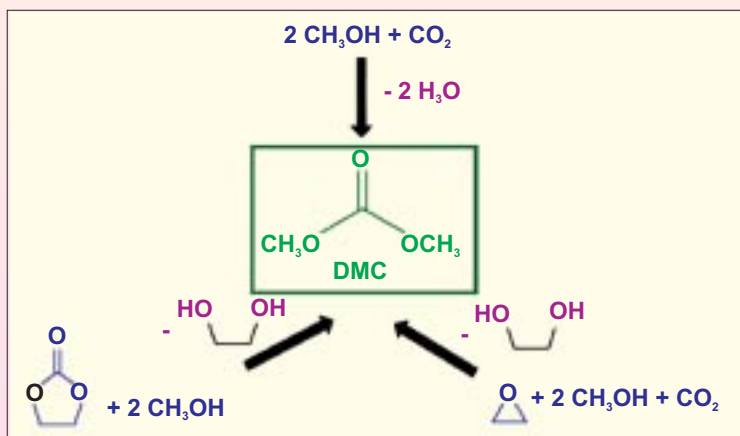




Innovating Green Technologies

Efficient and Eco-friendly Catalytic Route for producing Dialkyl Carbonates

Scientists at the National Chemical Laboratory (NCL), Pune, have discovered a novel, solid Fe-Zn double metal cyanide catalyst which is highly efficient for the synthesis of dimethyl carbonate (DMC) from cyclic carbonates and methanol. Dialkyl carbonates, especially DMC, find important applications in the "green" chemical synthesis as raw material and reagent for carbonylation and methylation reactions, replacing toxic-phosgene and dimethyl sulfate, respectively. DMC is the precursor for manufacture of engineering polymers such as bis-phenol-A polycarbonates. It finds application also as an octane booster, solvent, electrolyte in lithium ion batteries, lubricant fluid, etc. The conventional manufacturing processes of DMC via oxidative carbonylation and phosgenation of methanol are hazardous. Eco-friendly routes for the synthesis of DMC include: (1) direct carboxylation methanol with CO_2 , (2) reaction of epoxides, CO_2 and methanol, and (3) transesterification of cyclic carbonates with methanol. The yield of DMC is higher in the third option. This route catalyzed by homogeneous catalyst has been adopted recently in the manufacture of bis-phenol-A polycarbonate. A solid catalyst-based process has advantages over a homogeneous catalyst-based process. However, the yield and selectivity of DMC over the known solid catalysts are considerably low (below 60%).





The NCL scientists, Darbha Srinivas and his group credited with this discovery of the novel bimetallic cyanide catalysts, report that a range of dialkyl carbonates could be synthesized in high yields by transesterification of cyclic carbonates with alcohols. DMC, for example, was produced with 100% selectivity and an isolated yield of more than 86%. Unsymmetrical carbonates could also be synthesized by using different alcohol mixtures. Structural and spectroscopic studies revealed that Lewis acidic Zn ions are the possible active sites in the transesterification reaction. Similar double-metal cyanides are well-known catalysts for the copolymerization of epoxides and CO₂ yielding biodegradable polycarbonates and synthesis of propene oxide-based polyether polyols like polypropylene glycols (PPG) which are used in a wide range of polyurethane applications. Srinivas and colleagues have reported, for the first time, the application of double metal cyanides in transesterification reactions.

R. Srivastava, D. Srinivas and P. Ratnasamy, *J. Catal.* 241 (2006) 34 – 44.

Indian Institute of Chemical Technology Hyderabad

R & D Highlights: 2005-07

The Indian Institute of Chemical Technology (IICT), Hyderabad, is engaged in the development of globally competitive and environmentally viable technologies for Drugs and Drug Intermediates, Organic and Inorganic Chemicals, Agrochemicals, Catalysts, Polymer Coatings, Adhesives, Oils and in many other areas. The institute also offers wide-ranging knowledge based services in analytical testing and characterization, new molecule and product development, process up-gradation and restandardization, process safety studies, design-engineering and project viability studies.

A few of the important performance indicators of this highly acclaimed institute are as follows:

	2005-06	2006-07
• Projects undertaken	65	46
• Projects completed	52	46
• Patents		
- Filed in India	29	9
- Filed abroad	82	34
• Patents		
- Granted in India	31	18
- Granted abroad	33	28
• Research Publications	432	551
(SCI journals)	(2005)	(2006)
Average Impact Factor	1.94	2.05
• External cash flow		
- Govt Deptts:	16.66	23.76
- Non Govt. Agencies: (Rs in crore)	8.25	9.04

The various projects in the area of Synthetic Organic Chemistry & Drug Intermediates, Natural Products, Agrochemicals & Pheromone Chemicals, Fluoroorganics, Inorganic & Physical Chemistry, Lipid Science & Technology, and Organic Coatings & Polymers are mentioned here. The projects in other areas, i.e. (i) Biology and Pharmacology (ii) Coal, gas and Energy and (iii) Chemical & Instrumental Analysis, Chemical Engineering Sciences, Mechanical Design & Engineering, Computer Centre, Bioengineering and

Environment Centre, General Engineering Services, Pilot Plant (Up scaling) Facilities will be highlighted in the forthcoming issues of the newsletter.

Synthetic Organic Chemistry & Drug Intermediates

Designer molecules from sugar amino acids and other scaffolds synthesis of non-natural peptides with skeletal and secondary structural diversity from C-linked carbo-amino acids (Caa) — C-linked carbo- β -amino acids (β -Caas) have been developed as a new class of β -amino acids and utilized to prepare β -peptides with helical diversity and robustness. Though β -amino acids are ubiquitous in nature, β -, γ - and δ -peptides are not. Hence, new designs were envisaged and peptides were realized with novel helices such as 9-, 9/11-, 11/9-, 12/10- and 11/13-helices form different backbones, while using L-Pro-Gly as turn motif, Helix-Turn-Helix super secondary structure was achieved

Synthesis and structural studies of peptides containing a glucose derived furanoid sugar amino acid (Gaa) — Detailed NMR and constrained MD studies revealed that the peptides with repeating Gaa-Leu-Val units had conformational signatures very similar to those of linear homooligomers of Gaa

Conformational analysis of some C2-symmetric cyclic peptides containing tetrahydrofuran amino acids — Conformational variability exhibited by mellitic acid anions

(MA-n) with organic amine cations.

Organic Synthesis and Synthesis of Natural Products

Antascomicin A — A stereoselective synthesis of the C1-C21 fragment of the non-immunosuppressive immunophilin binding natural product, antascomicin A was achieved.

Clavosolide A — Total synthesis of (-)-clavosolide A was achieved employing a radical-mediated route to build the substituted tetrahydropyran unit, a Yamaguchi reaction to construct the diolide aglycon and the Schmidt method for the final glycosidation step.

Iso-Cladospolide-B, Cladospolides-B and C — The syntheses of iso-cladospolide-B, cladospolide-B and cladospolide-C were achieved with (4*S*,5*S*,11*S*)-configuration.

Pharmaceutically relevant chiral tetrahydrofurans — Operationally simple and flexible methods of making chiral tetrahydrofurans of therapeutic relevance were developed.

Xylobovide — Total synthesis by an intramolecular radical cyclisation protocol on a carbohydrate derived 5-hexynyl-system and determination of the absolute stereochemistry of xylobovide was achieved

4-Substituted coumarins — A versatile and efficient route to 4-substituted coumarins *via* a Pechmann reaction using $ZrCl_4$ as

the catalyst (10 mol%) was developed which provides several advantages over alternative procedures such as mild, solvent-free conditions at ambient temperature, and direct isolation of the products in high yields.

trans-1,8,12,13-Tetraoxadispiro [4.1.4.2] -tridecanes — Important components of many bio active compounds. These new class of peroxides have been synthesized using Birch reduction of aromatic compounds followed by ozonolysis and acid catalysed cyclisation.

*(1*S*,2*R*,5*R*,7*S*)-2-Hydroxy-exo-brevicomine* — It was synthesized from 1,2;5,6-di-isopropylidene-D-glucose in seven steps. The key reaction in the synthesis was the formation of bicyclic ketal under acid mediated acetal exchange of 1,3-acetonide of D-glucose derivative.

bis-Hydroxytetrahydrofurans — A short asymmetric approach for the synthesis of bis-tetrahydrofuran unit of various annonaceous acetogenins was developed.

6-epi-Pentenocin B — Stereoselective synthesis of 6-epi-pentenocin B was achieved using stereoselective Grignard reaction and ring closing metathesis (RCM) as the key steps

Scalemic tertiary phosphineboranes — A method was developed for the formation of P-C bond virtually using non-basic conditions with sub-stoichiometric amount of copper iodide as a catalyst. A series of compounds were subjected to



coupling reaction and the corresponding products were obtained in high yields with retention of configuration.

Belactosin — A metabolite of streptomycetes and a potential drug for antitumour activity, was synthesized.

(-)-Microcarpalide — Total synthesis of the actin-targeting metabolite (-)-microcarpalide was achieved using ring-closing metathesis of a dienic ester as the key step.

L-1-deoxyallonojirimycin and D-1-deoxygulonojirimycin — A general strategy for the synthesis of deoxyzasugars from D-glucose was developed using ring-closing metathesis and stereoselective dihydroxylation reactions as key steps.

Diastereoselective Passerini reactions—*p*-Toluenesulfonylmethyl isocyanide (TosMIC) was used for the first time as the isonitrile component in a diastereoselective Passerini reaction with sugar-derived aldehydes to afford products in moderate to good yields (40-90%) and selectivities (30-90% de's).

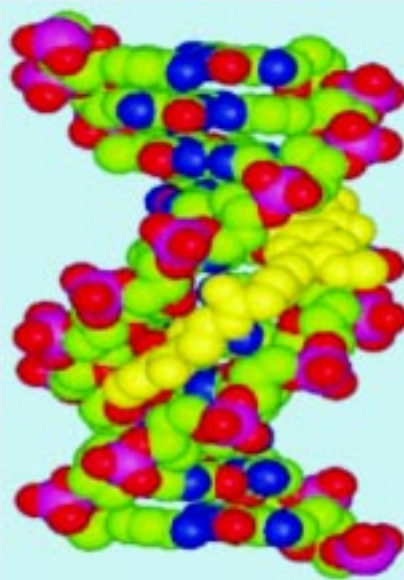
Diversely substituted sugar-linked α , β -unsaturated γ -lactones — A versatile protocol for the production of sugarlinked α , β -unsaturated γ -lactones with stereochemical and functional group diversity was developed starting from sugar-derived Baylis-Hillman adducts via ring closing metathesis

(-)-Decarestrictin D — A

convergent stereoselective total synthesis of (-)- decarestrictin D from L-malic acid was achieved.

(+)- Cardiobutanolide and (+)-3-epicardiobutanolide — A chiron approach, starting with 3-*O*-benzyl-1,2-*O*-isopropylidene- α -D-xylopentodialdo,14-furanose utilizing a Grignard reaction, Mitsunobu stereoinversion, ethyl diazoacetate addition, and selective reduction of the ketone, was employed for the total synthesis of (+)-cardiobutanolide.

DNA minor groove binding heterocycles as potential anticancer agents — As a part of continuing research on the design and synthesis of new anticancer agents, a number of new and efficient methodologies including the solution and solid phase synthesis have been developed particularly for the synthesis of pyrrolo[2,1-*c*][1,4]



Representation of anthramycin docked in the minor groove of DNA

benzodiazepines (PBDs) and their dimers.

C2R-fluoro substituted DC-81 and its dimers — The products have been synthesized that exhibited significant DNA binding ability, particularly the five carbon alkane spacer compound showed significant DNA melting temperature and promising anticancer activity.

Pyrrolobenzodiazepine-azepane conjugates — One of the compounds among the series of these conjugates prepared, elevated the DNA helix melting temperature significantly.

Novel 4β -N-heteroaryl analogues of podophyllotoxin were prepared by employing red phosphorous/I₂ reagent system. These 4β -N-heteroaryl analogues have been evaluated for their cytotoxicity against six human cancer cell lines and some representative ones have shown promising anticancer activity.

Synthesis of symmetrical pyrrolobenzodiazepine dimers linked through a piperazine side-armed-alkane spacer — New pyrrolobenzodiazepine (PBD) dimers have been designed and synthesized that comprised of two DC-81 subunits tethered to their C8 positions through piperazine moiety side-armed with alkaneoxy linkers (comprised of two to five carbons). DNA thermal denaturation studies exhibited very high ΔT_m values. Thus incorporation of a piperazine moiety instead of an inert alkanedioxy linker alone significantly

enhances the DNA binding ability in comparison to DSB-120 that lacks a piperazine moiety in the linker spacer. Some of these compounds have also shown promising *in vitro* anticancer activity in the panel of sixty human cancer cell line of NCI.

A series of *N10-1-[2-anilino-3-pyridyl]carbonyl-1-benzenesulfonylhydrazide derivatives* have been synthesized and evaluated for their *in vitro* anticancer activity at the National Cancer Institute (NCI) against a panel of 60 human tumour cell lines. These compounds have also been evaluated for their antibacterial activity against various Gram-positive and Gram-negative strains of bacteria. Most of these compounds showed better inhibitory activity in comparison to the standard drugs of such class.

A series of *benzothiadiazine 1,1-dioxide derivatives* have been synthesized and screened against *Mycobacterium tuberculosis*, *M. avium* and *M. intracellulare*. One of the compounds exhibited potent anti-tubercular activity, particularly for the resistant strains. However, the *in vivo* testing in a mouse model of tuberculosis infection did not show significant anti-tubercular activity, probably due to its poor bioavailability. Therefore efforts are in progress to improve its bioactivity.

Coumarin-linked fluoroquinolones, phthalimides and naphthalimides — A hybrid molecule synthesis strategy has been employed to develop new molecules

with potential antibacterial activity. Three types of coumarin-linked hybrids have been synthesized. The coumarin ring system has been linked to phthalimido, naphthalimido and quinolone moieties at 4-position through piperazino alkane spacers. These compounds have been evaluated for their antibacterial activity. Some of these new hybrids particularly phthalimido and naphthalimido ones have exhibited DNA gyrase inhibition activity.

New synthetic methodologies — The achievements pertain to:

- Selective reduction of aromatic azides in solution/ solid phase and resin cleavage by employing BF₃.OEt₂/ EtSH
- An efficient solid-phase synthesis of pyrrolbenzodiazepine dimers and their C2- fluorinated analogues
- Solid-phase synthesis of a library of pyrrolo[2,1-c][1,4]benzodiazepine-5,11-diones
- Conversion of amines to imines employing polymer supported reagents: Synthesis of pyrrolo[2,1-c][1,4]benzodiazepines
- Polymer assisted solution-phase strategy for the synthesis of fused [2,1-b] quinazolinones and preparation of optically active L-vasicinone.

Biotransformations : IICT has been actively involved in biotransformations/ biotechnology

processes with a view to developing greener and safer processes/ technologies catalyzed by enzymes. In continuation of these efforts towards the synthesis of biologically important compounds, new and simple methodologies have been developed for the synthesis of certain drugs, drug intermediates and related for commercially important chiral compounds. The achievements pertain to:

- Chemoenzymatic synthesis of enantiomerically enriched kavalactones
- Enantioconvergent synthesis of (R)-GABOB
- Chemoenzymatic synthesis of (3R,4S)- and (3S,4R)-3-methoxy-4-methylaminopyrrolidine
- Chemoenzymatic synthesis of (5S) and (5R)- hydroxymethyl-3,5-dimethyl-4-(methoxymethoxy)-5H-thiophen-2-one: A precursor of thiolactomycin
- Chemoenzymatic synthesis of calcilytic agent NPS-2143 employing a lipase-mediated resolution protocol
- Polyethylene glycol (PEG) as an efficient recyclable medium for the synthesis of β- amino sulfides
- Oligomers of cis-β-norbornene amino acid: Formation of β-strand Mimetics
- Total synthesis of natural (+)-membrenone C and its 7-epimer



- First total synthesis of (-)-diospongins B
 - Formal synthesis of fostriecin by a carbohydrate-based approach
 - A viable efficient sex pheromone trap for *Aproaerema modicella* Dev. (Gelechiidae: Lepidoptera)
 - A convergent route to β -hydroxy δ -lactones through Prins cyclisation as the key step: Synthesis of (+)-prelactones B, C and V
 - Stereoselective total synthesis of iso- Cladospolide B
 - Stereoselective synthesis of the C1-C20 segment of the microsclerodermins A and B
 - Practical and highly stereoselective approaches to the total synthesis of (-)-codonopsinine
 - Poly(ethylene Glycol) (400) as Superior Solvent Medium against Ionic Liquids for Catalytic Hydrogenations with PtO₂
 - Three-component coupling of alkynes, Baylis-Hillman adducts and sodium azide: a new synthesis of substituted triazoles
 - Palladium-catalyzed addition of hydroxylamine derivatives to Baylis-Hillman acetate adducts
 - Tris(pentafluorophenyl) borane-catalyzed synthesis of N-benzyl pyrrolidines
 - An efficient protocol for regioselective ring opening of epoxides using samarium triflate: Synthesis of propranolol, atenolol and RO363
 - The first asymmetric total synthesis of (R)-tuberculolactone, (S)-jasmine lactone and (R)- α -decalactone
 - Stereoselective syntheses of (-)-tetrahydrolipstatin via Prins cyclisations
 - A chiron approach to the total synthesis of (-)-tetrahydrolipstatin
 - A novel one-pot conversion of amines to homologated esters in poly(ethylene glycol)
 - A new asymmetric synthetic route to substituted piperidines, which are an important class of therapeutic agents
 - Stereocontrolled synthesis of conformationally constrained azetidinic amino acids for utilizing them as new tools in peptide chemistry
 - An environmentally benign and highly efficient procedure has been developed for the direct one-pot synthesis of β -hydroxysulfides with broad substrate specificity in good yields under neutral conditions in the presence of aerial oxygen using β -cyclodextrin in water.
 - Stereoselective synthesis of (*E*)-vinyl sulfides in water with excellent yields.
 - C-3 selective ring opening of 2,3-epoxyalcohols/epoxides with aromatic amines catalysed by cyclodextrin in water at room temperature to afford the corresponding β -aminoalcohols in excellent yields and high regioselectivity.
 - An environmentally benign supramolecular Michael addition of thiols to α -, β -unsaturated compounds in quantitative yields.
 - A potential drug delivery system has been developed for the antitubercular drug 'Rifampicin' using β -cyclodextrin and its derivatives to increase the bio-availability and to overcome the degradation of 'Rifampicin' in the presence of other anti-TB drugs, which has become a major issue in fixed dose combinations. ("US patent No. 7001893" dated 21-02-2006, "EP No. 02783368" dated 01-06-2005)
- Other achievements include: Preparation of 4-chloro-2-substituted tetrahydropyrans under different Lewis acids like BiCl₃ and ZrCl₄, Zinc dust mediated N-sulfonylation of amines to the corresponding sulfonamides, An efficient and eco-friendly one-pot synthesis of dihydropyrimidin-2(1H)-ones under solvent-free conditions, Intramolecular cyclization of thioformanilides to 2-substituted benzothiazoles, Co-

solvent effect on enzyme activity in aqueous binary systems, Asymmetric synthesis of non-proteinogenic amino acids with L-amino acid transaminase: Synthesis of (2S)-2-amino-4-oxo-4-phenylbutyric and (3E, 2S)-2-amino-4-phenylbutenoic acids, Preparation of enantiomerically pure (R)- and (S)-3-amino-3-phenyl-1-propanol via resolution with immobilized penicillin G acylase, Design, parallel synthesis and evaluation of glucosamine-6P synthase (GFAT) targeted inhibitors, Exploitation of sulfilimines as intramolecular nucleophiles for the regio- and stereoselective elaboration of bromosulfonamides from olefins, and Solid-phase organic synthesis adopting strategic solution-phase reactions that permit diversity efficiently have been adapted to solid-phase.

Molecular Modeling

Molecular Modeling activities at IICT are directed towards the application of a range of computational methodologies to understand structures, energies and reactions of organic and biochemical molecules. The major classes of molecules currently studied in the group are proteins, nucleic acids, Inorganic and organic molecules. Thus, IICT works in the interdisciplinary area of computational chemistry and computational biology. Quantum chemical, molecular mechanics, and molecular dynamics approaches are applied to understand the

structure, reactivity and function of small to large molecules. Besides, application of molecular modeling techniques are used to drug design which spans the areas of protein modeling, docking, QSAR, database design and development, and the application of statistical and machine learning tools to analyze the databases. Studies have been also carried out for the CSIR coordinated programme, Task force and NMITLI projects. In addition, support from molecular modeling group is extended to several scientific groups in IICT.

Database design and datamining

siRNA database for Oncogenes (<http://203.199.182.73/gnsmmg/databases/sirna/dstho.html>) — The database is designed to aid the synthesis of siRNAs targeted at human oncogenes and provides siRNAs of known efficacy from previous experiments, some

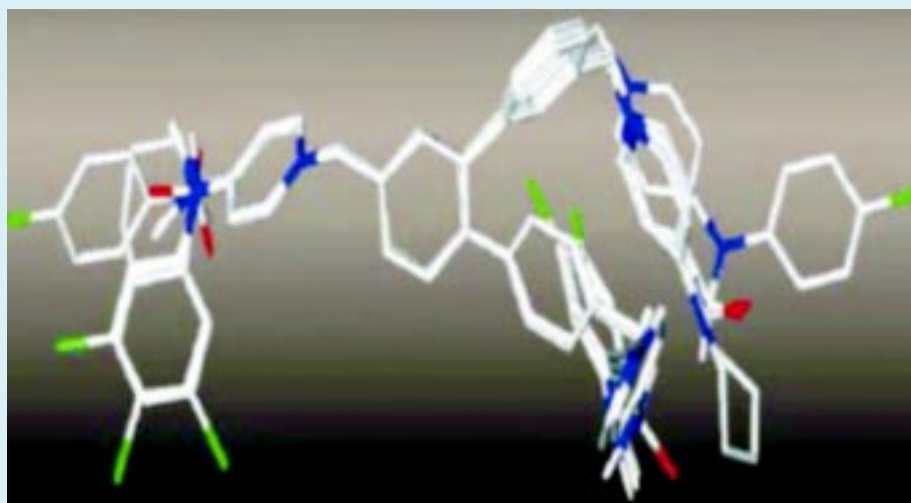
theoretically pregenerated putative target sequences and links to published literature.

Cation-Aromatic Interactions Database

(<http://203.199.182.73/gnsmmg/databases/cad>) — CAD is a publicly available web-based database that aims to provide further understanding of interaction between a cation and the p-moiety of the aromatic residues in protein data bank (PDB).

Quantum Mechanical Calculations

The studies pertained to Diphenic acid as a general conformational lock in the design of bihelical structures, Design of the smallest planar tetracoordinate carbon and boron systems, Theoretical elucidation of the antioxidant mechanism of 1, 3-dihydro-1-methyl-2-himidazole-2-selenol (MSeI), Homology modeling



Database alignment of the dataset



of membrane proteins: Active site acidic residues and structural analysis of modelled human aromatase: A potential drug target for breast cancer, and 2D and 3D quantitative structure-activity relationship studies on a series of bis-pyridinium compounds as choline kinase inhibitors.

New R&D Facility : Pre-Biotechnology Process Generator (PBPG) — It has the state of art equipment and would be made available to the prospective tenants of BTIC/outside parties for carrying out bench scale processes/product development in the area of biotechnology. It also includes auxiliary facilities for cell culture, media preparation and related downstream facilities. Presently this facility is being utilized for the development of some of the in-house biotech projects such as: enzyme purification and isolation (nitrilases, amylases, lipases and oxido reductases) from cultures obtained under networking projects, Biotransformation of acrylonitrile to acrylic acid employing nitrilases, Lipase-mediated resolution of pharmaceutically important intermediates to obtain them in their optically pure forms, Bioethanol production from cellulosic biomass.

DST-DABUR and DST-ZRC projects were initiated towards drug development in the areas of cancer and arthritis. Project on design and synthesis of new chemical entities as TNF- α inhibitors towards anti-arthritis. More than 200 different skeleton compounds have been synthesized and were evaluated for

their biological activity for exploring their therapeutic potential. Further identification of lead structure is currently in progress.

DST-CSIR-financed set-up for molbank has been initiated for creation of National Facility for Combinatorial Natural Products. Over 5,00,000 compounds generated inhouse and in collaboration with other institutes/universities will be stored in the coming five years and their database will be created. All the samples will be screened by high throughput screening for biological activity.

IICT-EVOLVA: In collaboration with EVOLVA, a Switzerland based company (that works on gene chemistry), several analogues will be synthesized for a lead compounds and will be screened for various activities such as antifungal, anti cancer, etc.

Microbial oxidation of alkanes to dicarboxylic acids — Seventy-five species of microbes belonging to *Candida lipolytica*, *C. tropicalis*, *Pichia arinose* and *Rhodotorula sp.* etc. were mutated and more than 1000 mutants were isolated and screened for production of DCAs. Nine mutants of *P. farinosa* were most promising and produced brassylic acid ranging from 2.2 to 4.5 g/L with 10 to 25% yield (NMTLI Project)

Novel Polymeric Materials — Various functional polymers possessing epoxy groups were prepared in the group of Dr Ponaratnam at NCL, Pune. These

polymers were tested for immobilization of enzymes such as lipases, α -chymotrypsin, trypsin, sialic acid aldolase, alcohol dehydrogenase, peroxidase etc. Lipase from *Candida rugosa* was immobilized (75 mg/g resin) and used for resolution of naproxen via hydrolysis of its butyl ester. Interestingly, more than 90% of enzyme activity was lost during immobilization in aqueous solutions due to hydrophobic interactions of the enzyme with polymer. This observation led to designing of polymers internally modified with diabutylamine to provide polymers of varying hydrophobicity. A fairly linear relationship of polymer hydrophobicity and enzyme denaturation capacity was observed. The modified hydrophobic polymers can be used in processing of fruit juices. Active enzymes such as esterases and proteases can cause allergies on consumption by vulnerable patients. These enzymes can be easily and safely destroyed by a simple contact with the polymer for 30 min. at room temperature. The polymer can be Benchtop Fermentor / Bioreactor, 20 Lit. reused several times. Other applications are also being studied (Task Force Project).

Efficient immobilization of Lecitase (Phospholipase A1) in gelatin hydrogel — Its stability is studied with a view to utilizing the immobilized enzyme for degumming of rice bran oil. Excellent retention of enzyme activity (> 80%) was observed in hydrogels containing 43.5% gelatin crosslinked with



Benchtop fermentor/Bioreactor, 20 Litre

glutaraldehyde. Compared to free enzyme, which has a broad pH-activity profile (6.5 - 8.0), the activity of immobilized enzyme is strongly dependent on pH and has pH-optimum at pH 7.5. The optimum temperature of enzyme activity increases from 37 °C to 50 °C; and enzyme stability at 50°C increases by a factor of 5.

Fluoroorganics

In order to find a potent lead organic molecule, several trifluoromethyl substituted based on quinazolines, pyridopyrimidine, fused indazoles have been synthesized. Representative examples of each ring system were screened for anti-bacterial, antifungal, anti-cancer activities.

2H-Heptafluoropropane (HFC-227ea) — IICT has entered into an agreement with Centre for

Explosive and Environment Safety (DRDO), Delhi, for development of process for HFP. The technology developed has been transferred to a private industry and is under commercial implementation.

Fluoromonomers — Work is on for the development of technology for fluoromonomers and subsequently for preparation of fluoropolymers under the sponsorship of Terminal Ballistic Research Laboratory (TBRL), DRDO, Chandigarh.

The new facilities created in the area include: A separate building for wet laboratory, an automated vapour phase reactor system for 75-100 g catalyst, a 500 ml and 1000 ml Hastelloy - C reactor suitable to operate under high pressure and temperature, a batch pressure distillation unit, and an infrared spectrophotometer.

Organic Coatings and Polymers

Hydroxy phenyl maleimide epoxy blends with bismaleimides — Process was evolved for processing the blends at low temperatures compared to 'standard' bismaleimides, resulting in materials with high moduli, high Tgs, good thermal stabilities, making them suitable for aerospace and electronic applications.

Benzoxazine-epoxy copolymers are a new class of phenolic polymers being developed as an alternative to traditional high performance thermosetting resins for aerospace applications.

UV curable coatings — Acrylated epoxy oligomers have been synthesized and UV curable compositions have been prepared. Flexible films were obtained and studied for thermo mechanical properties by DMTA.

Hyperbranched polyesters (HP) in coating applications — Various functionalized polyesters by varying the cores and generations were prepared and these polyesters were used in the preparation of polyurethanes. The polyurethanes prepared have given the Tg around +150°C as against the conventional PU, which is usually around 40-50°C.

Polymer metal nanocomposites as heterogeneous catalysts for application in organic transformations — A simple experimental preparation technique



resulting in Poly (4vp-co-dvb)/CeO₂ nanocomposite in single step has been demonstrated for the first time. The method results in composites with higher metal content, well-defined crystallinity, near monodisperse and uniformly dispersed ceria nanoparticles in comparison to the conventionally synthesized counterparts. The process involves simple operation in one pot and has the advantages of low cost with absence of surfactants, γ -radiation, and could be extended to preparation of other metal/metal oxide polymer nanocomposites. Application of the above-synthesized catalyst in the three-component condensation has been established. The easy purification of products, easy catalyst handling, reusability of the catalyst, the use of water as solvent combined with the exploitation of multi-component strategy open good prospects to this process for its industrial applicability.

Biocompatible polymer materials for controlled drug delivery using chemically modified Chitosan — Controlled release technology is the permeation modulated transfer of an active agent from a reservoir to a target area and maintains a predetermined concentration or emission level for a specific period of time. Polymer membranes that are biocompatible are used in such applications. In drug delivery, pharmacokinetics is an important consideration because target tissues are seldom directly accessible and drugs must be transported from the portal entry in the body through a variety of biological interfaces to reach the receptors site. Modified

Chitosan (CTN) has been suggested as an alternative polymer for use in orthopedic applications to provide temporary mechanical support for the regeneration of bone cell in growth due to its good biocompatible, non-toxic, biodegradable and inherent wound healing characteristics.

Atom transfer radical polymerization (ATRP) — Preparation of various functional polymers and copolymers by ATRP has been achieved.

UV curable mesogenic acrylates for angle dependent coatings — Synthesis of various mesogenic acrylates carrying mesogenic moiety in the main chain and side chain has been achieved. From the binary (thermotropic) and ternary (lyotropic) cholesteric mixtures, films were fabricated by photocrosslinking. The films prepared by UV curing have been characterized by DMTA to determine the molecular weight between crosslinks. The morphology of the particles was viewed by optical microscopy which shows characteristic smectic A type morphology.

Large Scale Study of Controlled Release Polymer Devices for Pest Management in Groundnut Storage (funded by Technology Mission for Oilseeds, Pulses and Maize, Ministry of Agriculture, New Delhi) — A process for the preparation of controlled release polymer devices that can control pest infestation in post harvest storage of groundnuts has been developed. Improvement in the quality of the seed and oil through IPM - Eco-friendly

approach has been reported. Other major advantages being: User and consumer protection from carcinogen application and residues, Reduction in chemical pesticide usage, and Cost effective and commercialization adaptable technology.

Development of emulsion polymerization process for acrylonitrile terpolymers — Emulsion polymerization is a heterogeneous process in which the water solubility of the monomer plays a dominant role in affecting reactivity of the monomers, rate of polymerization and the composition of the copolymers produced. To understand the behaviour of individual monomers in emulsion polymerization, the individual reactivity ratios for acrylonitrile with other monomers have been studied.

Polyurethane-laminating adhesive — with very good green strength has been developed for a Nepal customer. This adhesive can be used to laminate polyester to LDPE, HDPE, aluminum foil and paper. This process has been demonstrated to the sponsor.

Development of rain erosion resistant grey paint with antistatic properties for LCA radome — The process for the preparation of rain erosion resistant with antistatic properties has been developed and tested for rain erosion resistance at 1750 RPM with 2mm drop rain for 180 mts. The developed paint has passed all the tests required as per MIL specification and the process is ready for getting type approval from CEMILAC, Bangalore.

Conference on Challenges and Applications of Mathematical Modeling Techniques in Building Science and Technology (CAM2TBST)

The title conference was organized on 7-8 February 2008 as a part of year-long Diamond Jubilee celebrations of the Central Building Research Institute (CBRI), Roorkee.

A premier building research organization in the country CBRI, has been actively pursuing the national agenda and contributing by way of developing appropriate construction technologies, new building materials, providing architectural and structural options along with a number of IS codes, guidelines, intellectual inputs and demonstrations at varying scales. It is also playing a lead role in bringing all concerned with the building industry on a common platform to network them, review the challenges in the emerging scenario and prepare an innovative and coordinated approach to address the challenges, in particular in the domain of modeling and simulation.

More than 100 eminent personalities from India and overseas attended the conference. Welcoming the participants, the organizing secretary, Dr S. Chakraverty informed that 150 abstracts had been received for the conference and the proceedings of the conference containing 84 full

length papers covering various themes presented in two volumes along with a CD having the soft copies of the full length papers brought out and released during the inaugural function.

Research papers pertaining to mathematical modeling were presented on various sub themes which include Structural, Earthquake and Concrete Engineering, Geo-technical Engineering (geo-radar application, landslide, pile foundation, GIS and GPS Applications, Seismology), Mechanical (process, vibration, construction machinery), Chemistry and Physics Related to Building Problems, Architecture, Public Health and Town Planning, IT and Computer Aided Designs, Land/Damage Classifications, Fire and Condition Monitoring.

The Chief Guest at the inaugural function, Shri H.S. Dogra, Additional Director General (Border) and Director General designate CPWD, in his address remarked that to reduce the repeated analysis experiments, money and time, the simulation and mathematical modeling are now becoming a new challenge in building research. Shri N.K. Verma, Chief Engineer, Engineering

Service Unit, CSIR, who was the Guest of Honour, said that the development of building industry in the modern time for various needs and uses was not possible without a sound mathematics, modeling, simulation and computer representation.

Dr M.O. Garg, Director, CBRI, the Chair Person of this conference, inaugurated the conference and opined that this conference represented a critical turning point as it has demonstrated how the most current, advanced and revolutionary computational techniques and simulation could be put to effective use in building research not only to satisfy the intellectual aspirations, but to handle the challenging problems practically in a better way. Dr Ashok Kumar Gupta, Sr. most Scientist of the institute presented a brief introduction of the Chief Guest, while Shri Vinod Kumar, Scientist 'F', introduced Shri N.K. Verma, Chief Engineer, CSIR.

Dr Rajendra Dobhal, Director, Uttarakhand State Council for Science & Technology, Dehra Dun, was the Chief Guest at the valedictory function. Three "Best Paper Awards" to the outstanding full papers of the conference were also announced.



National Seminar on 'Exploration for Platinum Group Elements (PGE), Gold & Diamonds in India'

A two-day National Seminar on 'Exploration for Platinum Group Elements (PGE), Gold & Diamonds in India', was organized at the National Geophysical Research Institute (NGRI), Hyderabad, in the recent past, with the support of Department of Science & Technology, New Delhi. The objective of the seminar was to take stock of all the accumulated data on PGE, gold and diamonds for building a conceptual framework to guide our country's future exploration efforts. About 80 abstracts were received pertaining to the following themes: (i) crustal evolution and PGE mineralization in varied geodynamic settings, (ii) structure controlled gold-silver-base metal mineralization in cratonic



Dr V.P. Dimri, Director, NGRI, presenting the 'Prof.C. Naganna Gold Medal' for 2006 to Dr N.V. Chalapathi Rao from BHU, Varanasi



regions, (iii) analytical techniques and PGE-gold determination, (iv) kimberlites/lamprophyres, xenoliths and diamonds - probes to deep crust-mantle processes, and (v) surface geochemical prospecting and geochemical environment baseline mapping. The seminar had 34 oral presentations including invited talks, and 18 poster presentations in six sessions.

Inaugurating the seminar, the Chief Guest, Shri B. Ramesh Kumar, Chairman-cum-Managing Director, National Mineral

Development Corporation (NMDC), Hyderabad, emphasized the importance of the need-based application oriented research on precious metals, and described the role of NMDC in sustained growth and development of the country. He also released the 182-page conference proceedings volume containing all the abstracts, full manuscripts on important topics, activities of NGRI and list of participants.

Presiding over the inaugural function, Dr V.P. Dimri, Director, NGRI, welcomed the gathering and highlighted the on-going activities at NGRI on studies related to mineral, hydrocarbon and groundwater

Shri B. Ramesh Kumar, Chairman-cum-Managing Director, NMDC, inaugurating the seminar. Dr V.P. Dimri, Director, NGRI, is also seen

exploration, earthquake hazard studies and other special activities.

Prof. V.L.S. Bhimasankaram, Eminent Professor at Osmania University, delivered the 'Prof. C. Naganna Endowment Lecture' entitled 'Does geophysics help locate diamond, gold and platinum', in which he cited several examples of successes in finding hidden mineral deposits through the application of geophysical techniques.

Around 200 delegates attended the inaugural function during which 'Prof. C. Naganna Gold Medal' for 2006 to Dr N.V. Chalapathi Rao, Reader, Banaras Hindu University, Varanasi, and the 'Prof. S.M. Ramananda Setty Award' for the year 2006 to Shri S.N. Solankar, Geologist, Exploration Department, The Hutti Gold Mines Ltd, Karnataka, were also awarded.

Fifteen invited presentations were made by experts from various earth science organizations across the country. A special lecture on 'Application of atomic spectroscopy techniques to determination of complex PGE sample matrices' was delivered by Dr Eric Vanclay from United Kingdom and an invited presentation on "QEMSCAN® – An automated mineralogical tool" was given by Dr Elizabeth Whiteman from Australia.

NBRI organizes Chrysanthemum and Coleus Show

The National Botanical Research Institute (NBRI), Lucknow, organized the Annual Chrysanthemum and Coleus show on 8-9 December 2007. The main idea to organize the flower show is to promote floriculture industry and to develop awareness about the floriculture. The show provides an opportunity to the general public to see the entire diversity of Chrysanthemum and Coleus and develop knowledge on their cultivation practices. A total of 112 exhibitors with 891 entries participated in this year's flower show. Local exhibitors as well as exhibitors from outside of Lucknow took part in the flower show.

NBRI is maintaining more than 250 germplasm collections of Chrysanthemum comprising almost all colours and types. Besides the four new varieties of Chrysanthemum and five stable cultivars of Coleus developed by NBRI, different varieties of Chrysanthemum — potted as well as cut flowers, large and small Chrysanthemum flowers and arrays of Coleus were also displayed and explained to the visitors, who got a unique opportunity to interact with scientists of NBRI working on Chrysanthemum and get first hand information on agro-technology, techno-economics pertaining to commercial cut flower varieties and other cultivation practices.

The function was organized in the open-air theater of the institute, amidst the swing blooms of vast array of Chrysanthemum and splendid varieties of Coleus scattering colour and joy in the

atmosphere. A total of 330 prizes in addition to 23 running challenge cups, shields and trophies were given away to the winners. Lt. General Gautam Dutt, VSM, Chief of Staff, HQ Central Command, Lucknow, was the Chief Guest and Prof. Basant Ram, Vice Chancellor, N.D. University of Agriculture and Technology, Faizabad, was the Guest of Honour, at the prize distribution function.

This year, the entries received from Headquarter, Central Command, Lucknow Cantt and Executive Engineer, Headquarter, U.P. Power Corporation, Shakti Bhawan, Lucknow, got the maximum seven trophies/running challenge cup, shields each. The Headquarter, Central Command, Lucknow, received the 'Indian Explosives Ltd, (Fertilizer Division) Running Trophy' for the highest score in the specimen pots of Chrysanthemum, 'G.O.C. in-C. Central Command Running Challenge Cup' for the highest score in specimen Coleus plants, 'Percy-Lancaster Challenge Cup' for a collection of nine pots of different varieties of Korean type Chrysanthemum, 'Quazi Syed Masood Hasan Running Challenge Trophy' for 'Prince of the Show' for a specimen pot of spider bearing single bloom, 'Smt. Madhuri Rai Challenge Shield' for a set of two specimen pots of Chrysanthemum, one each of large and small-flowered type trained in attractive styles other than Sen Rin Tsukuri and cascade styles, 'Smt. Kumud Rastogi Memorial Running Challenge Trophy'



F lower Shows

Display at Chrysanthemum and Coleus Show at NBRI



for the best specimen Coleus pot plant and 'Vikramajit Singh Running Cup' for the highest scorer in the show.

The Executive Engineer, Headquarter, U.P. Power Corporation, Shakti Bhawan, Lucknow, won the 'Nabi Mohd. Running Challenge Cup' for the highest score in specimen pots of Chrysanthemum, 'M.Y. Khan Running Challenge Trophy' for the highest score in Chrysanthemum cut-flowers, 'Begum Saeeda Khatoon Running Challenge Trophy' for the highest score in cut blooms in large flowered Chrysanthemum, 'Smt. Krishna Devi Memorial Running Trophy' for a collection of four pots of different varieties of Spider Type large flowered Chrysanthemum, 'Mehboob Ali Memorial Running Challenge Trophy' for a collection of six pots of different varieties of incurved type large flowered Chrysanthemum, 'Syed Shaheer Hasan Memorial Running Challenge Cup' for the best specimen pot of a reflex type large flowered Chrysanthemum and 'Devi Shanker Sinha Memorial Running Challenge Trophy' for the artistic group of large-flowered Chrysanthemum only, of 3 metres diameter. Director, Central Institute of Medicinal and Aromatic Plants, Lucknow, won the 'Mahfooz Ali Memorial Running Challenge Trophy' for the artistic group of small-flowered Chrysanthemum of 3 metres diameter and 'R. V. Sitholey Memorial Running Challenge Cup' for the artistic group of Coleus only of 3 metres diameter.

Those who got one cup/shield/

trophies each in the show were: Mohd. Irshad Ali, Rangeen Chaupal, Shahjahanpur (Savitri Devi Memorial Challenge Trophy for 12 pots of 12 different varieties of large-flowered Chrysanthemum), Shri Sarika Mehra of Lucknow (Mohammad Mullick Memorial Running Challenge Trophy for six pots of six different varieties of large-flowered Chrysanthemum), Major General J.J. Man, Lucknow (Shri Govind Prasad Memorial Challenge Trophy for 12 pots of 12 different varieties of small-flowered Chrysanthemum), Shri Mahmood Ahmad of Shahjahanpur (Ranjit Singh Memorial Trophy for 'King of the Show'), Smt. Kiran Nandrajog, of Lucknow (Queen of the Show for a specimen pot of small-flowered Chrysanthemum), Shri Uma Shankar Sahu of Lucknow (Ram Kishore Sharma Memorial Trophy for the Flower of the Year for a specimen pot of large-flowered Chrysanthemum with single plant bearing single bloom) and Shri Shahjad Mallick of Lucknow and Executive Engineer, U.P. Power Corporation, Lucknow, jointly got Qazi Syed Hasan Memorial Running Challenge Trophy.

Dr Rakesh Tuli, Director, NBRI, welcomed the guests and highlighted the purpose of organizing the show. He said that NBRI was one of the few institutes in India and abroad where technical expertise for cultivation of Chrysanthemum was available. He further said that public participation provided NBRI with a feedback for quality improvement.

Speaking on this occasion, the

Guest of Honour Prof. Basant Ram, said that there were plenty of opportunities for stakeholders in the floriculture industry. He hoped that various universities would collaborate with NBRI for the development of floriculture industry.

The Chief Guest Lt. General Gautam Dutt said that flowers brought happiness to everyone adding that NBRI was serving to the society by imparting knowledge and developing new varieties of Chrysanthemum and Coleus. He appealed to the public to make the best use of this opportunity by taking maximum participation in the show.

Canadian High Commissioner visits CFTRI

Dr David M. Malone, Canadian High Commissioner to India, accompanied by Shri D.P. Vittal Nath, Trade Commissioner, Canadian Office, Bangalore, made a short visit to the Central Food Technological Research Institute (CFTRI), Mysore, on 29 September 2007. The High Commissioner was taken around the institute's facilities and the International Food Technology Training Centre (IFTTC) Hostel Complex, which was constructed with the assistance of the Canadian Government. Dr Malone appreciated CFTRI's role in the area of nutrition.



Brazilian Consultant's visit to CLRI

Mr Bira Trieweiler, a Brazilian Consultant for Council for Leather Exports (CLE), visited the Central Leather Research Institute (CLRI), Chennai, on 24 October 2007 with the basic objective of enhancing trade and promoting joint ventures, technical collaborations and other strategic alliances between India and Brazil and also to explore the possibility of establishing tie-ups between technical institutes in Brazil and CLRI. An interactive meeting was organized for the benefit of Industry & CLE members and facilitating the consultant to understand the R&D capabilities of CLRI including the Education & Training programmes in the field of Leather & Allied Industry.

NASI-Reliance Industries Platinum Jubilee Award to Dr G. V. M. Sharma

Dr G. V. M. Sharma, Scientist, Indian Institute of Chemical Technology (IICT), Hyderabad, has been conferred the prestigious NASI-Reliance Industries Platinum Jubilee Award 2007, at the 77th Annual



Convention of NASI (Allahabad) held in Mysore. This award was given by the eminent scientist Prof. M. G. K. Menon, former Minister, S&T, Government of India. Dr Sharma received this coveted award for his excellent contributions both in the basic research and drug discovery in Application Oriented Innovations covering Physical Sciences. The competitors for the award were from several disciplines such as Mathematics, Physics, Chemistry, Engineering, Electronics, Nanotechnology, Information & Computer Sciences.

Dr Sharma began his research career at the National Chemical Laboratory (NCL), Pune, as JRF in

1979 and received his Ph. D from University of Pune. His research interests include natural product synthesis, glycochemistry and non-natural peptides. His extensive application oriented synthesis resulted in lead molecules (IICT-187191 and IICT-TA67) and new routes to

lead molecules, covered in several US Patents. His research contributions include 145 research papers in reputed international journals. He guided 23 Ph. D. students during the last 10 years.

Earlier, he received CSIR Young Scientist Award for his contributions in 'chiron approach'. He is a Fellow of AP Academy of Sciences and Institute of Chemists. He has visited USA, USSR, UK and Germany, and has collaborations with scientists from USA, Germany and France. He has worked with several international industrial clients from USA, UK and Switzerland.