities such as **SET-NET workshops, remedial courses and preparation of the study material** for the P.G. students were also supported by the CSSH. Many departments were granted funds for **research assistance**.
- The CSSH has also facilitated the **strengthening of infrastructure** in Social Science and Humanities Departments of the University in terms of **physical infrastructure and equipment needs** of various Departments. Especially the **Departmental libraries** have been strengthened. The Interdisciplinary School, for example, added about 500 books in its library with the CSSH support.

- We had invited **Professor Javeed Alam**, Chairman, Indian Council of Social Science Research **(ICSSR)**, New Delhi to visit CSSH and IDS and to address the faculty and research students on **'Current trends in Social Science research'** on 23rd Feb. 2010.

- The UPE funding of Rs. 1,20,00,000 received from UGC in the first phase and funding of Rs. 60,000,00/- received through the 'University Fund' in past three years, was utilised by the CSSH and varies Departments/Centres for the above-mentioned activities.

UPE Second Phase : Interdisciplinary Programme in Social Sciences and Humanities

Aims and Objectives:

The aims and objectives of the CSSH will by and large remain the same, but there will be an expansion of activities for the better fulfillment of those aims and objectives. These aims and objectives, in a more specified form, as suggested by the Hob'ble members of the UPE Committee (on 19th Jan. 2011) are as follows :

- To enhance the standards of teaching and research in Social Sciences and Humanities;
- To systematically encourage Interdisciplinary research in identified areas through plural methodologies;
- To initiate multiple pathways for achieving excellence (1) Curricular and pedagogical development, (2) Bridge and Capacity Building for students, and (3) Developing sustainable intellectual resources like Digital Archives;
- To facilitate better quality research through infrastructure.
-

Focus Area :

Our main focus area is the **continuation and strengthening of the Centre for Social Sciences and Humanities (CSSH)**. For achieving that we shall focus mainly on :

A. **Infrastructure Development** and **Capacity Building** in respect to about twenty Social Sciences and Humanities Departments/Centres associated with the CSSH;
B. Expansion of CSSH activities, especially Research and Documentation. For that, the key areas of emphasis during the second phase of the CSSH would be **Democracy, Development and Culture**. We propose to work, conduct research, develop projects and build excellence mainly in the following broad thematic areas relating to three thrust areas :

- Mapping Disciplinary Histories and constructing Interdisciplinary Theories and Methodologies in Social Sciences
- Rewriting Social and Cultural History of Maharashtra
- Development and Globalization Studies
- Democracy and Collective action
- Contemporary forms of exclusion : Caste, Tribe and Gender
- Cultural Studies

At this point, some explanation and elaboration about the above-mentioned focus cluster is necessary. The social sciences and humanities today are going through a very challenging and critical phase. In this age of globalization, knowledge-explosion and communication revolution the whole world is witnessing vastly growing material and mental complexities. It has, for comprehending these complexities, become necessary for the educators of social sciences and humanities to evolve new research methodologies, apply new pedagogical tools and enhance the cross-disciplinary dialogue. The descriptive and positivist role of these disciplines will have to be supplemented more by the normative role. Rather, we have ushered into the age of emancipatory social sciences and humanities. It is with this awareness that we have articulated our UPE second phase proposal. For the balanced disciplinary growth, our University proposes to strengthen the domain of social sciences and humanities. In fact we wish to play a leading role at least in Western India, in this respect. We are trying to rebuild our domain of social sciences and humanities in respect to the current trends and future possibilities. Hence the identification of three focus areas : **Democracy, Development and Culture.** These areas are very much in tune with the work done during the UPE Phase I.

Democracy :

Democracy is an area of crucial importance in the global and especially in the Indian context. The 20th century was the century of expansion of democracy and the 21st century aspires for the deepening of democracy. Broadly speaking, **the contemporary research agenda directed at democracy studies encompasses the following areas** :

* the idea of democracy and its theoretical implications, the liberal, radical liberal and neo-liberal conceptions of democracy;

* the institutional arrangements ‘necessary’ for democracy, the art and science of constitution-making, and the mechanisms to make elections transparent and free;

* the inquiry into the state-civil society relations, the socio-economic conditions of democracy and the comparison between western and non-western democracies; and

* democratisation of the ‘private’ domain and interpersonal relations as well as inter-community relations.

This research agenda needs to be further strengthened both by theoretically sharpening the focus and by expanding the empirical terrain covered by democracy studies. In the empirical sense, India provides a rich filed of investigation but at the same time, calls for more complex comparisons to arrive at a better understanding of the democratic processes. The crucial area of investigation is probably the relationship between social hierarchies and democracy, to what extent social hierarchies constrain the march of democracy and to what extent democracy obviates or reproduces social hierarchies. Equally fascinating is the question of democracy in the midst of contemporary global capitalism. Therefore, the **Centre for Social Sciences and Humanities would like to launch an ambitious, ongoing and multi-pronged programme on the theme of Expansion and Deepening of Democracy as a part of its activities over the next five years.**

Development :

The discourse of **Development** is one of the most influential, almost hegemonic discourses of our times. It is also accompanied by a maximalist capitalism. But besides the challenges coming from the advocates of 'alternative development', environmental concerns and issues of rehabilitation of the development affected populations, have given rise to the language of inclusion and 'inclusive' growth. While on the one hand development is seen as maximizing the potential of technology, on the other hand, it is also increasingly seen as a moral choice. These concerns are not limited to debates about domestic development policy, they are equally pertinent to issues of relations between and among members of the global state system.

The Development Studies are researched and taught at many renowned Institutes all over the world. For example, City University, London and Institute of Development Studies, Brighton are two such Institutes in U.K. Just to give some idea of the development issues studied by them we shall have a glimpse at two tables :

CITY UNIVERSITY LONDON: List of development issues

Aid, Environmental Activism, Ocean Acidification, Child Labour, Population Climate Change, Poverty, Food Security, Refugees, Gender, Terrorism Globalisation, Trade and Poverty, HIV and AIDS, Tropical Forests, Human Rights Volunteering, Migration, Water and Sanitation

Institute of Development Studies, Brighton

Aid and Debt, Gender, Poverty, Children and Young People, Governance Rights, Climate Change, Health, Rural Development, Conflict and Emergencies HIV/AIDS, Trade Education, ICTs, Urban Development, Environment Livelihoods, Water and Sanitation, Finance and Economics, Migration.

As one could easily realize, all these issues are important in the Indian context too. But while pursuing the Development Studies in India, we need to add **some specific Indian issues** such as **Poverty eradication, Caste issues, Dalit Studies, Devadasi practice, National security, Neuro-psychological assessments,**

Democratisation of Edutcation. etc. We shall, therefore, take into consideration the progress of Development Studies in some of the Indian Institutes such as

- Institute of Development Studies, Kolkata,
- Centre for Women's Development Studies, New Delhi,
- Institute of Development Studies, Jaipur,
- Centre for Development Studies, Trivandrum, etc.

Culture :

The area of **Cultural Studies** is gaining prominence in the current academic world. Culture is a hyper-complex term having plurality of definitions. The twin issues of democracy and development in a rapidly globalizing global social order deeply affect the mental and material set-up of communities and nations. Therefore, communication, language, artistic expressions are all undergoing a phase of redefinition. As spatial mobility gains momentum, intermixing of communities enforces new ways of cultural expression, literary articulations and unmatched requirements of transliteration of vocabularies, experiences and formal interactions. As communities shape new collective identities for themselves, there is a need to accept particularities and honour them. At the same time, the rise of particularities gives rise to a moral and political burden on most societies to take a call on pluralist public policy and a pluralist collective ethic in order to escape the path of majoritarianism.

In India Cultural Studies are pursued at many Institutes. The Jawaharlal Nehru University, New Delhi has a separate School of Language, Literature and Culture Studies. B.A. Course in English (Cultural Studies) is taught at Jadavpur University, Kolkata. M.A. Course in Media and Cultural Studies is taught at Tata Institute of Social Sciences, Mumbai. International Centre for Cultural Studies is active at Nagpur. We also have a Centre for Performing Arts. While developing Cultural Studies under the UPE second phase programme, we are aiming at keeping pace with the current trends in Cultural Studies, studying the alternate and subaltern models and mapping the Indian Unity in Diversity as well as Diversities in Indian Unity. We shall have a special focus on Literature from below. We propose to strengthen all our Language Laboratories.

Preparatory work :

For undertaking all the above-mentioned programmes and activities the preparatory work has already begun in the first phase of UPE. Let me put before you one such important effort for educational excellence.

The CSSH has planned the areas of intervention on the basis of a **baseline survey of 11 Universities in Maharashtra** conducted through the Women's Study Centre during 2008-9 :

- Documentation of experience in 11 Universities in Maharashtra
- Detailed interviews with over 100 faculty members and students
- Interviews with Curriculum designing bodies: Members of BOS, Faculty , Academic Council
- Collection and analysis of textbooks, guides, question papers, syllabi in practice, reports of various seminars, debates on higher education in the region

Broad Findings of the survey were as follows:

- Absence of teaching materials in Indian languages,
- Lack of innovative pedagogies,
- Predominance of 'Western frameworks',
- Dearth of 'relevant and situated' theories and curricula,
- Absence of Interdisciplinary Curricula,
- Risks of 'applications' mode and vulgar vocationalization,
- Lack of imagination for training of students whose futures will be outside the academia,

Thus, we feel that **building excellence** requires

- Bridge and Integrated Programmes to address the gap between UG and PG programmes,
- Workshops for Curriculum Transformation, Building Teaching and Research Capacity for new times,
- Building new teaching resources and methodologies

It may be noted here that **in the recent past, the University of Pune has revised the Curriculum of all the Faculties and encouraged innovation and quality improvement**. The social sciences and Humanities Departments have taken **many important steps that suit with the contemporary requirements**. Let me mention a few examples to prove the point. The Department of Sociology organized some remedial programmes committed to training students in English communications and developing Marathi as an academic language. Similar activity is being carried out by the Departments of Political Science, Economics and Sanskrit and planned by the Department of Pali too. The Women's Study Centre has designed and made compulsory a Bridge Course. The Department of Political Science has also launched a compulsory Introductory Course for bridging the gap between UG and PG courses. The Department of History has planned a Certificate Course in *Modi* Script to facilitate research in Maratha History. Let me give a few examples of the **courses relevant to current trends and requirements** :

- Department of Marathi : Course on Functional Marathi,

- Department of Anthropology : inclusion of recent trends such as Medical Anthropology, Urban Anthropology, Development Anthropology in the syllabus,
- Department of Economics : Course on Political Economy of India's Development,
- Department of Sociology : Courses on Urban Collective Action, Sexuality and Violence Studies, Rural Development in India,
- Women's Study Centre : Masters Programme in Gender, Culture and Development Studies, first of its kind in India, that brings three interdisciplinary fields together to develop skills for criticality and employability.

All these Courses and experiments are the **indicators of our progress towards the achievement of the objectives of our UPE Programme** and the UPE funding for the second phase will certainly boost these efforts.

These efforts will also be based on some Guidelines from the reports on the state of research and training in Social Sciences in India by Individual scholars and institutions like the **Vaidyanathan Committee Report** (2001) of the Indian Council of Social Science Research (**ICSSR**) and the **Partha Chaterjee report** (2002) of the Social Science Research Council (**SSRC**).

Methodology of running the Second Phase Programme :

The second phase programme of the UPE will be conducted through the **Centre for Social Sciences and Humanities (CSSH)** and **all Social Sciences and Humanities Departments/Centres** will be associated with the CSSH in running the programme. It will be a **team-work** done in a perfect team-spirit. The **multiple methodologies** of different disciplines will be respected and the **interdisciplinarity** will also be promoted. The following Departments/Centres will participate in the programme (and if necessary, any new Departments/Centres will also be included and the cross-disciplinary dialogue will also be created with the other faculties such as the faculty of natural sciences) :

1.	**Centre for Advanced Study in Sanskrit**
2.	**Centre for Dr. Ambedkar Studies**
3.	**Centre for Performing Arts**
4.	**Centre for Studies in Classical Indian Buddhist Philosophy and Culture**
5.	**Department of Adult, Continuing Education and Extension**
6.	**Department of Anthropology**
7.	**Department of Defence and Strategic Studies**
8.	**Department of Economics**
9.	**Department of Education**

10. Department of English
11. Department of Foreign Languages
12. Department of Hindi
13. Department of History
14. Department of Journalism
15. Department of Marathi
16. Department of Pali
17. Department of Philosophy
18. Department of Politics and Public Administration
19. Department of Psychology
20. Department of Sanskrit and Prakrit Languages
21. Department of Sociology
22. Interdisciplinary School (Humanities and Social Sciences)
23. Jayakar Library and Department of Library Science
24. Krantijyoti Savitribai Phule Women's Studies Centre

Phase wise programme:

The second phase programme will be divided into the following three sub-phases :

- Phase I: First year : Infrastructure development, appointment of staff, documentation and digitization, initial academic activities such as Seminars etc.
- Phase II: Next three years : Capacity building, Research projects, continuation of documentation and digitization and other academic activities. This will be a more mature stage of expansion yielding more results.
- Phase III: Last one year : Peer review work-shops, publication of reports of research projects. This will be the concluding phase completing the tasks and planning for the future programmes.

Expected Outcome / Deliverables :

Given the broad scope of the second phase we visualize the following deliverables :

- Publications by Faculty on research done under the focus areas
- Policy intervention regarding higher education, translation studies and urban development

- Publication of Reading Material in Marathi for Social Sciences and Humanities
- Creating a digital archive of source materials pertaining to focus areas
- Development of new Courses and Curricula integrating with the focus area
- Augmenting infrastructure in Social Sciences and Humanities Departments/Centres particularly libraries, reading rooms, language laboratories and psychology laboratories.

Budget :

We shall require the funding of minimum two crore rupees. For the fulfillment of the above-mentioned task, we propose to have the structured programme as shown below:

Item	**Yearly Budget**					**Rs.In Lakhs**
	1st	2nd	3rd	4th	5th	Total
Infrastructure Development	04	03	01	01	01	**10.0**
Curriculum Development and Teaching	03	3.5	03	03	2.5	**15.0**
Capacity Building (Innovative courses, teaching/study material, pedagogical tools, orientation etc.)	05	05	05	05	2.5	**22.5**
Research and Documentation	05	7.5	05	06	04	**27.5**
Seminars, Workshop, Conferences, Travel	2.5	3.5	2.5	2.5	1.5	**12.5**
Translations and Publications	1.5	2.5	3.5	3.5	1.5	**12.5**
Grand total	21	25	20	21	13	**100.0**

(The reallocation will be made if necessary and in consultation with the CSSH Co-ordination Committee. Wherever regular recruitments are not possible, the instrument of Hiring charges will be adopted as it was done in Phase I.)

Justification :

Considering the previous experience, the huge task and the nature of the CSSH activities (that include the activities of more than twenty Departments/Centres associated with the CSSH), the above-mentioned provision is necessary for the successful completion of the second phase of the UPE. We have given highest priority to research and documentation. Therefore the table shows the highest budgetary provision for research and documentation. Capacity building will potentially be a major innovative area. Therefore, it is also given high priority in budgetary provision.

Closing Statement :

The CSSH is a small step towards generating interdisciplinary balance. The Centre aims at reorganization of academic and administrative activities of the

concerned Departments and make the faculty and students more capable of handling emerging intellectual and practical challenges of the new knowledge society that is simultaneously globalised and iniquitous. The CSSH foresees expansion of the role of social sciences and humanities in this scenario and hope to contribute to the puzzle called human society.

We hope to receive generous funding and continue and strengthen the CSSH in the UPE Phase II. We shall try to utilize it in the best possible manner.

This suggests new lines for researching medical practice against formidable backdrop of knowledge, orientation and elitism of modern medicine. The constant everyday work of translating knowledge and experience to address a local situation and do justice to the individual patient remains largely invisible and undervalued in research. Theorising this practice, and changing contours of health providers and workers will open up new directions in health care.

Area III - Centre for Modeling and Simulation in collaboration with the Center for Social Sciences and Humanities

1. Vision and Mandate

The Centre for Modeling and Simulation, University of Pune, was established in August 2003 with the aid of the University with Potential for Excellence (UPE Phase I) funding from the University Grants Commission (UGC). Keeping up with the modern trends in academics and research worldwide, the Centre's vision and mandate is as follows:

1. To promote, support, and facilitate academic and research activities related to mathematical modeling and computational simulation and, in particular, the use of computation as the \third scienti_c methodology" (besides theory and experiment).

2. To aggressively promote a problem-centric outlook to real-life problems, and highly multidisciplinary approaches that transcend traditional boundaries separating in- dividual scientific disciplines.

3. To keep up with the state-of-the-art in computing and, in particular, develop strong expertise computing technologies such as high-performance computing, grid computing, etc., and to promote a culture of sophistication in computing on the University of Pune campus.

4. To establish a backbone for research and academics that cuts across disciplines, and serves as a seed for nucleation of such activities on the University of Pune campus.

Last, but not the least, is the highest and unstated mandate of all academics: to create excellent, versatile minds that are capable of learning by themselves, of thinking deeply, of questioning dogma and authority, and of seeing beyond the immediate. **Our achievements (Sec. 2) and proposed future plan (Sec. 3) should be judged in the light of the above vision**. We also list below our achievements in the first phase of UPE.

Contributing Faculty : Dr. Mihir Arjunwadkar, Dr. Sukratu Barve and Prof. Anjali Kshirsagar

2. Achievements 2003-10

2.1 Academic Programmes

1. Innovative, broad-based, and highly multi-disciplinary academic programmes (2-year Master of Technology (M.Tech.) Programme in Modeling and Simulation, 1-year Advanced Diploma Programme in Modeling and Simulation) that train students on generic methodologies (applied mathematics, applied statistics, computing) useful in dealing with a range of Modeling & Simulation scenarios + minimum 6-month project/internship/industrial training. (Details at http://cms.unipune.ac.in/programmes/).

2. Multi-disciplinary input: Masters (any discipline) or B.E. + F.Y.B.Sc.-equivalent mathematics background. Continuous assessment, student:teacher ratio is _ 4 : 1.

3. All CMS courses are open to campus students. Conversely, CMS students often take specialized courses (e.g., Stochastic Models in Finance, Department of Statistics) offered by other departments. Common-interest courses are often organized jointly with other departments.

4. Faculty shares their expertise in Modeling and Simulation by way of taking up collaborative research with other departments and delivering introductory lectures occasionally on M & S for other disciplines like Defense, Zoology and Social Sciences etc.

5. Representative student success stories:

   - Rashmi Kulkarni (alumnus 2008-10, microbiologist), now in Ph.D. programme at IISER, Pune, in mathematical/computational ecology.

- Anirudh Rana (alumnus 2006-07, mathematician), now in Ph.D. programme at University of Victoria, Canada, related PDEs governing atmospheric dynamics.

- Vilas Shinde (alumnus 2005-06, chemical engineer), at Birla Technology Centre, an elite organization within the Birla group, working on CFD simulations.

- Aquila Mavlankar (Alumnus/2007-09, Department of Physics), who did her M.Sc. project with Mihir Arjunwadkar (CMS) on modeling vehicular traffic (2008-09), is the recipient of the _rst Dr. Manmohan Singh Fellowship, University of Cambridge (2009).

- All our M.Tech. students from the first batch that passed out in June, 2010 have been placed (with two of them securing jobs in the last semester before they finished the program).

- Most of our Advanced Diploma students are continuing in the field of modeling and simulation in Industry.

- High level of interest from working professionals seeking to enhance their skills in M&S. Running the programmes in part-time/virtual mode needs additional manpower and a critical faculty mass.

- Our pioneering efforts are recognized *post facto* by, e.g.,

  - Similar programmes that have come up in India (there are only two other teaching programmes in India but at lower levels than ours).(We have signed an MOU with a University in Norway and negotiations are in progress for a joint M.Tech. Program with a university in UK),

  - US Congress Bill H.R.4165 introduced to \provide grants to encourage and enhance the study of modeling and simulation at institutions of higher education."

  http://www.house.gov/forbes/newsroom/msnewsletter/01152008.htm

- **Strong Industry Association** : Involvement of people from local industry (Tata Research Development and Design Centre, Persistent Systems Ltd., Computational Research Laboratories Ltd., Tech Mahindra Ltd., etc.) has been with the Centre right from its inception; they have contributed to the development of curricula and are associated through periodic colloquia, case-study sessions, courses on specialized topics, student projects, etc.

2.2 Research

- **Collective funding generated :** ~1.96 Crores over 9 projects, primarily by 3 in-house faculty emphasizes the efforts of faculty for individual research; (the two Directors' individual funding attached to their parent departments is not counted). Agencies: DST, DBT, DRDO, EU.

- Research areas: computational materials modeling, complex systems, industrial/ applied mathematics, computational/systems biology, statistical data modeling and analysis for astrophysics.

- Publications: ~ 60, with at least one author having CMS affiliation. Average impact factor 3+.

- Multi-disciplinary Ph.D. thesis: 4 in-house + 7 collaborative/supported. Illustrative titles of in-house theses:

  - M. Ali Saif, *Studies on Agent Based Models in Complex Systems*. Awarded: 2010.

  - Abhijeet Sonawane, *Dynamical Phases and Related Phase Transitions in Coupled Map Lattices.* Submitted : 2011.

  - Amir Reza Aghamousa Farashi, *Cosmological Parameter Estimation: New Methodologies for Better Inference*. Expected completion: 2012.

  - Prachee Chandrachood, *Thermodynamics, Geometry and Electronic Structure of Confined Systems*. Expected completion: 2012.

  - Organized one international workshop (electronic structure calculations), two local workshops (CFD); ~65 M&S colloquia, research seminars, case-study presentations given by local, national, international speakers from industry and academics, primarily for our students but they are usually open for all and are attended by interested faculty and masters and research students from other departments.

2.3 HPC Services for the Campus

Establishment, management, and maintenance of HPC facilities for campus researchers:

1. Symmetric multi-processing (SMP) platforms (SGI Altix 3700, Bull), 14-node Linux cluster

2. Users across the campus: ~18 faculty (quantum chemistry, computational materials, computational biology, complex systems, bioinformatics), ~40 research students.

3. Estimated publications that resulted from CMS computing facilities: 120.

4. Maintaining Bull machine (SMP) platform for NISDA (Defense related project on the University Campus)

2.4 In-House Infrastructure

- GP/GPU computing for research and educational purposes: 6 NVIDIA CUDA machines.

- A 10-node blade-based HPC cluster for funded research in computational/systems biology (2009).

- Building: has been inaugurated and Cetre is in the process of shifting to the new building by end of February, 2011.

- In-house library: ~1900 hand-picked books on specialized topics related to M&S.

- Website http://cms.unipune.ac.in/:
  - as a medium for disseminating educational material to our students.
  - to document almost everything that we have done.
- In-house lab for students: ~20 Linux desktops, 24/7 access, Internet access, large software base, web space for all.

3. Proposed Plan for UPE Phase II

3.1 Teaching

1. Specialized courses (1 and 2 credits) or special purpose short duration need based courses, catering to the computing needs of campus departments, e.g., Computing (e.g., R) and M&S courses for biologists, social sciences, and humanities students with non-mathematical background.

2. Special-purpose courses and short duration programmes tuned to the needs of local industry.

3. Masters in Computational Finance, to deliver a balanced mixture of domain knowledge of finance/economics and computational methods, can be taken up in collaboration with economics/commerce departments. Syllabus is ready.

4. M.Tech. Programme in M&S (Virtual Mode/ web based): to cater to working professionals (we do receive lot of queries through out the year for this,

industries and national institutes are ready to depute persons for such a programme).

5. Joint academic programmes with campus departments (1 year in the domain department + 1 year with us), e.g., M.Sc. in Physics with specialization in M&S.

6. Outreach programmes for undergraduates and school kids, summer internship programmes, affiliate programmes for teachers.

3.2 Research

Strengthen existing research focus areas (computational materials, industrial/applied mathematics, computational biology) by adding at least one faculty for each area.

Add new research focus areas by bringing in new specialized faculty with expertise in M&S related to highly relevant areas such as: infectious disease modeling, modeling for ecology and environment, complex systems and agent-based modeling, modeling for behavioral and social sciences, modeling for Security and Defense applications etc.

The importance of these areas need not be emphasized here. We propose to undertake research in these areas by having a joint Ph.D. program with faculty of University of Pune from Social Science, Defense studies and Health Science Departments.

- Modeling for pollution/environment, disease propagation and disease control using the vast amount of data available across the disciplines; it will enable correlating available resources for health care for children and women. There will be inherent need for special collaborative efforts among the M&S specialists and subject experts from respective disciplines. We propose to use grid models for data collection and analysis.

- Traffic modeling for urban areas and modeling for Defense using Game theory may be undertaken in collaboration with NISDA and experts from defense institutes in nearby area.

- A Virtual M&S Journal: a high-quality, peer-reviewed, Internet-based journal dedicated to computational science, modeling and simulation, and related multidisciplinary areas, to advocate and promote multidisciplinary, problem-centric approaches.

3.3 Manpower

- With the building ready, the Centre is ready to expand the scope of its activities. A ertain critical man power is needed to develop a vigorous and dynamic intellectual ambiance and sustained overall productivity and a meaningful growth of the Centre. University of Pune has taken steps to appoint faculty on a long-term basis with periodic assessment.

- We therefore propose to have a position at the Research Scientist level for five years with a consolidated salary.

- The Centre has been lucky to have efficient and excellent support staff (administrative and technical) so far.

- Continued financial support from the UGC and the University (plus efficient and adequate administrative support and a strong "will" on part of the University) are therefore of paramount importance for the growth of the Centre!

Phase-wise Plan :

Phase I (year 1) : Organization of lectures /short-term workshops for Social Scientists (faculty + research staff) and subsequent designing of need based courses for masters and research students.
(A sample course is attached.)

Phase II (year 2 and 3): Identifying requirements of the individual faculty and designing projects under CSSH, getting the sanctions of the University bodies for running the course and their implementation.

Phase III (year 4 and 5) : Actual implementation of the courses and carrying out the projects as per needs with the help of M.Tech. students of modeling and simulation.

A Sample Lecture Course in Statistical Modeling for Social Sciences has been designed and is given below.

- **INTRODUCTION**

Extensive application of mathematical models in behavioral sciences is one of the upcoming trends that University of Pune would identify for future growth. Following up on this view, we propose to promote and facilitate academic interaction between CMS and the social sciences departments. The course of modeling which we suggest is developed with this in mind.

Such an interdisciplinary and multidisciplinary activity is expected to face the usual prospect of getting slotted into a vanilla course in mathematics or statistics. To avoid this we have decided to frame a course specially for teachers with behavioral sciences background. A short course is proposed restricted to the domain of statistical modeling, which is a very frequently encountered aspect of mathematical modeling in social sciences. The teacher is expected to build on real life examples from projects taken up by various teachers who take this course.

We hope that this interaction generates useful feedback which can be employed for improving this course and designing more of such courses for behavioral sciences.

- **SYLLABUS**

The mini course is planned over a period of 15 lectures, each of 1 hour duration. The syllabus is outlined below. Each section would take about 3-4 lectures. The teacher is expected to select a few topics from each section so as to ensure continuity in the course.

A. Descriptive Statistics

Distribution of scores, Central Tendency, Variability, Transformation, Regression and correlation coefficients, Ordinal and Nominal Variables.

B. Inferential Statistics

Statistical principles, Normal Distribution, Sampling Distributions, Testing statistical models, Two group design, One way and two way analysis of variance,testing measures of association, models for ordinal and nominal dependent variables

C. Programming environments

Hands-on sessions on two environments R and SPSS are recommended. Two examples from descriptive statistics section and two from inferential statistics may be taken for tutorials.

D. Advanced topics

* Structural Equation Modeling and factor analysis
* Multilevel models
* Cluster analysis
* Latent class model
* Item response theory
* Survey methodolgy and survey sampling

- **TEXTBOOKS**

  Statistics for Social Sciences -David A Kenny

BUDGET ESTIMATES: SUMMARY

3. Non-Recurring

Item	Amount (in lacs)
Research Scientist @ Rs. 35,000/- pm for first two years @ Rs. 40,000/- for next three years	22.8
Expenditure for infrastructure @Rs. 5 lacs per year Management and maintenance of high-performance computing facilities	25.0
Contingency	12.2
TOTAL	**50.0**

Area III- Bidiversity:

Capacity Building Programme in Biodiversity Assessment of Western Maharashtra

A Joint Project Proposal involving Departments of Botany, Zoology, Microbiology, Geology, Geography, Chemistry, Physics, Statistics, Mathematics, Bioinformatics, Biotechnology, Health Sciences and Institute of Bioinformatics and Biotechnology

Project summary

Biological resources are vital to maintain ecological balance as well as for economical and social development. The resources play an important role in ecological security both at regional and national level by contributing to climate stability, water resources and to mitigation of global climate change. The resources also provide means of sustenance to the local communities. In recent years National level initiatives have been undertaken is the form of biodiversity assessment program and strategies for its conservation through National Biodiversity Strategy and Action Plan and Biodiversity Act of 2002.

Pune region is one of the rapidly growing urban areas in the country having spread over few thousand sq km area and which continues to grow further. On its western side are the Western Ghats, which are characterized by high altitude plateaus which comprise of diverse ecosystems like fresh water lakes, grasslands and forests in the valleys. The Western Ghats show high biodiversity and constitute one of the Hot Spot areas identified at International level. To the eastern side of Pune is the rain shadow region, which receives scant rainfall, but which host large man-made lakes due to construction of dams on the rivers flowing eastwards. This region therefore consists of large wetlands surrounded by grasslands and dry deciduous forests. Thus two distinct regions, each with a distinct climate and characteristic biodiversity, exist on either side of Pune. In addition, the Western Ghats border the Arabian Sea, which constitutes another interesting ecosystem.

The Departments participating in this Joint proposal wish to undertake in-depth biodiversity studies on representative sites in each of these regions, with a view to evolve strategies for conservation as well as utilization of the biodiversity. Each of the departments have contributed to various frontier areas of biology, public health, chemistry and earth sciences, as well in statistical and bioinformatics methods, as is evident from the support they have received from National funding agencies and research publications.

Key words:

Biodiversity assessment and analysis, Western Ghats, Carbon sequestration, Species recovery, metagenomics, plant microbe interaction, PGPR, public health and disease risk, bioprospecting, bioremediation, restoration and management.

Introduction

Biological diversity refers to the variety existing within the living word. It is commonly described and studied in term of ecosystem, species and genetic diversity corresponding to fundamental and hierarchical-related levels of biological organization. Over the years there is an increasing pressure on biological resources resulting from human activity and this has caused a reduction in biodiversity. Due to growing concern all over the world, UNEP took the initiative to protect and conserve biological resources. In 1992, the Convention of Bio Diversity (CBD) was introduced in Rio's UN Conference on Environment and Development. This initiative became the basis of various research, teaching and awareness programs in academic institutes and community based organizations. The governments took efforts in planning and management of biodiversity through various legislative and conservation measures.

India in recent times is in a state of rapid development and Pune region is one of the fastest growing centers in the vicinity of the Western Ghats. This region has various climatic zones and habitats and exhibits high biodiversity. The British ecologist Prof. Norman Mayer recognized Western Ghats as one of Hot Spots of diversity. His classification of an area as a Hot spot was based on two criteria: (a) the region should have more than 1500 endemic species and (b) the region should have changed/ lost

70% of its original habitats. Hence there is an urgent need to understand and document this biodiversity and take measures for its conservation.

Several Departments of the University of Pune wish to undertake an interdisciplinary research program to investigate different aspects pertaining to biodiversity.

The Botany, Zoology and Microbiology Departments would undertake studies on ecological, systematic, biochemical, physiological and genetic aspects of biodiversity in plants, animals and microorganisms in the identified ecosystems. Besides this, efforts would be made towards conservation, and identification of potentially useful plants, animals and microorganisms. The broad work plan involves survey, sampling, habitat-taxa characterization, determination of diversity indices and laboratory based study of cytotaxonomy, chemotaxonomy and molecular taxonomy. The Botany Department would also undertake studies on carbon sequestration by the vegetation in different ecosystems and plant species. The Zoology Department would mainly focus on studying the diversity of Dipteran insects, Rotifers and Anuran Amphibia. Department of Microbiology would carry out metagenomic studies of rhizosphere soil to give and account of the vast majority of microorganisms that may have previously gone unnoticed. The Department would also study bioactivity, plant growth promotion activity and biodiversity of endophytes and rhizobacteria of wild plants as well as extremophiles from selected area.

The Earth Sciences Departments of Geology and Geography would be involved in studies on soil chemistry, geomorphology and climate in the concerned regions. With tools like remote sensing and GIS, they would provide valuable inputs for biodiversity studies. These Departments would undertake studies on the carbon sequestration capacity in rocks, soils, water bodies.

Bioinformatics, Mathematics and Statistics Departments would play an important role in data analysis on biodiversity. The Bioinformatics Department would help in developing a database and an interface for querying the data. Statistical techniques to measure and analyze diversity, to estimate spatial distribution of species, to assess relationship between biodiversity and environmental variables would be developed by

the Statistics Department, who would also model the future extent of occurrence of species. Mathematical modeling will be done by the Mathematics Department.

The role of Chemistry Department would be in the field of Natural Products, isolation and characterization of biologically active components along with their chemical synthesis. In addition to this structure –activity relationship will be studied. The studies will be also focused on plant waste and medicinal plants towards their therapeutic and nutrient potential for the development of nutraceuticals as well as manage malnutrition and environmental pollution. As most of the elements are the components of the biologically active molecules, the work on estimation of the elemental content and their bioavailability in the medicinal plants will be undertaken.

The Interdisciplinary School of Health Sciences will explore the issue of biodiversity and public health. The implications of biodiversity loss for the global environment have been widely discussed and the Department would carry out research that leads to an understanding of the relationship between biodiversity and human health.

The Institute of Biotechnology and Bioinformatics would explore the area of marine biodiversity. Marine microorganisms from different ecosystems of the marine environment would be isolated, characterized and explored for their potential use as biofuels, surfactants, enzymes,metal-interacting proteins and potential biological activity would be explored.

The Biotechnology Department will study the biodiversity of unculturable microorganisms from Western Ghats for the bioprospecting of polyketides as antifungal metabolites (antibiotics) by metagenomics approach. From 40,000 microbial cultures screened in 10 years, only three usable antibiotics were discovered and 99% of bacteria have remained uncultivated. Hence the Department proposes to use new approaches to study the production capacities of the microbes in these regions.

Objectives:

To study the geological, ecological and biological aspects of biodiversity and identify species of plants, animals and microbes of economical, adaptive or experimental value from identified regions in Maharashtra representing distinct agro-climatic and marine zones.

This objective will be met through studies on the following aspects:

1. Analysis of geological, geomorphologic and climatic factors including rocks, soil and water in the area undertaken for study.
2. Use of remote sensing and GIS to study land use patterns and vegetation in these ecosystems and to compare the chemical and biological carbon sequestration capacity between the different ecosystems.
3. To document diversity in plants, animals and microbes in different ecosystems in these regions, their population structures, interrelationships and associations. Species recovery and conservation.
4. To develop a web-based database for archiving biodiversity data and analysis of diversity using appropriate statistical and mathematical tools.
5. To develop disease risk maps and spatial models to examine possible correlations between habitat, pathogen distribution, and the emergence and spread of vector-borne and zoonotic diseases.
6. Bioprospecting for species having commercial value.

Work Plan:

a. Isolation, Characterization and biological activity of functional phytochemicals and biodegradation of xenobiotics; Synthesis of biologically active compounds and study of structure activity relationship.
b. Bioprospecting and diversity of microbial endophytes and rhizobacteria associated with wild plants from selected areas
c. Bioprospecting of microorganisms inhabiting special ecological niches characterized by extreme conditions with respect to environmental factors

d. Bioprospecting of marine microorganisms for biofuels, novel antibacterial, antifungal, antiviral agents, surfactants and enzymes and metal interacting proteins
e. Bioprospecting of polyketides as antifungal and antibacterial metabolites by metagenomics approach

Methodology:

The work described below will be undertaken by the Dpatments of Botany, Zoology, Microbiology, Geology, Geography, Chemistry, Statistics, Mathematics, Bioinformatics, Biotechnology, Health Sciences and Institute of Bioinformatics and Biotechnology

Plant biodiversity:

Various ecosystems will be identified based on different ecological attribute for field studies. These then will be studied for vegetation analysis such as frequency, density, abundance, canopy cover and their correlation with edaphic conditions. Association of plant species with other plant species, microbes, insects and animals will be documented. Listing, identification and classification of plant species from these regions will be carried out.

Carbon inventory methods for carbon mitigation will be used. Carbon sequestration potential in various ecosystems will be studied by measuring rates of carbon fixation in different plant communities and plant communities having higher potential would be identified, which could serve as guide lines for protection and identification of plant communities for afforestation program to mitigate carbon level from atmosphere.

Use of molecular markers for assessing genetic diversity in selected plant species by: (a) Estimation of within and between population genetic diversity and determination of various population genetics parameters like gene differentiation and gene flow, and (b) Determination of genetic relatedness between different individuals, populations, species, using distance based methods.

Multiplication of potentially useful medicinal plants using tissue culture techniques and chemical and genetic manipulations to improve yield of potentially active components.

Animal biodiversity:

For the biodiversity assessment work of selected animal groups, namely the Dipterans insects, Anuran amphibians and rotifers, following methodologies will be employed to assess, document and analyze the biological and genomic diversity.

- Sampling and characterization: *ad hoc* searches which will help in preparing the check list of available species in the region and *transect* method for the quantification of seasonal changes in the diversity.
- Determination of biodiversity indices: Data generated through transect sampling method will be used to estimate the species richness of the region by fitting regression curve (Michaelis-Menten Equation). Moreover, other parameters like species richness Simpson's diversity index, Shannon's index will be determined.
- Phenotypic: examination of morphological variation, verification of taxonomic keys. For rotifers. mastax (teeth) preparation will be done using 10% chlorax and mounted for SEM photography.
- Cytotaxonomic: determination of chromosomal variations (neither morphological, NOR, banding techniques etc.)
- Chemotaxonomic: analyzing allozyme variation of selected enzymes for estimating intra and inter-specific viriation and diversity
- Molecular taxonomy: development of molecular marker and analysis of intraspecific and intraspecific DNA level polymorphism.

Bioassay of Phytochemicals : In addition to this line of investigations, compound/s isolated by other participant groups, will be bio-assayed using various animal and microbial systems.

Microbial biodiversity:

1. Work would involve collection of wild plants and their rhizosphere soil. Samples would be processed to isolate endophytes and rhizobacteria.
    - Isolation of extremophiles would be done from samples obtained from special ecological niches.
    - Biochemical and molecular identification of these isolates would be done using commercial kits and 16S rDNA sequencing.
    - Under non cultivable approach, soil DNA extraction would be carried out followed by its PCR amplication using universal and group specific primers. The amplicons would be subjected to denaturing gradient gel electrophoresis (DGGE).
    - Phylogenic relationships would be constructed from the data obtained using bioinformatics tools.
    - Screening endophytes and rhizobacteria for various PGPR properties like nitrogen fixation ability, production of plant growth promoting hormones, phosphate solubilization, production of siderophores or any other prospective bioactive agent.
    - Screening of extremophiles obtained for a range of newer products like enzymes (new lipases and proteases /new nucleases including restriction endonucleases, new proteases) capable of working under unusual conditions (pH, Temperature, salts, etc).
    - Characterization of these compounds would be carried out with the help of Chemistry Department.

2. Isolation of marine microorganisms: Microbes would be isolated from deep sea, mangroves, plants (Epiphytes), animals (Epizoic microorganisms), corals and sponges, coastal areas, estuarine regions and sediments.
3. Morphological, Biochemical and molecular characterization: These will be carried according to Bergey's manual and standard protocols.
4. Bioprospecting studies: The following areas will be explored:

- Biofuels
- Novel antibacterial, antifungal, antiviral agents.
- Surfactants and enzymes
- Agents with potential biological activity e.g. anti-diabetic, anti-cancer etc.
- Metal interacting proteins
- Biomaterials

5. *Setting up a culture collection of tropical marine microbes*: All the isolated microorganisms would be maintained, preserved and made available for the scientific community at large for basic and applied research.
6. Collection, analysis and preservation of the soil samples from western regions of maharashtra.

Geological assessment:

Field surveys for geological mapping, collection of soil, water and rock samples using the random grid method.

Petrographic, geochemical and magnetic characterization of above materials using petrological microscopes, magnetic susceptibility equipment and geochemical instrumentation.

Use of GIS for preparation of graphical representation of both biological and geological database to develop geobase equation to biodiversity.

GIS and remote sensing studies:

Use of remote sensing and GIS for studies on geomorphology, climatology, cartography etc. all of which will provide important baseline information to studies on biodiversity

Data analysis:

Development of a database/resource to archive biodiversity data generated.

Development of algorithms/software tools to facilitate analysis of data

Development of data formats to enable inter-operability of data

Use or development of appropriate statistical methods to measure and analyze diversity, to estimate spatial distribution of species, to estimate relationship between biodiversity and environmental variables.

To model future extent of occurrence of species.

Mathematical analysis:

To give the applications of ordinary differential equations to simple biological problems, the use of mathematical modeling in biochemical reactions, the application of partial differential equations in describing spatial processes, and the use of delay-differential equations in physiological processes.

Chemical assessment:

Isolation, purification, characterization and synthesis of biological active compounds:

Identification and selection of medicinal plants (along with Botany Department)

Elemental analysis (including metals) in soils and plants and studies on their bioavailability.

Identification , separation and characterization of phytochemicals.

In vitro and in vivo biological studies of identified active constituents (along with Zoology Department)

Synthesis of drugs from identified biologically important molecules as the natural source of bioactive compounds is limited.

Isolation and characterization of microorganisms and their degradation potential

Process development of nutraceuticals

Physical Aspects:

Plant growth and development are affected by a lot of different environmental abiotic factors such as light, temperature and water supply. Immediately upon germination, another physical stimulus, gravity, strongly influences the growth of plant organs, root and shoot, in order to ensure their correct orientation in space and the survival of the young seedling. Since plants have evolved under the constant stimulus of gravity, its presence is one of the most important prerequisites for their growth and spatial orientation. The ability of plants to change their growth orientation in response to gradients in light and gravity maximizes their ability to obtain energy from light and moisture and nutrients from soil. Establishing the role of gravity in plant requires information about how gravity regulates individual cell metabolism. Plant cells and tissues *in vitro* are valuable models for such purpose. Effects of gravity and radiation on plants were studied independently by many researchers all over world. But as per our knowledge, the combine effect of gravity and radiation on plants has not been studied yet.

Analysis of public health data:

1. Collection of baseline data on ecological, demographic, agricultural, land use patterns
2. Collection of data on infectious diseases (especially malaria, and other vector borne diseases) as well as maternal and child health parameters
3. Development of GIS map incorporating the spatial data
4. Analysis of data on ecosystem, vegetation, eco-topological maps, climatic data and their relationship with
    a. geographic distribution of diseases
    b. climate and spatial and temporal trends of disease
    c. Mapping populations at risk
    d. Stratifying risk factors

Expected Outcome:

1. Documentation of diversity and diversity loss in these regions, identifying the critical species and developing strategies for their conservation.
2. Identification of plant communities that show maximum carbon sequestration and develop methods for their use in afforestation programs.
3. Identification of useful organisms as experimental tools and for their adaptive value and bioremediation.
4. The compiled data would be able to assist in the developmental planning, specifically in planning and targeting health and ecosystem interventions and in monitoring diseases and interventions over time
5. Identification of novel biochemicals from plants, animals and microbes (including endophytes and non-culturable microbes) and their application in health and agriculture.
6. Generation of a library of active compounds from which lead molecules can be identified. This study will focus on targeted drug molecules.

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BUDGET ESTIMATES: SUMMARY

A. Equipment: ICPS: 100.0 lacs

Field equipments: 045.0 Lacs

Item	Budget					Rs.In Lakhs
	1st Year	2nd Year	3rd Year	4th Year	5th Year	Total
JRF (20) @15,000/-	36.0	36.0	36.0	36.0	36.0	180.0
Contingency	15.00	15.00	15.00	15.00	15.00	075.00
Chemicals and Consumables	50.0	50.0	50.0	50.0	50.0	250.0
Travel, Field Trips, analytical services	10.0	10.0	10.0	10.0	10.0	050.0
Total	111.00	111.00	111.00	111.0	111.0	555.0

Justification for Field Assistants:

Field assistants are required for collection of samples and project assistants are required for carrying out experimental work in the laboratories. All this work will require extensive amount of chemicals and consumables. The biodiversity project involves visit and sampling of soil, plants, microbes, animals and marine products. For collection of these samples from different sources field assistants are necessary.

Justification for Contingency:

Contingency is required for meeting expenses such as Xerox, postage, buying of stationary, literature search, networking facilities, collection of samples from the fields etc. Travel budget is required for the field trips as well as attending seminars and conferences.

Justification for Chemicals:

Chemicals and consumables are required for isolation of phytochemical, their characterization and synthesis of biologically active compounds.

Phase wise Analysis:

Phase I: Phase one of the programme involves visit to Western Ghats and literature search. Study of geological, ecological and biological aspects of biodiversity. Identification of species plants, insects, animals, microbes and finding of their location. The broad work plan involves survey and sampling.

Phase II: Determination of diversity indices and laboratory based study of cytotaxonomy, chemotaxonomy and molecular taxonomy. Study of carbon sequestration by the vegetation in different ecosystems and plant species. Study of the diversity of Dipteran insects, Rotifers and Anuran Amphibia. Study of soil chemistry, geomorphology and climate in the concerned regions. Collection of plant and marine samples.

Phase III: Biodiversity studies on the carbon sequestration capacity in rocks, soils, water bodies. Isolation of active ingredients by using chromatography instruments, purification of samples. In vitro and in vivo biological studies of identified active constituents, characterization of compounds by using spectral methods. Analysis of data. Publication of results. To find possibility of patent.

Phase IV: Analysis of ecological, geological, geographical and health related data. Synthesis of bioactive compounds in the chemical laboratory on large scale. Publication of results.

Documentation of diversity and diversity loss in these regions, identifying the critical species.

Phase V: Documentation of novel biochemicals from plants, animals and microbes (including endophytes and non-culturable microbes) and their application in health and agriculture. Development of strategies for their conservation. Generation of a library of active compounds from which lead molecules can be identified. Publication of data in the form of publications and patents. Documentation of different type of data and their application in health and agriculture. Submission of strategic plan for conservation of ecosystem. Analysis of data on ecosystem, vegetation, eco-topological maps, climatic data and their relationship with geographic distribution of diseases, climate and spatial and temporal trends of disease, Mapping populations at risk and Stratifying risk factors etc.

Infrastructural Development

(a) Creation of Convention Center

It is proposed to have a convention centre comprising of auditorium (1000 capacity) attached with conference halls (300 capacity), students centre with café taria, internet facility, bank, post-office etc. The seed money required for this is Rs. 300.00 lacs.

(b) Central Instrument Facility:

Departments are involved in interdisciplinary research. There is a high level of scientific interaction among the faculty members and research scholars from various Departments. Some of the equipments are highly sophisticated and expensive. It is not possible for the small Departments to buy all these equipments. It is therefore proposed to establish. The central Instrument Facility will comprise of:

Highly Sophisticated Equipments like

MicroRaman (Rs.100.0 lacs)

High Field 500 MHz NMR Spectrometer (Rs. 250.0 Lacs)

LC-MS-MS (Rs. 150.0 Lacs)

Budgetary Requirement (Part funding) : Rs.500.00 lacs

(c) Construction of Boys Hostel:

There are 16 hostels on the campus, 8 for Boys & 8 for Girls in addition to 2 hostels for international students. Total capacity is about is about 2500 beds. There are about 4500 students studying on the campus. Thus there is a requirement of at least about 1000 beds. It is, therefore, proposed to construct another Hostel of about 300 beds capacity.

Budgetary Requirement (Part funding) Rs. 100.00 lacs

(d) Support for National / International Conferences:

The faculty and students of the University are actively involved in research. We organize and participate in many National / International conferences. Financial support for payment of registration fee, travel including air travel, DA, honorarium etc has to be paid.

Budgetary requirement : Rs.100.00 lacs

(e) Creation of Scientist Complex:

University attracts large number of distinguished scientists and senior professors from within the country and abroad. Senior faculty members in the University also need a place for academic discussions. This complex will provide venue for such type of discussion meetings in addition to accommodating distinguished personalities from outside.

- Budgetary requirement : Rs. 100.00 lacs

University with Potential for Excellence

Total Proposed Budget Rs. in Lacs

No.	Item	Non-Recurring	Recurring	Total
1	**Focus Area**			
	a. Biotechnology	100.0	300.0	400.0
	b. (a) Novel Materials	180.0	070.0	250.0
	(b) Nano-materials and - nanobiotechnology	018.0	082.0	100.0
	Sub Total of Focus Area	298.0	452.0	**750.0**
2.	**Holistic Develoment**			
	(a) Health Science and Social Science	010.0	140.0	150.0
	(b) Center for Social Sciences and Humanities	--	100.0	100.0
	(c) Centre for Modeling and Simulation In collaboration with the Center for Social Sciences and Humanities	--	050.0	050.0
	(d) Biodiversity	100.0	250.0	350.0
	(e) Infrastructure Development			
	i. Convention Building	300.0		300.0
	ii. Central Instrumental Facility	500.0		500.0
	iii. Boys Hostel	100.0		100.0
	iv. Scientist Complex	100.0		100.0
	v. Conferences/Travel Grant	100.0		100.0
	Sub Total of Holistic Development			**1750.0**
	Total UPE Budget (1 + 2)			**2500.0**