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CSIR NEWS

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NEIST and DRL sign MoU

The North-East Institute of Science & Technology (NEIST), Jorhat, and Defence Research Laboratory (DRL), Tezpur, signed an MoU in the recent past for establishing a collaborative relationship between the two organizations in respect of the activities such as sharing of scientific information on collaborative research and extending scientific equipment facilities and other relevant scientific infrastructure; organizing short-term/long-term courses of mutual interest from the view point of human resource development; permitting mutual exchange of visits by students, scientific/technical personnel and Research Associates/Fellows, etc. and for availing library facilities; identification of topics of mutual interest and specific research projects to be mutually pursued; joint protection of Intellectual Property generated out of such collaborative projects; and to facilitate creation/development of new faculties through mutual co-operation through exchange of experts, etc.

NEIST signs non-disclosure agreement with Evolva

The North-East Institute of Science & Technology (NEIST), Jorhat, has signed a non-disclosure agreement with **M/s Evolva Biotech Private Limited**, a company having its registered office at Evolva SA of Hagmattstrass, Switzerland and its subsidiaries and affiliates, specifically Evolva Biotech Private Limited, Secunderabad, India, and Evolva A/S of Bulowsvei, Denmark, collectively and individually referred to as 'EVOLVA', for maintaining strict confidentiality in exchange of research information of mutual interest. Specific agreement for research activities to be carried out will follow in due course.

CENTRAL DRUG RESEARCH INSTITUTE, LUCKNOW

R & D Highlights: 2007-2008

The Central Drug Research Institute (CDRI), Lucknow, continued its competitive efforts in promoting the available leads on candidate drug molecules, standardized fractions, identification of new hits, development of new screens, molecular basis of disease progression and drug action, regulatory studies and new partnerships with industry. A brief summary of the salient features of the work done during the year is presented here:

Business Development and Contract Research

Collaborations continued with national and international research organizations and academic institutions. A research agreement was signed with DNDi, Geneva, for development of new chemotherapeutic agents for Human African Trypanosomiasis. Yet another agreement, in the area of Leishmaniasis, is being discussed. IPCA Laboratories, Mumbai, a leader in antimalarial drugs in India, entered into a collaborative agreement with the institute for further development of compound 99/411, a promising synthetic substitute, developed at CDRI, as a preferable substitute to artemisnin. Toxicity studies on another antimalarial candidate compound 97/78 were carried out under a sponsored project with IPCA and the compound was found to be safe. Its Phase I clinical trials will be initiated soon at PGIMER, Chandigarh.

An extended collaborative agreement with Duphar Interferan Limited, Mumbai, was executed to further extend Phase III clinical trials at different centres in respect of PICROLIV, a hepatoprotective agent. The institute received permission from Institutional Animal Ethics Committee and Committee on the Prevention, Control and Supervision on Experimental Animals for conducting 28 days toxicity studies in respect of herbal medicament (for treatment of cerebral stroke) in rhesus monkey, in collaboration with Themis Medicare, Mumbai. Ranbaxy Labs sought consultation for creating a facility for polypeptide synthesis at their R&D centre in Gurgaon. A material transfer agreement for providing pET28b CFP-10 expression vector was executed with Indian Immunological Limited, Hyderabad, for the development of diagnostic kits for tuberculosis in animals.

A novel formulation of compound 80/574 (a hypolipidaemic) with atorvastatin, which exhibited better synergistic lipid lowering activity, continued to be of interest to Cadila Pharma. Discussions with several large pharma companies are near finalization for collaborative development of a synthetic molecule 99/373 (anti-resorptive), CDR- 134D123 (antidiabetic and antidyslipedmic), Centchroman (non-steroidal female contraceptive) and *Bacopa monniera* extract (memory enhancer).

Phase I clinical trials were permitted for the compound 99/373. CDR-134D123 is to be taken up for multiple dose phase I studies. The other two products - Centchroman and *Bacopa monniera* extract are already in the market.

R&D Activities

Clinical Trials & Pharmacokinetic Studies

The clinical studies continued on nine candidate products, which are in different phases of drug development. Drugs Controller of India (DCGI) cleared CONSAP, a contraceptive cream of herbal origin, for human use. This product is expected to be extremely beneficial in family planning endeavor as it has good contraceptive efficacy, product acceptability by women and is devoid of any undesirable side effects. Multicentric clinical trials for efficacy of Arteether (blood schizonticidal) in 235 children suffering from *P. falciparum* malaria concluded at five centres and the dossier is under submission to DCGI. Safety evaluations in G6-PD deficient cases in respect of the compound 80/83 (anti-relapse

antimalarial) were conducted in Thailand. It was observed that its safety profile was better than primaquine. Phase III clinical trials continued on Picroliv (hepatoprotective) and 80/574 (hypolipidemic) and the data analysis is in progress.

Pre-clinical Safety Evaluation and Regulatory Toxicology

Regulatory toxicity studies have been carried out on the institute's as well as on outside products. institute's candidate drugs, CDR 267F018, 97/78, 99/373 and CDR 134/F194 were evaluated for their preclinical safety profiles. Amongst the products from outside agencies, evaluated for safety were AP76P, AP 20am 14, AP20am 15, AP20 am 16, Kajjali Yoga, Ras Sindoor, Vasant Kusumakar and ICB014P04A002. In addition to this, several basic research studies were also conducted, which included testing teratogenecity potential of Cyclophosphamide and Mitomycin-C at the platform of Metabonomics using NMR. This was planned with a view to developing a testing system which should not be time and cost intensive and also requires lesser number of animals (rats/mice).

A pilot study was also conducted to test renal toxicity using biofluids (urine) on the same platform. Furthermore, Single nucleotide polymorphism (SNP) diseases and standardization of initial parameters for neurotoxicity study were also accomplished. Also, the setting up of a laboratory for immunotoxicity studies of compounds has also been completed and standardization of various parameters and studies in this regard is under progress.

Biological Screening

A new in-house facility for screening of *in vitro* anticancer activity was established. The DST-Dabur project on anticancer drug development has been concluded. Leads thus generated were exploited and modified by synthesizing several chemical compounds. High throughput screening for antitrypanosoma activity was undertaken under a DNDi sponsored project. Over 7500 molecules were screened using pentamidine as standard drug and the active ones are being perused further. The HTS facility was used for screening of over 2400 new samples for anti-TB activity. Based upon the screening results and follow-up studies, four molecules exhibited variable degree of clearance of infection.

Cardiovascular, Central Nervous System & Other Disorders

Synthesis and screening of new synthetic molecules and natural products as antihypertensive, anti-stroke and anti-thrombotic agents continued during the year. Anti-stroke potential of some genomic extracts was studied wherein Gugulipid and Withanolide A were found to have significant activity and could serve as important anti-stroke agents. The neuroprotective role of AT1 receptor blocker Candesartan was assessed in focal cerebral ischemia model in rats and the study suggests that Candesartan may impart neuroprotection by reducing oxidative stress.

In the studies related to CNS, the effect of antidementia drugs, tacrine and donepezil, on biochemical markers of oxidative stress in brain was studied in STZ induced experimental model of dementia in mice. The results indicated that both the compounds suppress oxidative stress. Biological screening of synthetic compounds and natural products for antidementia, anti-anxiety, anti-depression and appetite suppression activities continued and those found active are being persued further. During the year, seven compounds showed promising anti-inflammatory activity while significant anti-ulcer activity was observed in one extract under CSIR coordinated project. Two synthetic compounds exhibited significant antihyperglycemic activity in mice. Antidyslipidemic effect of the compound 80/574 combined with atorvastatin was monitored in high fat diet fed hamsters and was found to be more effective than the effect of individual effective doses.

Filariasis

Compound S-005-116 was moderately active in both *B. malayi/ M. coucha* and jird models. An albendazole formulation ALB-1+DEC produced prolonged mf suppression (68-95%) till day 90 of treatment. However, ALB-1+ IVM produced better sterilization of

female *B. malayi*. The two fractions (F004 and F005) and a pure compound K009 of CDRI plant 4613 were adulticidal *in vitro* at 15.6 and 7.8 mg/ml *in vitro*. CDR-332A001 and AU2- 357A001 at 250 mg/kg × 5 days, p.o. and Crude and fraction/ sub-fractions of CSM-0012P04 and RJM-0069P03 revealed adulticidal activity on *B. malayi* in rodents. Fraction F004 of CDR-332 was highly active *in vitro*. Doxycycline at 25 mg/kg, i.p. killed all peritoneal micro- and macro-filariae within 15-30 days causing absolute female sterility. The recombinant *B. malayi* myosin (BmAF-Myo) offered significant protection against L3 challenge and was found to be immunologically Th1 inducer. *In vitro* culture of L3, adult male, female or Mf with mouse splenocytes revealed that adult worms and mf cause cellular hyporesponsiveness, adult and L3 principally induce pro-inflammatory responses while mf elicited mixed Th1/Th2. *B. malayi* B14 fraction eliminated >65% of adult parasites from the peritoneal cavity of host via NO production.

Molecular cloning of *B. malayi* hexokinase (1.7 Kb), its over-expression and enzyme kinetics revealed BmHk to be a tetramer with a subunit molecular mass of 72 kDa and C.D. analysis done. Antibody raised in rabbit to pure hexokinase reacted with BmHk in ELISA/blot. Molecular cloning and overexpression of *B. malayi* L3 DEAD box RNA Helicase was done, it reacted with IgG of all the categories of bancroftian subjects in blots and ATP utilization assay showed that dsRNA was the preferential substrate for the enzyme RNA Helicase. Immunoscreening of *B. malayi* lgt11 cDNA expression library with rabbit antibodies raised against circulating filarial antigen led to isolation of four cDNA clones and insert from one of these (Bm-6) was sub cloned in pGEM-T, sequenced, showed homology to *B. pahangi* and *Loa loa* antigens.

Leishmaniasis

Over 1200 synthetic compounds and marine extracts were screened against *L. donovani* infection and a sizeable number were found to be active *in vitro*. Based upon the leads from the results of *in vitro* screening, 10 synthetic compounds were evaluated *in vivo* against *L. donovani* in hamsters and one compound exhibited 92% inhibition in parasite multiplication and was selected for further optimization. Three materials - one from plant 4666K004 and two synthetic compounds (antifolate DHFR analogues: S-004-931 & S-007-1058) have shown more than 80% inhibition in parasite multiplication when tested *in vivo*.

Enhanced and stable expression of GFP in *L. donovani* clinical isolates was achieved by integrating GFP gene into the parasite genome. The immunomodulatory F2 fraction (68-97.4 kDa) and its four sub-fractions of soluble *L. donovani* proteins having significant prophylactic efficacy, were characterized which revealed that out of total 18 proteins, major immunostimulatory proteins were Elongation factor-2, p45, Heat shock protein (HSP)-70, HSP- 83, aldolase, enolase, triosephasphate isomerase, disulfideisomerase and calreticulin. Leishmania actin has been over-expressed in insect cell system by generating recombinant baulovirus and is being characterized biochemically.

In order to explore function of actin network in Leishmania, gene knockout experiments of various actin binding proteins, viz. coronin, cofilin and myosin have been performed. Gene knockout studies with leishmania ADF/cofilin homologue revealed essential roles in the flagellar motility function. The depletion of ADF/cofilin hampered flagellar growth and beating. Squalene synthase was purified for the production of antibodies in rabbit and partial purification was done in soluble form. Triose Phosphate Isomerase (TIM) cloned in pGEMT vector was further subcloned in pET 43.1a(+) to get protein in soluble form and was over expressed and purified.

Antibodies were raised against purified fusion tagged rLdTIM in rabbit for immunological studies. Based on biochemical studies, molecular modeling and docking strategy of Pteridine reductase 1 together with biological activity *in vitro* and *in vivo* led to identification of 2 out of 10 inhibitors of potential therapeutic value necessary to assist the structure based development of novel antileishmanial drugs.

Conformational stability of recombinant Trypanothione

reductase in presence of urea and guanidinium hydrochloride was studied. Biochemical characterization and molecular modeling of recombinant dipeptidyl carboxy-peptidase was carried out.

Malaria

Drug combination studies employing identified endoperoxide compounds CDRI 97/78 and CDRI 99/411 in combination with antimalarial drugs have been successful in optimizing regimens providing total parasite clearance with two to four fold lower doses of the individual components in the rodent model. Biochemical characterization of transketolase, as a novel enzyme target for drug development, has been undertaken. *P. falciparum* transketolase gene was cloned, expressed and the purified protein so obtained is being characterized. Studies have suggested that bilirubin, through the development of oxidative stress, induces *P. falciparum* cell death. Studies have been initiated on expression and characterization of *P. cynomolgi* CSP and MSP proteins to explore their potential for immunoprophylaxis against *vivax* malaria. Molecular studies with *P. falciparum* apicoplast have characterized *P. falciparum* gyrase subunits and their targeting to the apicoplast was confirmed. Inhibition of PfGyrB activity by novobiocin was characterized *in vitro*.

The role of human genetic factors in determining individual responses to *P. falciparum* malaria were studied in the context of SNPs in genes encoding cytokines and adhesion and immune regulatory molecules. The distribution of SNP frequencies across Indian populations and correlation of individual SNPs with cytokine levels and disease severity was established.

Microbial Infections

Upregulated genes of *M. tuberculosis* belonging to fatty acid metabolism, membrane transport, nitric oxide defence and PE_PGRS/PPE family were identified during residence in lungs of mice/*ex vivo* and in hypoxia condition using IVET approach, proteome and transcript analysis by microarray and subsequent validation by Real Time PCR. Genes for AHAS of *M. tuberculosis* cloned and over expressed *E. coli.* Few inhibitors of ICL of *M. tuberculosis* and synthetic compounds with antitubercular activity (MIC 0.79 μg/ml) were identified. Resuscitation of dormant mycobacteria by Rpf proteins from *Micrococcus luteus* and *M. tuberculosis* demonstrated *in vitro* and *in vivo* in mice using *M. fortuitum* as model. Interacting partners of Rpf, Eis (Rv2416c) and Erp (Rv3810) proteins identified on *M. tuberculosis* genome using bacterial and yeast two hybrid systems.

Novel (calcium dependent) PKC isoforms phosphorylated during the invasive process of macrophages with pathogenic mycobacteria have been shown and 18 differentially expressed proteins of the *M. tuberculosis* at sub lethal concentrations of isoniazid and rifampicin identified; a recombinant *M. aurum* for screening of FAS-II pathway inhibitors constructed; 24 clones for *C. albicans* and two for *A. fumigatus* from fresh fusion experiments with GPI anchored protein of *C. albicans* as well as metabolic proteins of *A. fumigatus* identified. Proteome analysis of amphotericin B resistant *C. albicans* revealed three proteins, which were over expressed.

Natural Products

Chemical and pharmacological investigations on Indian medicinal plants continued during the year. Significant anti-hyperglycemic activity was observed in ethanolic and purified extracts of several plants in streptozotocin induced diabetic rats. Isolation and characterization of chemical compounds from these materials is in progress. Regulatory pharmacology and toxicity studies related to CDR 134F194 (anti-hyperglycemic), which is in pre clinical phase, have been completed. Several compounds were isolated from the chloroform and n-hexane fractions of the plant 1020 (anti-osteoporotic) and five of them exhibited promising osteogenic activity. Of these, three compounds were synthesized and activity was reconfirmed. Dose dependent analgesic and anti-inflammatory activities were observed in two pure compounds isolated from the plant 4406. Chemical transformation of natural products continued during the year with a view of lead optimization.

Newer Approaches in Drug Design and Discovery

The crystal structures of the *M. tuberculosis* Feast/Famine regulatory protein and complexes with a variety of amino acid effectors have been solved. Secondly, crystal structures of Lysine e-amino transferase (LAT) from *M. tuberculosis* and some mutants were determined in a variety of enzyme states and complexes with substrates followed by identification of two novel inhibitors of the enzyme by virtual screening. Structure-based investigations and development of computational predictive models for structure activity relationship studies including molecular docking and CoMFA and CoMSIA 3D-QSAR studies were carried out on pyrrolidine carboxamide inhibitors as anti-mycobacterial agents and human mitotic kinesin Eg5 inhibitors as anti-cancer agents. The results provided clear guidelines and reasonably good activity predictions for novel inhibitor design.

A significant milestone has been achieved by solving structure of the potential drug target protein peptidyl-tRNA hydrolase from *M. tuberculosis* H37Rv (MtPth) in solution by NMR spectroscopy. Studies on two proteins namely *Plasmodium falciparum* glutathione Stransferase and *Toxoplasma gondii* Ferredoxin- NADP+ Reductase (TgFNR) have been completed. Twenty new compounds were synthesized and evaluated for PTP inhibition *in vitro*. Furthermore, 28 new compounds were synthesized as DPPIV inhibitors. A mild and efficient protocol for the Pictet–Spengler reaction in water using an acid catalyst has been developed and a number of tetrahydro-β-carboline compounds were synthesized in high yields and purity.

Reproductive Health Research

Designing, synthesis and bio-evaluation of new synthetic molecules/isolates from natural resources for development of male / female contraceptives continued this year also. Screening of these materials as anti-osteoporosis agents led to identification of one synthetic compound and two natural products. Follow-up studies are in progress. In the follow up studies related to 99/373, its binding affinity with Raloxifene, Tamoxifene and Centchroman is being studied. Crude extract of NP-1, led to the isolation of 26 pure compounds, of which five were active *in vitro*. A pharmaceutical composition 'OsteoAnabol' has been derived from an Indian medicinal plant for the prevention and treatment of bone disorders. The potent non-detergent spermicide S-003-296 caused total inhibition of conception at 200 µg dose when evaluated for contraceptive activity in rats. To design more effective, safer and cost effective molecules for Benign Prostatic Hyperplasia, 21 compounds were screened, nine compounds exhibited promising activity in rat model.

Technology Development

Chemical Technology: Pilot-scale preparation of CDRI candidate drugs was undertaken. Two antimalarial compounds 97/78 and 99/411 were synthesized and submitted to Pharmaceutics Division for quality control studies. Several antidiabetic fractions of CDR-134 were prepared in large scale and supplied for further studies. Herbal Medicament for treatment of cerebral stroke was prepared in additional amounts. An improved and cost effective process for Centchroman was developed at bench scale and an Indian patent filed.

Fermentation Technology: A *Streptomyces* strain (M4) was

Mycobacterium tuberculosis diagnostic kit

isolated from soil samples and it exhibited good broad-spectrum antibacterial activity. Two antifungal compounds were isolated from the fermented broth and cell extracts of *Streptomyces triostinicus*. Structure elucidation of these compounds is in progress. A fungus, *Talaromyces wortmanni* MTCC 8802, was isolated from soil dwelling termite and it exhibited strong broad spectrum antifungal and antitumor activities. Studies on stereochemistry of the compound wortmannin, isolated from this organism, are in progress. Studies related to generation of monoclonal antibodies against *C. albicans* and *A. fumigatus* are continuing. Fusion experiments for the development of hybridomas were carried out with GP1 anchored proteins of these fungi. Resulting hybridoma clones were screened with ELISA and western blotting and positive clones have been identified and subjected to single cell cloning. Characterization of resulting monoclonal antibodies is in progress.

Pharmaceutical Technology: Development of drug delivery systems being one of the major objects of the project, product development of inhalable microparticles containing two antitubercular drugs was carried out. Final formulation, intended for clinical trials, was standardized and its storage stability was demonstrated to be 2 years under ambient conditions. Development of non-ionic surfactant based formulations of cyclosporine continued and bioavailability experiments were conducted and were found to be 1.73 times better than the marketed product Neoral. Studies related to delivery system for septic shock, ultra thin polyelectrolyte microreservoir, etc. are progressing well. Quality control and stability studies on two natural products and two synthetic compounds were completed during the reporting period.

Publications & Patents

During the year the institute published over 225 research papers in various national and international periodicals and contributed several papers and poster presentations in different seminars/symposia and conferences. The average impact factor has increased considerably over the last few years. The success of institute's innovative approaches is well reflected in filing of 16 foreign and six Indian patents and grant of 16 foreign and eight Indian patents.

Technical Services Provided

Sophisticated Analytical Instrumentation Center (SAIF) and National Laboratory Animal Center continued to provide their services to the scientists, academic institutions, industrial houses, etc. SAIF analyzed over 9590 external and 23,720 internal samples through various spectral methods catering to the needs of around 1100 users. Over 800 grids of samples were analyzed for Transmission Electron Microscopy. The National Laboratory Animal Center supplied over 48,000 animals for research and testing to different projects of the institute and other organizations. Documentation & Library Services Division continued to publish current awareness bulletins, viz. *Drugs & Pharmaceuticals – Industry Highlights* and *Drugs & Pharmaceuticals – R&D Highlights*. Technical queries, received from clients, were promptly attended to. The institute continued to provide *in vitro* and *in vivo* biological screening facilities to different organizations within the country.

Human Resource Development

During the year, 27 staff members were deputed for various training programmes held at Human Resource Development Center, Ghaziabad. Six employees were deputed to attend the Awareness Program on Right to Information Act held at NBRI, Lucknow and two scientists were trained at Administrative Staff College of India, Hyderabad and one scientist at National Institute for Research in Reproductive Health, Mumbai. During the year, 45 research fellows and a backlog of 23 students submitted their thesis and many of them were awarded Ph.D. The institute continued to conduct the Advance Technology Training Program, for scientists and technical persons, mainly from industry besides imparting training to foreigners under bilateral cooperation with different countries and international agencies and training to sponsored students from academic institutions and ad-hoc short-term training for academia

and industry. During the year, 274 university/college-sponsored students were imparted training.

Honours and Awards

Several CDRI scientists were awarded by different bodies for their meritorious work and achievements in the field of drug research. Dr Rakesh Tuli, Director, received J.C. Bose Fellowship and the Science Counsellor Award – 2007 from Indian Society of Health, Environment, Education and Research. Dr Anup Kumar Misra and Dr Atul Goel were awarded Ramanna Fellowship Award in 2007 by Department of Science and Technology, New Delhi. Dr Goel was selected for the Dr Ghanshyam Srivastava Memorial Award – 2007 to be given by Indian Chemical Society, Kolkata. Dr Vinod Bhakuni was elected the Fellow of National Academy of Science. Dr C. Nath was elected Fellow of Indian Pharmacological Society. Dr Rakesh Shukla was given the S.B. Pandey Oration Award – 2007 by Indian Pharmacological Society and he continued to be the Treasurer of Indian Academy of Neurosciences, Lucknow Branch. Dr Neena Goyal, Dr Madhur Ray and Dr J.K. Saxena were given Best Poster Awards for their respective research papers. Dr Atul Kumar was conferred the OPPI Scientist Award 2007. One of the research students Shri Ashutosh, was conferred upon the M.B. Mirza Award at Annual Conference of Indian Society for Parasitology held at Visakhapatanam.

INDO- RUSSIAN ILTP

Workshop on "Manmade Triggered Seismicity and Prospects of Its Application for Earthquake Control"

An Indo-Russian ILTP Workshop on "Manmade Triggered Seismicity and Prospects of Its Application for Earthquake Control" was held at the National Geophysical Research Institute, Hyderabad, during 24-25 March 2008. It was attended by a delegation of Russian scientists led by Dr Victor Novikov of the Joint Institute for High Temperatures of the Russian Academy of Sciences. Several Indian scientists from different departments participated in this workshop. The main focus of the workshop was to discuss the efficacy of the technique of Pulsed Magneto-Hydrodynamic (MHD) developed by Russian scientists to mitigate earthquake hazard in seismically active regions by discharging tectonic stresses in the earth's crust.

The workshop was supported by the Department of Science and Technology, New Delhi and Russian Academy of Sciences, Moscow.

Inauguration of the Indo-Russian ILTP Workshop by lighting of lamp by the Russian delegation. Dr Victor Novikov (*second from left)*, Leader of Russian Delegation; Dr V.P. Dimri, Director, NGRI (*first from right*) and Dr R.K. Chadha, Scientist and Convener of the workshop (*third from right*) looks on.

Training Programme on Strategic R&D Management at HRDC

How do we go about strategic R&D Management to attain competitive edge in the global market? What is the status of publicly funded R&D elsewhere in the world, particularly in Europe and USA? What are the essential components of industrial R&D management particularly in Drugs Pharma Biotechnology? R&D as an essential constituent for corporate strategy, valorization of intellectual property, leveraging innovative assets of public funded R&D and Human Capital Management for R&D are some of the major aspects that were dealt with in a training programme on Strategic R&D Management organized by the Human Resource Development Centre, Ghaziabad, during 26 - 28 March 2008. Twenty-three senior scientists from various CSIR labs attended and actively interacted with the learned faculty.

The programme opened with a welcome address by Dr Naresh Kumar, Head, HRDC, who also introduced the key speaker Dr Y.S. Rajan, Principal Adviser, CII. Dr Manu Saxena, Scientist and Contact person for the programme, proposed a vote of thanks.

Delivering his keynote address, Dr Rajan lucidly explained the terms '*Strategic*' (Planning – in present day modern business, planning should not be for more than 10 to 20 years' period with some concrete results/ outputs within about 5 years. Thereafter we could go for incremental improvements like Mark I, Mark II, etc.); '*R&D*' (It could be imitative, incremental, new 'add on' which can enhance value and finally, totally disruptive which would bring in a perceptible change in the society, businesses, etc.); '*Management*' (Assessment of options, understanding future plans for market competitors' action, new developments, policies, standards, etc.; acquisition in related technology, IPR; choice of project

Left to Right
Sitting :- Ram Chandra, savita Kaul, Suchitra Sen, Minati Chatterjee, Manu Saxena, V. V. Krishna, Y. S. Rajan, S. N. Sharma, E. V. S. Prakash Rao, Gautam Palit, N. S. Mehla, M. L. Singla.
Standing :- Tariq Badar, Y. K. Sharma, A. V. Talkhande, G. Sekaran, R. K. Dhar, B. B. Nayak, G. Raghava, S. S. Amritphale, Ashok Kumar Ray, N. Gopala Krishnan, Navin Rastogi, S. A. Hasan, R. D. Singh, A. A. Zaidi, J. C. S. Kataky, B. C. Kashyap, P. M. Patni.

with detailed action plans, regular reviews, identification of key personnel, external and internal competition, incentives/dis-incentives, etc., networking and management of partnerships, identification of domain specific subject areas, extent of operation, i.e. global, domestic, local, etc.). Dr Rajan explained how with proper strategic R&D management we can launch products with competitive edge in the market.

The keynote address was followed by a presentation by Prof V.V. Krishna, Chairperson, Centre for Study in Science Policy, Jawaharlal Nehru University, New Delhi, on 'Large public research systems: Reflections on CSIRO and CNRS'. Prof. Krishna traced the history of formation and objectives of DSIR. He explained that the idea of 'Council of Scientists' as organizational framework to coordinate research in the British Empire evolved before WWI. BSA & IAS (1898-1923) served as model for the creation of DSIR on the Haldane Principal (government funds and autonomy to scientists). It envisaged centralization of R&D activities under advisory and executive councils, for the benefit of society, industry and national security. This model was transferred to the British colonies, e.g. Australia – CSIR (1926), CSIRO (1949); New Zealand – DSIR (1926), CRI (1992); South Africa (1946), Sri Lanka (1950) and India (1942). After end of WW2 colonial relation in science and hegemony changed into S&T cooperation in the Commonwealth. It is interesting to note that though British abundant the DSIR model in 1960s, the organizations created in erstwhile colonies continue to operate, observed Prof Krishna.

Prof Krishna then went on to explain the gradual changes in various public funded organizations, e.g. CSIRO-Australia and CNRS-France. For example in case of CSIRO, Cooperative Research Centers were created in early 1990s, partnership with university and industry was enhanced, 'flagship' programmes were undertaken and far more emphasis was laid on IPR management. Similarly, in case of CNRS, the major changes included CNRS-Industry relationship (between 1983 and 2000, 10 fold increase in contract research but public contracts decreased from 25% to 15%), mobility of research personnel from CNRS to other research and industrial research institutions, hybridization of CNRS and universities. In the context of CSIR-India, Prof. Krishna emphasized strengthening of R&D industry-university relationship, enhancing mobility, incentives to attract talents to R&D, unambiguous goals for research/ selection of projects, and strong networking.

In his presentation on 'Public funded R&D in Europe: Issues and learning, Dr Pradosh Nath, Scientist, NISTADS, pointed out that in Germany, PRIs are divided as Technology Service provider, Technology solution provider and Knowledge generator. Similar demarcation can be seen in Sweden, The Netherlands and Japan. According to him putting all the three under one organization may not be a good idea in the present day scenario of globalization and liberalization. He also spoke about the conflict between generation of revenue and knowledge by the R&D organizations. In developed countries the problem has been resolved by creating separate organizational arrangements for different type of activities and providing them appropriate work culture and practices. Basically, Dr Nath opined, R&D/S&T has to be organized in a format depending on the expected end result and emphasis has to be laid on proper identification of the problem/project selection, interaction with industry and other R&D organizations, and networking.

Dr Satish Kulkarni, Counselor, S&T, US Embassy, New Delhi, in his presentation describing the scenario of Publicly funded R&D in US, stated that the values for the scientists/R&D organizations ought to be: Passion for mission; Integrity and responsible stewardship of the public trust; Simultaneous excellence in science & technology operations, and business practices; Balancing innovation with disciplined execution; Teamwork while preserving individual initiatives; intense competition of ideas with respect for individuals; Treating each other with dignity; A high-quality motivated workforce with diverse ideas, skills, and backgrounds; Rewarding and recognizing performance; and Commitment to the collective success of the organization.

An interesting observation made citing the example of UC (University of California) System was that while

in USA the universities manage the R&D institutes, in India, we are trying to strengthen the R&D-university link. Also coming to IPR issues and pooling of resources, Dr Kulkarni said that when it was realized that the university as well as R&D institutes were not experts in managing the IPR, they brought in the real professionals in handling IPR. He also explained how identification of the objectives, proper planning, execution and deliverability within the target time were extremely important; if you do not deliver in time you are not there.

Dr Sachin Chaturvedi, Research and Information System for Developing Countries, MEF, made a presentation on Drugs, Pharma and Biotechnology: Emerging links and prospects. Pointing out that value addition in biopharmaceutical sector comes less from the labour or tangible capital intensive processes and more from intangible capital like basic research, intuitions and genetic pool, Dr Chaturvedi emphasized that efforts have to be made to switch over from labour intensive components of complex products to skill and technology intensive processes. He described the types of Global Production Networks (GPNs) and stages in the value chain.

Dr Chaturvedi noted that the production and R&D linkages between Indian pharmaceutical industry and their global partners have intensified with the prospective entry of generic dominated Indian pharmaceutical sector in the ambit of new technologies, particularly biotechnology and bioinformatics, leading to a strong biopharmaceutical sector in the country. The Indian biopharmaceutical market was valued at around $ 1.05 billion in 2006 and is growing at nearly 32%. Emergence of global production networks (GPNs) in biopharmaceutical sector has offered immense opportunities to India's pharmaceutical industry. Today, all the major global players are represented in India and there are several Indian entrants as well. Firms are moving from chemistry-driven drug development to biology-based drug development with a clear focus on biotechnology and genomics, bringing them in the GPNs through contract research organization (CROs), a critical link between local companies and the global pharma majors. Indian biopharmaceutical market is valued at around $ 1.05 billion and is growing at nearly 32%. Also, public allocations for medical biotechnology have increased by 69% in the time period 2001-02 to 2005-06.

To show how the pharma industry is moving up the value chain Dr Chaturvedi said: By 2010 the CRO industry in India would be Rs 5000 crore with 50,000 clinical research professionals and 400 clinical trials involving 1,00,000 patients and 300 sites. And the Indian CROs are adopting various strategies to enhance their business. For example, iGATE and Jubilant have acquired CROs in US and other western countries to provide end to end service to their clients. Some of the generic companies as CROs are: DRL, Wockhardt, Nichols Piramal, Zydus Cadilla and Ranbaxy.

Dr Chaturvedi also spoke about the specific regulatory support required at the sectoral level and public policy measures taken in the recent years, e.g. in 2000, New Millennium Indian Technology Leadership Initiative (NMITLI) was launched to support and encourage innovation in the PPP mode, it funded and monitored projects like the bioinformatics educational software development of Tata Consultancy Services, and new chemical molecule development with the help of the chemical industry. Similarly, gene marker identification initiated by the Institute of Genomics and Integrative Biology, Delhi, is funded in addition to other biotech/ bioinformatics projects. India has facilitated carrying out of the proof-of-concept studies, which required necessary changes in the Schedule Y of the Indian Drugs and Cosmetics Act, 1940, which was enacted in 2004. As a result, firms which have partnership in India may carry out phase II and Phase III trials simultaneously in India and other locations but they still have to do the Phase I trial in India.

Mandating of International Conference on Harmonisation of Technical Requirements for Registration for Human Use of GCP Guidelines is another major move to standardize measure for ensuring predictability for corporate behaviour. Removal of customs duty on instruments being imported for clinical trials was yet another important policy support measure. Earlier the duty was 55%. There is

also a proposal to provide 10 year tax break to CROs. Also, ICMR has adopted a very pragmatic approach towards CROs. Instead of compulsory registration, ICMR has applied peer pressure by facilitating online registration of all the clinical trials at the 26 ICMR institutions, said Dr Chaturvedi.

Dr Chaturvedi discussed several issues and made suggestions to eventually transform Indian pharma industry from being dominated by generic producers to one led by bio innovators.

Giving his presentation on 'R&D – A constituent of corporate strategy', Dr Vinay Kumar said that the major issues concerning industry today pertain to: Shorter life cycles of technology, Intense national and international competition owing to globalization, Quality, cost, delivery, after-sales service, international standards, intellectual property right issues, High risks in investment, Shorter time between innovation and commercialization, increasing importance of R&D, energy efficiency, environment friendliness, information and communication networks, socio-economic and socio-political factors and movement of capital across national boundaries. To meet the present day challenges, one has to go for a highly effective strategic planning, strategic implementation and strategic evaluation. Formulating strategy is a continuous challenge, requiring the evaluation of old practices and search for the new ones and central to the formulation of a strategy is the vision and a mission for the organization.

Top management creates the vision, states the mission clearly, sets the objectives and goals and a system of evaluation. It also evolves fair system of rewarding employees. Stating that an objective without a date is a hope and an objective with a date is a goal, Dr Vinay Kumar pointed out that these must be closely intertwined and highly integrated. Failure to develop and integrate technology strategy and business strategy is a major contributing factor in the decline of many firms' competitiveness. Boards should consider ways to improve their technological literacy and capability, Successful strategy formulation depends on creating a match between the resources available to an organization and the opportunities present in its environment.

Identification of the internal factors of strengths and weaknesses and external factors or opportunities and threats is an important step in strategy formulation process. Factors influencing the R&D strategy include: *External* — consumer needs, emerging technologies, market expansions, competitors strategies, growth potential, government regulations, environmental factors and IPR scenario; and *Internal* — resources, systems, core competency, motivation and drive, skill availability and technology life cycle.

Organizations can get more out of their research by linking it more closely to market need and customers' requirements rather than increased spending elsewhere. Other important factors include: R&D on 'business like' footing, Time and cost of R&D, Higher expectations from R&D, increasingly multi-disciplinary nature of R&D, Managerial skills in R&D personnel, Borderless laboratories, IPR issue, changing from a strategy of 'hope' to a strategy of a more systematic, disciplined and accountable R&D, increasing impact of ICT, etc. These are impacting R&D management systems and practices in a numerous ways, creating new threats and opportunities, and increased expectations of head of the institution.

The important issues in R&D corporate strategy development are: Human resource development, innovation and creativity, team orientation, reward system, R&D project management, management of technology acquisition, strategic alliances, technology pricing, financing and forecasting, technology financing, technology forecasting, Management of IPR and technology marketing.

Presenting the case study of Osborne Computer Co, Dr Vinay Kumar said that entering the market with a new innovation gives a company an early advantage in sales (Osborne's sales expanded dramatically over a short span of time), Innovation should be a continuous process. Timing of introduction of improved or new product should be carefully decided (Osborne underestimated the importance of continued innovation), Companies must listen to customers and be positioned to react faster than competitors do. Customers will not buy old models if they know that

new ones are on the way. An appropriate marketing strategy is needed to deal with old models. Innovation is important for all the phases of technology life cycle and finally, timing of public issue is very important, concluded Dr Vinay Kumar.

In the context of 'Valorisation of Intellectual Property (IP) of publicly funded R&D' Dr H.R. Bhojwani, Adviser to Minister for Science & Technology and Vice President, CSIR, explained that 'property' comprises physical assets (movable/ immovable), and Intangible assets [intellectual property (IP) and others, e.g. goodwill, skills, customer lists, etc.].

Speaking about importance of IP in business, Dr Bhojwani pointed out that 80% of assets of US firms are intangible; 90% of GE value is in intangibles. They serve as driver of business strategy (offensive: keep others out)/defensive (buy out threat), in revenue stream by way of licensing (IBM, Texas Instruments) or national positioning, e.g. in enhancing FDI (CSIR) and promoting domestic R&D (Ranbaxy), Dilemma of IP for publicly funded R&D in IP pertains to asymmetric arrangement between state & IP owner to exclude others from the use of IP, creation of monopolies & stifling competition, maximizing market share & profits, sometimes constraining R&D and the issue of bubble patents. Publicly funded R&D organizations proliferate widely knowledge and innovation in society to maximize benefits to society, stimulate further R&D and sell license IP on non-exclusive basis.

The main characteristics of IP of publicly funded R&D are: it is science driven, lacks profit motive, is risk averse (not able to make informed investment decisions, collegiate of lacking effective line management and non-corporate (lacks basic capacity to deal with the commercial world).

Dr Bhojwani further said that the increased R&D efforts world-wide are reflected by, e.g. increased patenting in USA- during the past 20 years (1982-2001). Applications filed have tripled (1 lakh to over 3 lakh), issued patents increased 2.5 times (60,000 to over 150,000). During the past 5 years alone applications are up by 67% and the issued patents up by 50%. But only 3% of all US patents have been licensed. Global licensing revenue amounted to $ 10 billion in 2005 – top 10% of patents licensed yielding 40% revenue while the bottom 50% of patents licensed yielded 10% of the revenue. Dr Bhojwani pointed out that the aspects important towards crafting valuable patents are that they should have adequate claimable space so as to enable them have strong claims, sufficient clustering and claims diagramming (filling gaps, bubble patents). They should need little development work to implement commercially. Other important factors are easy infringement detection, high value proposition to licensee and tenable portfolio of patents to be assembled.

Explaining the patent strategy framework, Dr Bhojwani explained when to valorize [when adequate IP rights have been secured, there is freedom to operate (FTO), the IP provides competitive advantage, no competitive IP is available, and market size and potential return justify valorization effort] How to have an FTO analysis? (Search available databases at lab level and externally, identify potentially interfering patents, in-house S&T evaluation/assessment of FTO and external in-depth legal evaluation of claims by attorneys). The modes of valorization of IP include: Assignment — transfer of ownership rights, conditional ties; Licensing — rights to use/operate IP, conditional ties & cross-licensing; IP as equity— transfer of ownership/in lieu of equity; Joint venture — co-owner, Development contracts leveraging IP and Franchising. Packaging the IP can involve: only IP licensee, IP license + know how, IP license + knowhow + consultancy, IP license + knowhow + consultancy + R&D support or IP license + knowhow + consultancy + R&D support + training. Basically the IP valorization involves: identification of business opportunities, evaluation and selection of these opportunities, strategic R&D leading to IP assets generation management of these assets and value realization. The hard facts are that to realize value, IP must be transmitted. For transmission, IP must have a container, and to have a container, IP must have an entrepreneur.

In his second presentation, Dr Bhojwani discussed 'Leveraging innovation assets of publicly funded R&D'. He began by explaining the business perspective of innovation (innovation is invention + exploitation, invention is the S&T R&D activity, exploitation is the delivery of invention to the market

and innovation has no correlation to R&D expenditure). Innovation, he said, is the creative process that transforms new processes, discoveries and technology into commercial value.

It is the ability to manipulate and apply knowledge as a part of a constant renewal process. Drivers for innovation (micro level) are competition, delivering value, going up the value chain, enhancing market share (local, national, regional and global); increasing investor aspirations, and/or building brand image/equity. The innovation conundrum for business of products are complex involving thousands of patents (Pentium 4 is covered by 100,000 patents, of which Intel owns less than 5%). Firms cannot afford to track down every patent of interest. They focus on solving 1-3 year problems, gap in longer term involves innovation. They need comprehensive solutions not pieces of the jigsaw puzzle.

The paradigms of publicly funded industrial R&D in India has shifted from ' Publish or Perish' in 1960s to 'Share, Publish and Prosper'. The emphasis now is on networking with domestic (and international) knowledge generators to ferret out nascent S&T ideas (Eureka concept); Searching proactively for S&T problems/ strategic needs of potential customers; and matching, prioritizing and developing promising leads to proof of principle stage; Catalyzing co development projects; Digesting, summarizing new S&T development for potential clients/network partners; and Motivating and retaining personnel: financial offsets, awards and 'psychic income'. Co-development for the purpose of enhancing innovation capacity, increasing flexibility/ productivity in R&D and reducing time for commercialization is a new concept for publicly funded R&D.

Dr Bhojwani then discussed the various drivers of co-development in publicly funded R&D and private industry and cited a few cases of co-development – a two step novel process for purification of natural streptokinase developed by IMTECH and with up scaling and further development in collaboration with Cadila Pharma the product was launched in 2003. Similarly lab scale technology for staphylokinase was developed by IMTECH. Stride Arcolab and MTA and Licensing collaborated for up scaling and trials. The up scaling has been completed at 25 litres scale and animal studies are under way. Yet other examples from the same CSIR lab pertain to clot specific streptokinase (IMTECH hybrid protein patented in US, Europe and India; Symmetrix Pharma, a biotech firm, collaborated in up scaling and Nostrum Pharma Inc., in licensing for development and trials; animal trials have been done in USA and toxicity studies are underway) and recombinant streptokinase (IMTECH developed non-patent infringing technology, Shasun and MTA and Licensing collaborated in scale-up and trials – a state of art pilot plant has been successfully set up (high yield and purity), clinical trials have been completed and marketing permission is awaited). Dr Bhojwani also discussed the advantages of co-development and remarked that ICT is going to serve as an important platform for business development.

Regarding the global scenario of new drug development, Dr Bhojwani noted that there is explosion in bio-medical knowledge and the resources are becoming beyond the capacity of a single entity. The exorbitant cost involved in the new drug discovery has led to decline in the productivity of new drugs. In addition, the regulatory requirements have become more stringent, development processes are inefficient and only a few new platform for technology development have emerged. In this context, he highlighted the CSIR initiative towards open source drug discovery. Finally, he remarked 'innovation does not happen; it has to be planned and crafted'.

Prof K.B. Akhilesh, IISc, Bangalore, gave a very informative interactive presentation on 'Human Capital Management for R&D'. He talked in terms of Talent (How to manage and put to maximum use the various permutations/combi-nations of 'ability' and 'willingness' and provide enabling culture?), Effort (The four dimensions are: Physical best (attentive but 16h employee concept), Intellectual Best (looks for incremental things), Emotional Best (involvement partici-pation) and Spiritual Best (cordial relationship, e.g. *Dabbawalas* of Mumbai who work with the motto '*Sewa*'), Performance (deliverables are to be well defined, if not, people will take different things in different ways), and finally, Awards (Pay satisfaction – generally pay level goes by length of service,

so up to say 40 years people remain dissatisfied and thereafter they get adjusted, But actually it should be performance oriented system).

The valedictory session had the valuable feedback and presentation of certificates. All the participants highly appreciated the contents and arrangements and suggested that the programme should be of greater duration. The session was presided over by Shri S.N. Sharma of HRDC. Dr Manu Saxena proposed a vote of thanks.

Molecular Catalysis on Surfaces

Prof. Gates delivers Doraiswamy Endowment Lecture at NCL

Prof. Gates delivering the lecture

Professor Bruce C. Gates, Department of Chemical Engineering and Materials Science, University of California, Davis, USA, delivered the ninth L.K. Doraiswamy Endowment Lecture in Chemical Engineering at the National Chemical Laboratory (NCL), Pune, on 28 January 2008. To honour Prof. L.K. Doraiswamy's accomplishments, representatives from Iowa State University's (ISU) Chemical and Biological Engineering Department, the NCL and the Department of Chemical Technology, University of Bombay, Mumbai, select an internationally recognized scientist or engineer to present lecture at ISU and NCL. Prof Gates spoke on 'Molecular Catalysis on Surfaces'. He also remembered the contribution of Prof Doraiswamy to the science and chemical engineering.

Prof. Bruce Gates in his talk dealt extensively with molecular catalysis on solid surfaces. Catalysts are highly complex materials used in several industries to produce valuable chemicals, petrochemicals, fertilizers, drugs, plastics, etc. It is essential to understand which part of the catalyst controls the reaction. When it comes to the catalytic activity, it is the active catalytic sites that matters most and by tuning the nature of catalytic sites one can change the activity. Real-world catalysts are complex materials because of the non-uniformity of their surfaces and are difficult to study by conventional methods. Prof. Gates illustrated special preparation methods that involve organometallic complexes as the main ingredient to create active catalytic sites on common solid supports such as alumina, titania and cerium oxide. Uniformly

distributed catalytic active sites on such supports (size of the order of a few nanometers or less) leads to very high yield of the reaction product. The uniqueness of this method lies in the creation of uniform distribution of actives sites on the support resulting in active catalysts producing the end product with high selectivity. Such catalysts also offer unique opportunities for fundamental understanding and facilitates incisive characterization of the catalytic species.

Narrating investigations in the area, Prof. Gates said that organometallic complexes of noble metals including rhodium, gold and iridium were supported on oxides and zeolites. Similarly, metal clusters of rhenium, iridium, and osmium were supported on oxides. These surface anchored organometallic complexes were used for reactions such as oxidation, reduction and polymerization. They were further subjected to detailed characterization by structural, spectroscopic and microscopic methods under reaction conditions. This enabled an understanding of the changes in the nature of active sites under reaction conditions. The approach developed by Prof. Gates has led to a finer understanding of the nature of active sites in terms of bonding to the support and distribution of active sites on a surface. It was also possible to identify transient reaction intermediates that eventually lead to product formation. Prof. Gates explained through elegant examples the principles of discrete molecular catalysis.

Earlier, Dr B.D. Kulkarni, Deputy Director and Head, Chemical Engineering and Process Development Division in his welcome remarks remembered the pioneering contribution of Prof Doraiswamy to the field of Chemical Engineering. He informed about the initiative behind the Prof L.K. Doraiswamy Endowment Lectureship in Chemical Engineering and also introduced Prof Gates to the audience. Dr Kulkarni also proposed the vote of thanks.

Dr A. Sivathanu Pillai delivers Dr Y. Nayudamma Memorial Award Lecture

Dr A. Sivathanu Pillai, Chief Controller (R&D), Defence Research Development Organisation (DRDO) and CEO and MD of BrahMos Aerospace, was conferred the prestigious Dr Y. Nayudamma Memorial Award for the year 2007 for his outstanding contribution to India's Defence Research and Development, at a function held on 2 February 2008 at Tenali, Andhra Pradesh, the native town of Dr Y. Nayudamma. Dr V.L. Dutt, Chairman and Managing Director of the KCP Group presented the award to Dr Pillai.

The award, instituted by the Dr. Nayudamma Memorial Trust in 1986, is presented to persons who have made significant contributions to the field of science and technology in India. The award is given in memory of the late scientist and internationally acclaimed leather technologist, Yelavarthy Nayudamma, who hailed from Yelavarru village near Tenali. He was killed in the *Kanishka* air-crash over the Atlantic Ocean in 1985.

Addressing the distinguished gathering Dr V.L. Dutt, the Chief Guest of the function lauded the services rendered by the late Dr Nayudamma to the field of science and technology. Scientific knowledge must reach the rural poor to transform the country, he stressed. Dr Dutt recollected Dr Nayudamma's contributions to leather technologies and indigenous technologies on the occasion.

Delivering the 16th Yelavarthy Nayudamma Memorial Lecture on 'India — An Emerging Strategic Power', Dr Pillai informed that research is on for developing a hypersonic missile, which will be five times more powerful than BrahMos supersonic cruise missile. He said growth of India as superpower will redefine the G-8 nations in the next decade. The recent successes of Indian industry and space sector have made the country an attractive and strategic partner of the big league in the world. "In fact, these achievements have created an inevitable situation for many nations to tie-up with India," said Dr Pillai.

He stressed the need for a strong association and better coordination among research and development organizations, academic institutions and industries to provide necessary scientific and technological strength to the nation.

He said that identification of agriculture and food

processing, education, healthcare, information technology and infrastructure as core areas to lay focus would help the country achieve 10% GDP very soon. "Once the GDP growth rate climb up to more than 10%, the people below the poverty line will be zero", he said. The rapid growth of India's economy has helped it become a force to reckon with in the world, he added.

Dwelling on the great initiative and impetus provided to leather industry in India by the late Director General of CSIR Dr Y. Nayudamma, Dr Pillai remarked that China has surpassed India in leather exports leaving us in the second place with export business of $ 2.5 billion per year. "A new leather technology vision has been worked out to promote leather industry and put it on the top of the world with a target of $ 7 billion exports annually by 2010", Dr Pillai added.

Dr Pillai said that India would be among the top three forces within next 10 years. The recent commercial launch of Italian satellite AGILE by PSLV was only an example to showcase the India's might in space sector.. He said that 'BrahMos' was a supersonic cruise missile, which could be launched from multiple platforms such as land, sea, sub-sea and air against a variety of sea and land targets. The success of BrahMos had also sent a strong message to the world nations that effective networking with partners would help everyone.

Dr Pillai felt that the near future would see the convergence of info-bio nano technologies. Luckily, India has the potential, but needs concerted and big mission projects to be at the forefront of these technologies, which will shape our future.

Shri R. Sampath, Senior Journalist and Chairman Dr Y. Nayudamma Award Selection Committee presided over the function. Shri P. Vishnu Murthy, Founder and Managing Trustee of the Dr Nayudamma Memorial Trust welcomed the gathering and read out the Citation of the award presented to Dr Sivathanu Pillai.

Shri Ratheish Y. Nayudamma, Chairman of the Trust and Managing Director, A.P. Tanneries Limited, Vizianagaram (A.P.) spoke on the activities of the trust.

Shri K. Balaharnath Murthy, Trustee, read messages received from Mr Hamid Ansari, Vice-President of India, Dr Y.S. Rajasekhara Reddy, Chief Minister of Andhra Pradesh, Shri K.R. Suresh Reddy, Speaker, A.P. Legislative Assembly, Prof. V.L. Chopra, Member, Planning Commission, Dr M.S. Swaminathan, Prof M.G.K. Menon, Dr Sukhadeo Tharat, Chairman, University Grants Commission and others.

Amongst the dignitaries present on the occasion were Mr Nadendla Manohar, M.L.A Tenali, Dr G. Uma, Ex-MLA, Dr T. Mastanamma, Municipal Chairperson and Mr Chukkapalli Pitchaiah, Chairman, popular Shoe Mart Group Companies.

Shri R. Srinivasa Rao, Trustee, proposed a vote of thanks.

National Science Day Celebrations at CECRI and NAL

Many CSIR laboratories celebrated the National Science Day (NSD) (28 February). The highlights of the celebrations at Central Electrochemical Research Institute (CECRI), Karaikudi; and the National Aerospace Laboratories (NAL), Bangalore:

Central Electrochemical Research Institute(CECRI) Karaikudi

At CECRI, Dr R.A. Mashelkar FRS, former Director General, CSIR and presently CSIR Bhatnagar Fellow, National Chemical Laboratory, Pune, delivered National Science Day Lecture. He explained the three pillars, Techno-national, Techno-globalism and Science & Technology for inclusive growth. He stressed that Solar Energy utilization is the most favoured challenges before us. In Information Technology, India is in front due to skill based concept rather than product based one. He

said that we had Brain-drain problem once. But it has become Brain-gain at present. Science and Technology requires innovation, passion and compassion. He stressed the need for at least 0.5% working population in Research and Development Sector.

Earlier, Prof. A.K. Shukla, Director, CECRI, welcomed the gathering. Shri C. Sri Vidya Rajagopalan, Chairman, Organizing Committee proposed a vote of thanks.

Prof. A.K. Shukla, Director, CECRI, welcoming Dr R.A. Mashelkar, FRS, CSIR Bhatnagar Fellow, and the distinguished gathering. Dr R.A. Mashelkar, who delivered the NSD lecture, is seen here unveiling the statue of Sir C.V. Raman

Dr Mashelkar also addressed the M.Tech and B.Tech students and interacted with them.

He also unveiled the statue of Sir C.V. Raman at the entrance of CECRI main building and planted saplings in the guest house premises.

National Aerospace Laboratories (NAL), Bangalore

At NAL, Prof Vijayalakshmi Ravindranath, Director of National Brain Research Centre (NBRC), Gurgaon, Haryana, delivered the Science Day Lecture on 'The Working of the Human Brain-Molecules and Networks to Behaviour'. Dr M. R. Nayak welecomed the gathering and highlighted the significance of National Science Day. He also introduced the speaker.

Prof Vijayalakshmi said that she was delighted to be at NAL as she was a CSIR alumni (She worked in

CFTRI as research scholar in early 80's). She shared her experience and excitement of being a neuro scientist giving a glimpse of what neuro science is all about. She enlightened the audience about how the scientific study as an independent branch was taken up 30 years ago, principally due to revolutions in molecular biology, neural networks and computational neuroscience. It has become possible to understand in detail the complex processes occurring inside a single neuron and in a network that eventually produces the intellectual behaviour, cognition, emotion and physiological responses. She explained about neurons, network, and the human brain structure, plasticity of the brain, etc. She spoke about the studies that have been taken up at NBRC in the area of learning and memory, role of genes, brain structure and experience. The brain is an active, dynamic supremely plastic structure, which starts working from the third week of conception. The network and wiring makes the human brain function efficiently. Biologists and engineers need to team up for future advancements. She concluded her lecture with the adage 'Brain — Use it or Lose it'. Exercise your brain: nourish it well and the earlier you start the better.

Dr A.R. Upadhya, Director, NAL, in his presidential remarks complimented the speaker for a very interesting and thought provoking speech. He remarked, "it is so ironic that the brain does so much thinking but we think about it so less."

Prof Vijayalakshmi's lecture was engaging, clear, structured and beautifully paced. The audience included former directors of NAL, senior scientists and special invitees from other organizations. At the end of the talk Prof Vijayalakshmi answered to all the queries from the audience.

Sri Lanka's Minister of Water Supply visits CLRI

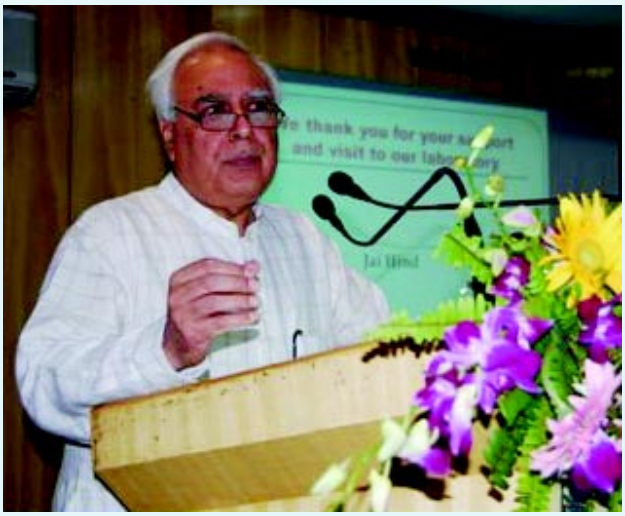
Led by Shri Mahinda Amaraweera, Minister of Water Supply, Government of Sri Lanka, a high level Sri Lankan Delegation visited Central Leather Research Institute (CLRI), Chennai, on 26 December 2007. The Hon'ble Minister evinced keen interest in seeking technical experience of CLRI to implement waste water treatment technologies, especially for treating tannery effluents in Sri Lanka.

The function ended with a vote of thanks by Dr M.N. Sathyanaraya, Jt. Head KTMD.

A view of the audience during National Science Day Celebrations at NAL

Science Funding to get a boost in XI Plan: Shri Kapil Sibal

"India has a long history of high quality research and development. Today, we not only have to see what the nation's technological needs are, but also what the nation may require in years ahead to maintain its global relevance," remarked the Union Minister of Science, Technology and Earth Sciences, Shri Kapil Sibal, while addressing scientists of the Institute of Minerals and Materials Technology (IMMT), Bhubaneswar, in the recent past. He reiterated his government's firm commitment towards science funding and said in the XI Plan period the budgetary allocation to S&T sector has been increased by three folds as compared to allocation made during the X Plan period. Shri Sibal, a noted constitutional lawyer, suggested that the research establishments like IMMT, industry, academia, and government need to work together for infrastructure and skill development so that the country's scientific output matches with the best in the world. Elaborating on the future research agenda in the context of minerals and materials research, he emphasized the need for development of indigenous, environmentally sound, zero waste and cost-competitive technological solutions to harness the rich mineral base of Orissa.



Shri Kapil Sibal, addressing the IMMTscientists

Earlier welcoming the minister, Prof. B. K. Mishra, Director, IMMT, presented an overview of IMMT's recent research achievements. In response, Shri Sibal lauded the efforts of IMMT scientists in forging successful research partnership with private industries and committed his ministry's full support in all its future endeavors.

Prof. B. K. Mishra, welcoming Shri Kapil Sibal and the audience

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Phone: 25846301 Fax: 25847062 E-mail: bck@niscair.res.in; meenakshi@niscair.res.in; vineeta@niscair.res.in; Website:http://www.niscair.res.in
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