CSIR ANNUAL REPORT
2016-17

75 Years of
CSIR Touching Lives

Council of Scientific & Industrial Research
Rafi Marg, New Delhi

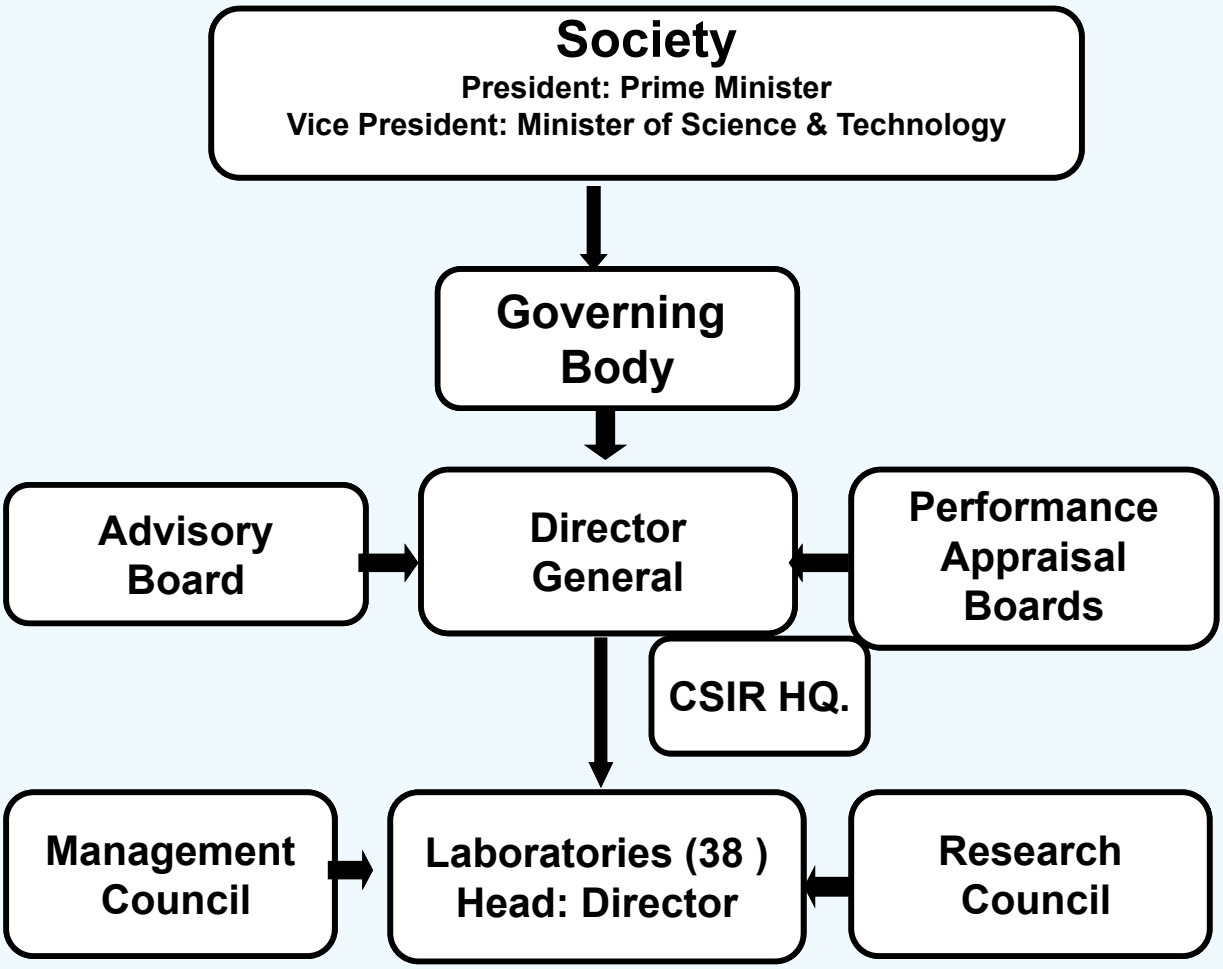
CSIR Tableau at Republic Day Parade 2017

Kitchen Waste Composter

Redefining the Chrome Tanning

Odour control system at 500tpd MSW mechanical biological treatment plant

CSIR ORGANISATIONAL STRUCTURE



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Resource Base

38 Laboratories
39 Outreach Centres
3 Innovation Complexes
5 Units
Budget
Rs. 4013.06 Crore Budgetary Support
Rs. 2260.00 Crore Plan Fund
Rs. 1753.06 Crore Non-Plan Fund
Staff Strength
Consisting of 12644 Permanent Staff (as on 01.01.2017)
Comprising 3618 Scientists 5472 Technical and Support Staff 3554 Administrative Staff

Performance Indicators (2016-17)

Intellectual Property	National S&T Human Resource Development
More than 5500 Research Publications 9.61% of India's total research output during 2016	Research Fellows/Associates supported: 6919
2902 Patent-in-force (Abroad) 298 Filed Abroad	Senior Research Associates (SRAs) in position 142
1387 Patents-in-Force (India)	771 Research Schemes Supported
225 Filed in India	131 Emeritus Scientists in Position

EXECUTIVE SUMMARY

1.0 Preamble

- The Council of Scientific & Industrial Research, constituted in 1942 is an autonomous body which is known for its cutting edge R&D knowledgebase in diverse S&T areas, is a contemporary R, D&E organization. CSIR has pan India presence through its network of 38 National laboratories which undertake well focused basic and applied research in diverse fields of science and technology. CSIR has also established 39 outreach centres, 3 Innovation Complexes and 5 units. CSIR's R&D expertise and experience is embodied in about 3618 active scientists supported by about 5472 scientific and technical personnels.
- Into its 75th year now, CSIR has been playing a stellar role in building up the scientific and technological prowess of the country. Through its technological interventions, CSIR has not only provided solutions and innovations for the industry but has also proved to be a catalyst in improving the quality of life of millions of people across the country. CSIR covers a wide spectrum of science and technology areas from radio and space physics, oceanography, earth sciences, geophysics, chemicals, drugs, genomics, biotechnology and nanotechnology to mining, aeronautics, instrumentation, environmental engineering and information technology. It provides significant technological intervention in many areas with regard to societal efforts which include environment, health, drinking water, food, housing, energy, leather, farm and non-farm sectors.
- CSIR is the Nation's custodian for Measurement Standards of Mass, Distance, Time, Temperature, Current etc. CSIR has created and is the custodian of Traditional Knowledge Digital Library (TKDL) which is a powerful weapon against unethical commercial exploitation of Indian traditional knowledge. CSIR maintains Microbial Type Culture Collection(MTCC) and Gene Bank.
- Pioneer of India's Intellectual Property movement, CSIR today is strengthening its patent portfolio to carve out global niches for the country in select technology domains. CSIR has pursued cutting edge science and advanced knowledge frontiers. It has published around 5549 papers in SCI Journals during 2016 with an average impact factor of 3.227.
- CSIR through its various constituent laboratories is also placing major focus upon creating incubation facilities for spin offs and startups. The CSIR would hand hold these companies so as to create a new segment of knowledge enterprises.
- CSIR has been focusing in a significant manner on the development of S&T Human Resource and provided the yeoman service through various fellowships. It has been imparting skills in diverse S&T areas so as to empower youth for better career and employment opportunities. CSIR proposes forging linkage with Ministry of Skill Development and Entrepreneurship to enhance and widen its contributions for Skill Development in the country.
- CSIR has been ranked 12th in the world among the government institutions in the world, improving its position after being at 14th spot for three consecutive years, according to 2016 report of the prestigious Scimago Institutions Rankings. The overall global ranking of CSIR also improved from 110 to 99th position. CSIR leads the country at the top spot and is the only Indian organization to have found a place among the top 100 global institutions.

2.0 Significant Events

The Hon'ble Prime Minister Chairs Meeting of CSIR Society

The Hon'ble Prime Minister, who is also the President of the CSIR, chaired a meeting of the CSIR Society in New Delhi on 6 April 2016. An overview of the work being done at CSIR was presented before the Hon'ble Prime Minister. He was apprised of the efforts of CSIR in addressing national challenges, and its recognition as a major Indian innovator. It was emphasized that a huge potential exists within CSIR for a large number of start-ups to emerge from the research being done in its labs. Research in areas such as medical device manufacturing, energy, and waste management has immense potential for commercial applications.

The Hon'ble Prime Minister Shri Narendra Modi called for laying down parameters to assess the performance of CSIR labs; and a mechanism whereby there could be internal competition among various labs. He emphasized that CSIR should direct its efforts towards making the life of the common man better, and providing technological solutions to the problems of the poor and downtrodden sections of society. He also expressed that the CSIR should take the lead in providing breakthroughs in sickle cell anaemia among the tribal people, defence equipment manufacturing, life-saving equipment for the jawans, innovations related to solar energy, and innovations related to the agriculture sector.

Hon'ble Prime Minister and the President of CSIR Society launches CSIR's Platinum Jubilee Function

Hon'ble Prime Minister of India Shri Narendra Modi graced CSIR's Platinum Jubilee Celebrations on 26 September 2016 at a function held in Vigyan Bhawan in New Delhi. During the occasion he had live interaction with farmers from five different locations across the country via video-conferencing where he urged them to strive for taking a quantum jump in agriculture with the help of science & technology. Hon'ble Prime Minister dedicated seven new varieties of medicinal plants developed by CSIR laboratories to the nation

An exclusive exhibition of major technological contributions of CSIR was organized for the benefit of the PM. The exhibits showcased some of the most stellar achievements of CSIR including the ones that are in the pipeline and have great potential of delivery to remove the drudgery of the common masses, largely in the areas of healthcare, water conservation, solid waste management, waste-to-wealth, communication & IT, housing, industrial competitiveness, and contributions to the strategic sector.

Hon'ble Prime Minister released new varieties of turmeric, khus, rose-scented geranium, aromatic grass Citronella, Lemongrass, flowering plant lily and ornamental flower plant Gerbera developed by CSIR labs. These were simultaneously handed over to farmers at five different locations – Hyderabad, Cuddalore, Palampur, Jorhat and Jammu. He also encouraged them to use modern technology, increase participation of youth in agriculture, concentrate on value addition based agriculture and explore different markets for their produce.

Later, addressing a distinguished gathering, he said that starting with the indelible ink, which is the hallmark of our democratic fabric, CSIR has left an indelible mark on every sphere of life. With an all-round approach to towards Research and Development CSIR is a reflection of India in its diversity and heterogeneity.

Hon'ble Prime Minister said that from agriculture to aerospace, bio-sensors to bio-pharmaceuticals, chemicals to climate change, drug development to deep sea explorations, from earth sciences to energy, food to fragrance, glass to genomics, housing to healthcare, instrumentation to informatics, leather to Light Combat Aircraft, microbes to mining to materials, optics to optical fibers, pigments to

power electronics, roads to robotics, sensors to solar energy, tractors to transport, UAVs to under water vehicles, and water to weather forecasting, CSIR has registered its pan presence.

Swaraj, the first Tractor of the country, Baby Milk Powder, the first Supercomputer of the country – these are just some of the accomplishments of CSIR, he said. He appreciated the exhibition showcasing CSIR's achievements and suggested that the exhibition should be taken to other parts of the country, so that people can know and appreciate CSIR's contributions.

Hon'ble Prime Minister said that he looked forward to CSIR making an important contribution to the current Government's mandate of doubling the farmers' income by 2022, the year the country celebrates 75 years of its Independence. In his message to the scientific fraternity across the country, Shri Modi stressed upon the urgent need to find technological solutions to address major problems being faced by the farmers, not only in terms of increasing the yield of the produce but also in growing crops in the wasteland areas through initiatives like 'Per Drop More Crop'. He said we should have another objective, which should be "An inch of land, and a Bunch of crops."

Hon'ble Prime Minister Shri Modi said that considering the contributions of CSIR over the last 75 years, the nation has large expectations from CSIR in delivering for the nation in a time-bound manner. This could be possible only by synergizing its activities and outcomes with all important functionaries in the entire value chain of taking the technology to masses, including all the important stakeholders, the government, industry, society and the ultimate users. Shri Modi gave a call to the scientific community to personally mentor science students to give shape to their ideas & energy and give India 'Research Entrepreneurs' of tomorrow. He said our labs should become a place of attraction for children.

Hon'ble Prime Minister noted that CSIR has contributed significantly in the health sector. However, today when the nation faces the challenge of diseases like TB, Chikungunya, Dengue, etc. CSIR should also focus on development of affordable diagnostics that would help in the prevention of epidemics. He added that development of technologies enabling affordable products is the key to today's world economy scenario that would not only cater to the domestic requirements but also help improve the country's exports.

Hon'ble Prime Minister, Shri Modi also challenged the scientists to look at solutions to problems that the world was grappling with. For instance, the scientific fraternity could develop a suitable battery for mobile phones that lasts long and does not burst. He wanted leather technologists of CSIR's Chennai-based lab to develop shoes for specific needs of sportspersons of different hues. Another thrust area suggested by him was development of technology to turn waste into wealth. He also urged CSIR to create an 'Ease of doing Technology Business' platform to bring in the right stakeholders so technologies reach beneficiaries.

Union Minister of Science & Technology and Earth Sciences, Dr. Harsh Vardhan while thanking the Hon'ble Prime Minister for his valuable support and guidance, assured him that CSIR would definitely deliver to the nation in a time-bound manner. The distinguished gathering consisted of senior scientists, Directors of National Science Institutions, awardees and 150 science students.

Fig: 2.1 Hon'ble Prime Minister showing keen interest to CSIR technologies

Fig: 2.2 Hon'ble Prime Minister at exhibition of major technological contributions of CSIR

Fig: 2.3 Hon'ble Prime Minister Shri Narendra Modi had a live interaction with the farmers via video-conferencing

Fig: 2.4 Hon'ble Prime Minister releasing plant varieties developed by CSIR laboratories

CSIR Platinum Jubilee Techno Fest'- CSIR Technology Showcase at India International Trade Fare (IITF)

After the Prime Minister of India and President of CSIR Shri Narendra Modi inaugurated the Platinum Jubilee celebrations of CSIR on 26 September 2016 from the Vigyan Bhawan, CSIR showcased its myriad achievements, technologies and processes during the 'CSIR Platinum Jubilee Techno Fest' at the India International Trade Fare (IITF) in New Delhi during 14-27 November 2016.

Inaugurated by Union Minister for Science, Technology and Earth Sciences, Dr. Harsh Vardhan, the CSIR Techno Fest pavilion was visited by hordes of visitors for more than a week, catching glimpses of some of the significant and pathbreaking technologies developed by CSIR laboratories.

Dr. Harsh Vardhan said, "This Techno Fest is an Opportunity for the young students, scientists and the common people to come under one roof and witness the knowledgebase of achievements and researches by CSIR." The S&T Minister also unveiled theme publications brought out on the thematic areas encapsulating the vast area of influence of CSIR laboratories.

The developments and achievements of the 38 CSIR laboratories situated across the country were displayed under 14 theme pavilions: Water, Aerospace & Strategic, Energy, Leather, Healthcare & Generics, Ecology & Environment, Chemicals & Petrochemicals, Food & Nutrition, Agriculture & Floriculture, Engineering & Infrastructure, Metals, Minerals, Mining & Metallurgy, CSIR 800 (Societal Interventions), Human Resource Development, and IP & Entrepreneurship.

Dr. Girish Sahni, Director General, CSIR remarked that the Techno Fest was a matter of pride and satisfaction. "It is an honest attempt to make people aware about the contribution of CSIR scientists," he said. "All 38 labs of CSIR contributed to the Techno Fest, presenting CSIR efforts to solve various issues of the common Indian. We are looking forward to contribute more with every passing year."

Several live exhibits were displayed at the Techno Fest. These included a Lithium-ion battery powered four-door electric car; free swimming robot 'Maya', an Autonomous Underwater Vehicle for coastal area surveys and mapping salinity of water in reservoirs and dams; a multi-fuel domestic cook stove, 'Neerdhur', for rural households, which can be fueled by cow dung cake, wood chips, wood logs and charcoal; water purification technologies; biogas generation from organic waste; carbon composites and simulators for civil aircraft; Helmet Mounted Display for aircraft pilots; vehicle and human detection system for Indian Army; a model depicting encasing of nuclear waste in glass, and several others.

Apart from live exhibits that evoked huge public curiosity, on each day events such as panel discussions and lectures were organized based on a pre-decided theme area. Several MoUs were signed during the event.

To spark interest among students and spread awareness about CSIR technologies and achievements, quiz and public speaking competitions were also organized for students.

Fig: 2.5 Union Minister for Science & Technology and Earth Sciences, Dr. Harsh Vardhan inaugurating the CSIR Platinum Jubilee Techno-Fest 2016

India International Science Festival (IISF)

The IISF 2016 was jointly organised by the Ministry of Science & Technology and Ministry of Earth Sciences in collaboration with Vijnana Bharti (VIBHA). The theme of the science festival this year was "Science for the Masses".

The programme was kicked off on 7 December, 2016 with the inauguration of the Mega Science Technology & Industry Expo by Dr. Harsh Vardhan, Union Minister for Science & Technology and Ministry of Earth Sciences, and Shri Y.S. Chowdary, Minister of State. Speaking at the event, Dr. Harsh Vardhan said, Äny new and innovative idea will be appreciated and supported by our science department and the Government." We elucidated on learning science in a more creative way.

Inauguration the Young Scientists' Conclave, Union Home Minister Shri Rajnath Singh appealed to the youth to take Prime Minister Shri Narendra Modi's S&T programmes such as Digital India, Make in India, Skill India, Stand Up India-Start Up India to the common man.

Underlining the need to create scientific temper in the society, Shri Rajnath Singh said India is the world leader in Software Technology. Indians constitute the largest majority of software developers among immigrants in the Silicon Valley while the top executives of leading software companies including Microsoft and Google are headed by Persons of Indian Origin, he added. Shri Rahnath Singh said he would not like India to emerge as a Superpower, but rather aim to be the world's "guru" or teacher, as it will be enlightening rather than being intimidating.

Speaking on the occasion, the Union Minister for Science & Technology and Earth Sciences, Dr. Harash Vardhan said India's R&D matches the best in the world, we are now providing data on Earth Sciences and Weather forecasting to around 30 countries. With CSIR scholarship scheme such as the INSPIRE, we are witnessing today brain gain instead of brain drain, he added.

Fig: 2.6 Dr. Harsh Vardhan inaugurating the India International Science Festival 2016
IISF-2016 Mega Expo

Showcasing Technology

The five day IISF 2016 not only aimed at developing scientific temper and attitude among young minds, it also showcased India's S&T prowess and technological developments through the Mega Science & Technology Expo.

The Expo projected Indian technological developments through more than 400 scientific models and exhibits by CSIR laboratories and other organisations like DST, ISRO, DRDO, DBT, etc. The event emphasised interdependence of Science-Technology Innovation and Society. The Mega Science Expo also displayed innovations as parts of government missions such as Swachh Bharat, Digital India, Unnat Bharat Abhiyhan, etc. The IITs showcased various technologies developed under the Unnat Bharat Abhiyan whose mission is to enable higher educational organisations to work with the ;people of rural India in identifying development challenges and evolving appropriate solutions for accelerating sustainable growth.

Celebrating Science

However, the highlight of the IISF was the "Science Village"- a conglomeration of around 3000 school students from all across the country. The students were selected by Members of Parliament from their respective adopted villages under the Pradhan Mantri Sansad Aadarsh Gram Yojana. These students from villages schools were exposed to many scientific activities like interaction with scientists during special interactive sessions, planetarium, science films, laboratory visits and tours around Delhi.

Fig: 2.7 Ho'ble Home Minister Shri Rajnath Singh at IISF

Industry Academia Interaction

The industry-Academia Interaction focused on Outstanding Technologies; Industry Oriented Curriculum Development; Entrepreneurial Ideas for Inductable Technologies in Small Industries; Metrology for Time & Frequency, Need for Environment Pollution production and Monitoring Initiatives, and Agriculture & Industries.

Young Scientist's Conclave

A key component of IISF 2016 was the Young Scientist's Conclave, during which parallel sessions were organised to discuss topics which are of great relevance to the society. This included various activities like plenary lectures, oral and poster presentations and workshops. Plenary sessions were conducted under six themes – Agriculture, Health, Water, Information Technology, Space and Defence & Energy – in which eminent scientists shared their research work through a series of highly informative talks.

The Final Day

In the Valedictory Function held on 11 December, Dr. Harsh Vardhan, Union Minister of Science and Technology and Earth Science said, ÏISF has the potential to be the greatest science event and it should be a regular annual activity such a huge gathering even during the valedictory session is unprecedented and proves its popularity success. He appreciated that many of the innovative ideas presented by the students.

CSIR Tableau at Republic Day Parade 2017- CSIR@75: Touching Lives

Fig: 2.8 A model of the CSIR Tableau

The contributions of the Council of Scientific and Industrial Research (CSIR) once again found resonance in a colourful tableaux displayed during the Republic Day Parade on Delhi's Rajpath on 26 january 2017. The tableaux with the theme, **CSIR@75: Touching Lives**, showcased the successful

innovations of one of the largest network of scientific laboratories in the world during its journey of 75 years. CSIR participated in the Republic Day Parade for the second time after its debut in 2011 with the theme, **Healthcare: From Generics to Genomics**.

Into its 75th year now, CSIR has been playing a stellar role in building up the scientific and technological prowess of the country. Through its technological interventions, CSIR has not only provided solutions and innovations for the industry but has also proved to be a catalyst in improving the quality of life of millions of people across the country.

The CSIR tableau, which took part in the Republic Day Parade this year depicted a few of the significant milestones of the organisation since its inception. The centre of the tableau highlighted major achievements of CSIR so far, featured as decade-wise sparks from the CSIR wheel with the support of its 38 national laboratories. It also highlighted its global standing – CSIR ranks 12th in the world amongst all government funded institutions.

Several outstanding contributions of CSIR were depicted as three-dimensional larger-than-life size models spread across the tableau, including those related to its initiatives in pioneering civil aviation industry, developing affordable drugs, enabling provision of potable water in even remote areas, and introducing high value medicinal & aromatic plants. A modern laboratory set-up depicted CSIR's role in fostering, sustaining and upgrading the pool of specialised scientists and engineers in the country.

The front part of the tableau displayed a face placed on a laptop, depicting ideas generating in the mind and the knowledgebase thus created and appropriately used for catalysing the growth of Indian industry, improving the quality of the lives of common masses and nurturing S&T human resource development. Beneath the face was projected the 'Drishti transmissometer' now being used at several Indian airports to measure visibility.

At the end of the tableau the model of India's first indigenously developed five-seater multi-purpose aircraft was shown taking off.

Fig: 2.9 CSIR Tableau at Republic Day Parade 2017

3.0 Significant S&T Achievements

Design and Development of Continuous Ragi Mudde Making Machine and Ball Making Unit

The production of ragi mudde (finger millet ball) in large scale was felt difficult by many catering institutions, student hostels, jails, matt and restaurant due to existing manual method of batch type operations. It is a quite a cumbersome, manual process that undergoes three stages to get the final product namely preparation of ragi porridge and addition of ragi powder fallowed by vigorous mixing and final cooking and then making it into round balls. All these cumbersome stages are carried out by manual operation which are time consuming, drudgery to the chef. Further the manual operations leading to the end product is un-hygienically prepared one and quality of the product is also questionable due to the presence of blow holes with encapsulated raw powder in the mudde etc.

The need was felt to standardize the ragi mudde making process and mechanization to serve large population society. Thus ragi mudde making machine was conceptualized and materialized by CSIR-CFTRI. It was developed with the funding from Department of Science and Technology, Government of India.

Unique features of the Machine include:

- It is fully automated Machine;
- It is steam cooked inside the machine;
- It is untouched by human elements. Ragi flour and water is added to the machine, ragi balls come out as continuous discharge with consistent shape and weight; and
- It can discharge 200 to 250 mudde/ hr. (200gm each ball weight).

This machine is very useful in big restaurants, hostels, industrial canteens, defence canteens, jails, airport restaurants etc. Ingredients required are ragi flour and water. Steam quality and other working parameters of the machine is maintained within the range by the control system of the machine. Unit is easy to clean and has provision for CIP (Clean in position) ensuring quality and hygiene.

Fermentation Technology for production of metal Gluconates

CSIR-IIIM has developed a technology for converting glucose to gluconates using a fungal strain i.e. *Aspergillus niger* with a productivity of 5-6 kg/Kl/h under certain specifically defined physico-chemical conditions. A final product recovery of 90- 95% can be achieved at 120-150g/l glucose concentration within 72h.

Gluconates have several established pharmaceutical, agricultural and other industrial applications. Calcium, copper, ferrous and zinc salts find use in oral metal supplements for humans, animals and agricultural applications. Sodium gluconate being an excellent sequestrant, finds application as metal or bottle cleaning agent. For its ability to slow the process of polymerization of cement at highly reduced moisture conditions, very large quantity of sodium gluconate is used as an additive by cement industry in Europe and Japan.

Oneer- a novel solution for safe drinking water for domestic and community purpose.

Water is one of the most essential requirements of life. As per WHO estimate, nearly 80% of the diseases are caused directly or indirectly by the consumption of unsafe water due to poor or lack of sanitation. In India, 15-20% of infantile mortality has been reported to be due to gastroenteritis. The existing technologies are mainly based on microfiltration, UV irradiation or Reverse Osmosis which are expensive to install and maintain for community supply purpose

CSIR-IITR has developed device based on the principle of anodic oxidation. The device is particularly useful for the treatment of drinking water supplies that have microbial contamination to disinfect pathogenic microorganisms and to provide safe drinking water to communities as per National and International standards [World Health Organization (WHO) and Environmental Protection Agency (EPA) USA] prescribed for potable water. This has high disinfection efficiency of >8 Log reduction of bacteria *(E.coli)* and is maintenance-free. It is a low-cost water disinfection device that can even treat brackish or turbid water unlike UV technology. Cost of treated water is less than 1 paisa per litre. Domestic device can supply 10 litres of water for homes and small establishments while the online version can supply 450 litres of safe water for communities.

Argemone Oil Detection Kit (AO Kit)

Mustard oil constitutes a prime dietary component of various households. Consumption of mustard oil adulterated with Argemone Mexicana oil is known to cause an epidemic popularly referred to as Dropsy. Out of the several outbreaks reported in the past, the dropsy incidence at Delhi in August 1998 appears to be the largest reported in the country involving over 2500 victims with more than 60 deaths. Consumption of Argemone oil contaminated edible oil, even at low levels of adulteration for short duration, causes toxicity. Hence presence of Argemone oil even in trace quantities needs to be ascertained.

CSIR-IITR has developed AO-kit which is used to detect Argemone oil adulteration in Mustard oil. The kit consists of a paper strip and a small instrument for the visualization of fluorescence. The test is easy to perform and takes about 20 minutes. The test is very sensitive with a minimum detection limit of 0.01% (100ppm).

Pedal operated millet dehuller

Small millets are the staple food of millions. Their slow digestibility and nutritive value makes them one or most preferred commodity among health conscious population. A few important small millets are foxtail millet, kodo millet, little millet, banyard millet and proso millet. Farmers growing these millets consume it themselves since there are no small scale mills. With an aim to empower them to dehusk these millets, a pedal operated millet dehuller was developed by CSIR-CFTRI. Being manually operated, this system is most suited for the rural sector. This system has dehusker and an aspiration system to separate the husk from the mixture and all components are available locally. It was found that the speed at which each person operates the system varied and hence the dehulling percentages were found to be different. In addition, different types of millets require different speeds for maximum dehusking and there was no system to indicate the speed of the impeller. Hence, a speedometer was retrofitted onto the system which indicated the speed of the impeller in km/h. With this simple gadget in place, studies were conducted on different millets at different speeds to determine the optimum condition for maximum dehulling efficiency. It was found that for little millets, impeller speed of 4500 rpm (SM: 15.3km/h) gave maximum dehulling percentage, for foxtail millets, impeller speed of 4140 rpm (SM: 14.5km/h) gave maximum dehulling percentage and 4860 rpm (SM: 16.4km/h) was found be best suited for proso and kodo millets. Dehusking efficiency is more for foxtail and Proso millets at impeller speed of 3420 rpm (SM: 11.3 km/h), for little millets at impeller speed of 3780 rpm (SM: 12.8 km/h), for kodo at 4140 rpm (SM: 14.5 km/h) respectively. It was found that at higher speeds percentage of brokens were more for these millets. These speeds were found to be quite easy for the operator and were not tedious.

Jalabhishek - Eco-Friendly Immersion of POP - Ganesh idols

Large number of Plaster of Paris (POP) based idols worshiped and immersed during various festivals in India is a major issue of concern to society due to the water pollution caused by insoluble POP

especially in the situation of water scarcity. In Pune city every year around 5 - 6 lakh POP Ganesh idols are immersed in rivers/lakes during the Ganesh festival. To address this issue CSIR-NCL has worked out an eco-friendly, very simple solution without hurting the sentiments of the devotees by using food grade salt to dissolve POP based idols. In this process food grade ammonium bicarbonate (ABC) dissolved in water is used to immerse POP made Ganesh idol which converts POP into water soluble fertiliser (ammonium sulphate) and cement additive (calcium carbonate). This project was successfully implemented during Ganesh festival 2016-17. About 30,000 in 2016 and 50,000 in 2017 citizens immersed the idols using this concept. Several cities around Pune, and other CSIR laboratories (NEERI, IITR) also initiated this activity in 2017.

A new class of self-expandable stents

CSIR-NCL in collaboration with a start-up has developed a new class of self-expandable stents based on a novel scroll design. These stents have been made with simple polymer-metal composites unlike the shape memory alloy based stents. The novel design allows these stents to meet the characteristics of shape memory alloy based stents. These stents could be made a much lower costs than the currently available ones.

Synthetic Aviation Lubricants

Indigenous technology for synthetic aviation lubricants was developed for the first time in the country by CSIR-IICT in collaboration with five other organizations using indigenously available renewable raw material to a major extent. Thus a new knowledge base has been created successfully in the country which will help in import substitution of aviation lubricants catering to defence and civil sectors. The developed lubricants have passed all the mandatory tests. With this landmark development, India will join the select group of countries having capabilities in aviation lubricant technologies. Moreover, Indian aviation sector is growing at a very rapid pace with many small and big players entering the market. The process developed for base oils SVS-11 and SVS-21 in pilot plant scale (100 kg/batch) was designed, fabricated and commissioned with indigenous capabilities meeting stringent specifications. The developed formulations for aviation lubricants SVS-11 & SVS-21 meet the stringent specifications of MILPRF-23699FDEF-STAN 91-98. The lubricant passed Ryder test at US NAVAIR.

Organic Light Emitting Diodes (OLEDs)

Organic light emitting diodes (OLEDs) are the next generation lighting sources whose aesthetic appeal and the resemblance to the natural light make it more suitable for lighting application. White OLED with brightness more than 20000 cd/m^2 has been developed by CSIR-NIIST. These have maximum current efficiency of 40 cd/A and max power efficiency of 26 lm/w. At 10000 cd/m^2 the values are 38 cd/A and 16 lm/w. Further, CSIR-NIIST developed a light extraction technique which when applied improved the performance to 62 cd/A and 48 lm/w. At 10000 cd/m^2 brightness the values are 52 cd/A and 24 lm/w.

Utilization of Fly Ash through Geopolymer Technology in the Construction Sector

CSIR-CBRI has signed an agreement with NTPC Ltd. on June 7, 2016 for utilization of fly ash through geo-polymer technology in the construction sector (buildings/roads). The Institute undertook a systematic study on the development of heat and ambient cured geo-polymer using fly ash as a precursor. The technology is ready for commercialization. Considering the “zero waste objective”, geo-polymer technology is capable of utilizing huge amount of fly ash as it can be produced from the fly ash as a major constituent. The concrete is cured at ambient condition and also requires no water during curing. The main advantages of using geo-polymer concrete are its high early compressive strength, low permeability, good chemical resistance and excellent fire resistance behaviour. Because

of these properties, geo-polymer is a promising candidate for producing building materials, concrete, structural elements etc.

Development of Acoustic Based Hit Identification and Analysis System (ABHIAS)

CSIR-NAL has taken up the development of Acoustic Based Hit Identification and Analysis System (ABHIAS) for marksmanship training in the subsonic range. It is primarily aimed at the strategic market consisting of the Armed Forces-Army, Navy and Air Force, CRPF, CISF, NSG, BSF etc. Considering there are more than 2000 firing ranges across India requiring at least 8 systems per firing range, this indigenous system has good market potential. The system currently under ruggedization with armed forces and MoU at final stage with BEL, Bengaluru for productionisation, marketing and after sales service. Apart from low maintenance cost this indigenous system is 60% of the cost of comparable imported system.

GMR based gear tooth position sensor

A giant magnetoresistance (GMR) based gear tooth position sensor was successfully developed at CSIR-NAL. The developed speed sensor module (NAL GSTM-14xx) as per the system required specification (SRS) provided by TVS motor Limited, Tamilnadu. CSIR-NAL GSTM-14xx was certified by Automotive Research Association of India (ARAI), Pune and the vehicle test was covered more than 10000 km. The accelerated test was conducted by TVS Motor Ltd and they were very much satisfied with the performance.

CSIR Features in the Thomson Reuters Top 50 Indian Innovator Companies and Research Organizations for the Year 2015

The Council of Scientific and Industrial Research (CSIR) features in the Thomson Reuters top 50 Indian Innovator companies and research organizations for the year 2015. The Top 50 Indian Innovators lead the country in innovation output. They are a group of businesses and research institutions that develop, recognize and protect great ideas and use it to their full potential.

Thomson Reuters India Innovation Awards honours the most innovative academic institutions and commercial enterprises in India for their spirit of innovation in R&D as it relates to Indian patent publications.

Thomson Reuters 2015 India Innovation Awards is based on research and analysis done using the Derwent World Patents Index, the world's most trusted and authoritative value-added patent database. Data from 2010-2014 was used for the analysis. The metrics used are patent volume, grant success rate, globalization, and citation influence. This analysis is done using proprietary Thomson Reuters data and tools. The threshold for inclusion in the Top 50 Indian innovators is at least 25 patents published during the period 2010-2014.

CSIR was also the recipient of the Thomson Reuters India Innovation Awards 2013 in the category of Hi-Tech Academic & Government.

Pioneer of India's intellectual property movement, CSIR today is strengthening its patent portfolio to carve out global niches for the country in select technology domains. CSIR is granted 90% of US patents granted to any Indian publicly funded R&D organization. On an average CSIR files about 200 Indian patents and 250 foreign patents per year. About 9% of CSIR patents are licensed – a number which is above the global average. Amongst its peers in publicly funded research organizations in the world, CSIR is a leader in terms of filing and securing patents worldwide.

The next challenge that the Institution places before itself is to convert this wealth of innovation for societal and industrial outcomes.

CSIR-NBRI Develops Low-arsenic Rice Grain

Rice is a much favoured crop in most parts of the country. But arsenic contamination in rice has been posing serious health risks like kidney disease, cancer and skin problems. Riding on 10 years of intensive research, the CSIR-NBRI has developed 'transgenic rice' that will reduce arsenic accumulation and contamination in rice grains.

Arsenic contamination is most rampant in parts of Uttar Pradesh such as Ballia (most prone) followed by Bahraich, Rae Bareli, Gorakhpur, Ghazipur, Meerut, and Chandoli. It is also a major problem in West Bengal, Bihar, Jharkhand and Odisha.

Arsenic present in the groundwater percolates down into the soil during irrigation and contaminates rice. Rice is most susceptible to absorbing arsenic during cultivation. Cultivating rice varieties that accumulate less amount of arsenic can tackle the challenge of exposure to carcinogens (cancer causing elements).

The new variety of rice developed by CSIR-NBRI has 'arsenic methyl transferase', a gene isolated from a fungus that accumulates less arsenic and would be less toxic.

CSIR-NPL Invents a Novel Hydro-electric Cell as a Source of Green Energy

The CSIR-NPL has developed "Hydroelectric Cell" that operates at room temperature, produces no excessive heat and greenhouse gases, and being made of inexpensive precursors cheaper than fuel cells. The hydroelectric cell also scores over the fuel cell in being risk-free.

A novel renewable energy source and a unique manifestation of the galvanic cell, the hydroelectric cell employs a combination of the material properties and electrode chemistry using only water to generate electrical power. The novelty of this work lies in the generation of electrical energy by the dissociation of water molecules at room temperature by nano-porous lithium substituted magnesium ferrite material.

At present, this cell has a current density of 4.8 mA/cm^2 with a voltage of 950 mV and a maximum power output of 74 mW. Three such cells of diameter 4.8 cm can run a small fan as well as 10 LEDs. The cell is an economical green source for producing renewable energy.

"Divya Nayan" Developed by CSIR-CSIO for Visually Impaired- A text-to-speech reading machine developed for the visually impaired to help them read

A reading device developed by CSIR-CSIO helps the visually impaired by reading the text aloud. The advanced reading machine named "Divya Nayan" is a stand-alone, Portable Reading Machine (PRM). The PRM enables the visually impaired to read printed archives, ebooks, etc. without any third person's involvement. It is based on the principle of contact scanning of a printed document and converting it into speech. Currently, it supports English and Hindi language, but soon will be programmed for other Indian and Foreign languages.

The device is completely wireless and uses open source hardware and software, can analyse a multi-column document and provides for seamless reading to the users. It is capable of page, sentence and word-level navigation while reading, hence enabling newspaper, magazine, etc. reading effortless. The device allows the visually impaired to read the print media as well as the electronic files like eBooks.

The device has internal storage of 32 GB with a run-time of up to three hours and weighs 410 grams. It can also be connected to a monitor and used as a mini computer with screen reader utility.

CSIR Lab Grows Kashmiri Saffron in Pune-

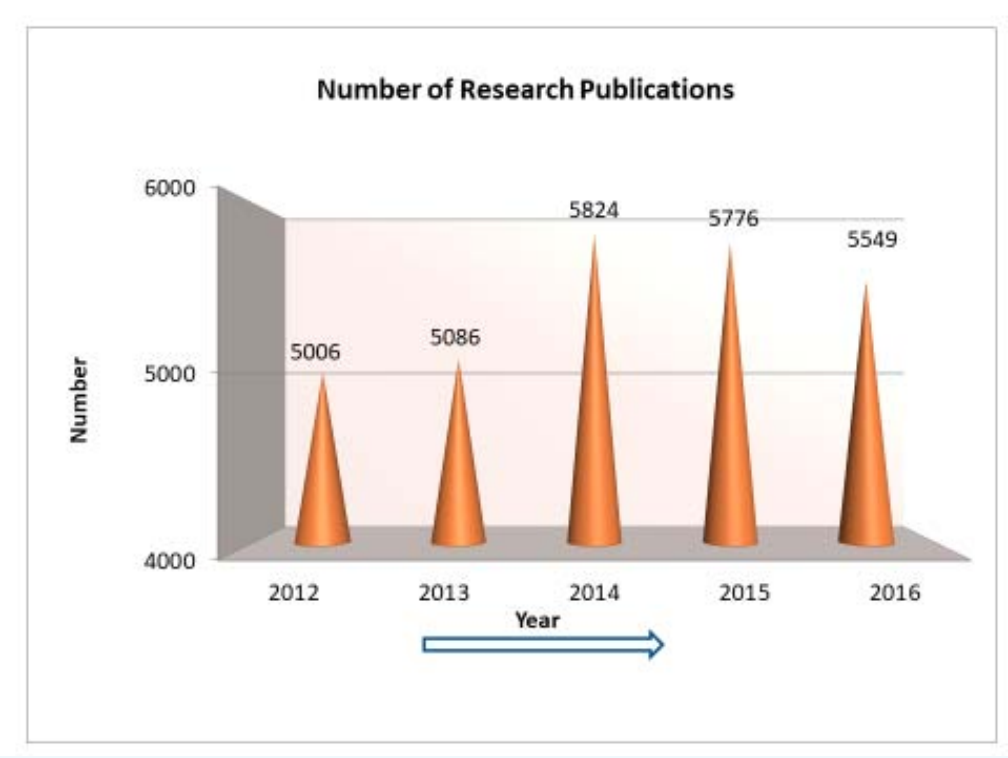
Saffron, widely identified with Kashmir, can now be grown in Pune as well. CSIR-NCL has produced a new variety of saffron crocus that can grow well in wider environmental conditions. The crop grown in a greenhouse in Pune has shown flowering almost like that in Kashmir. The new technology could benefit progressive farmers and Agri-biotech industries.

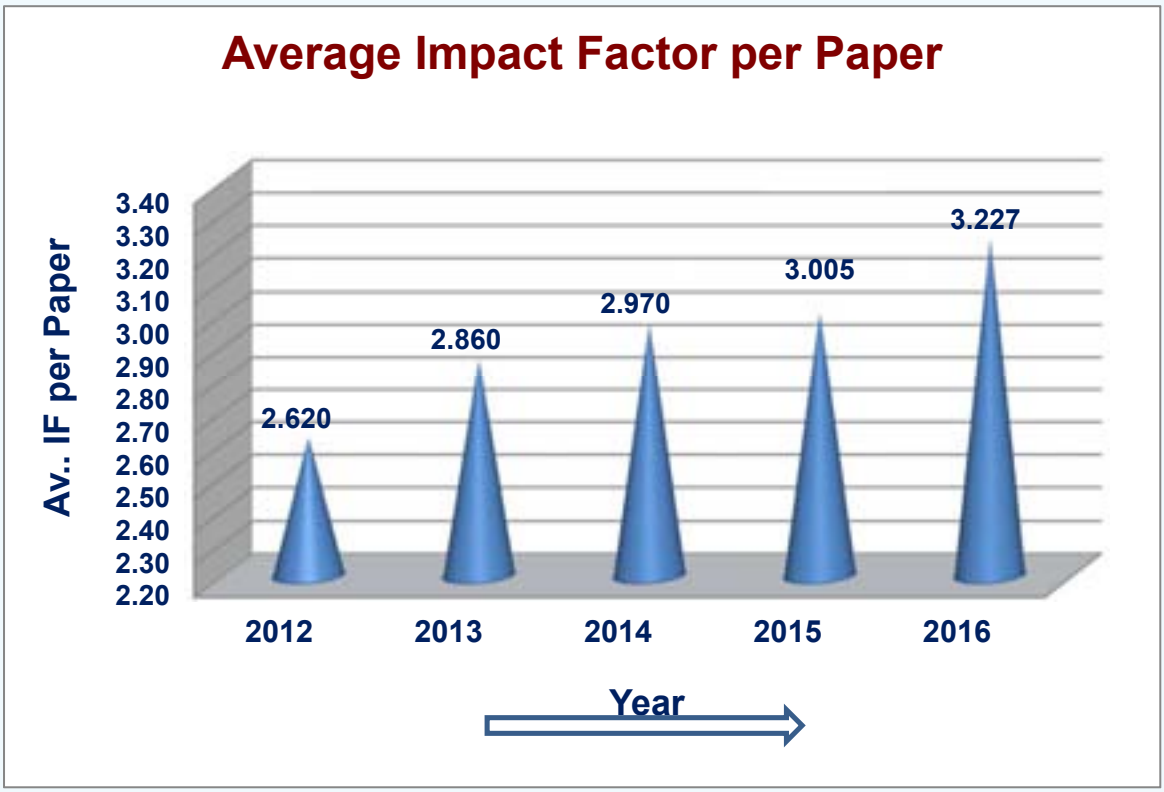
CSIR-NCL studied the soil from a saffron field in Kashmir after which a suitable planting medium was formulated. Saffron corms were procured from Kashmir and planted in a modified greenhouse cooled by natural processes, without a fan, pad system or ACs. A simple irrigation method was devised to minimise the use of water and give cold/ice cold water directly to the roots.

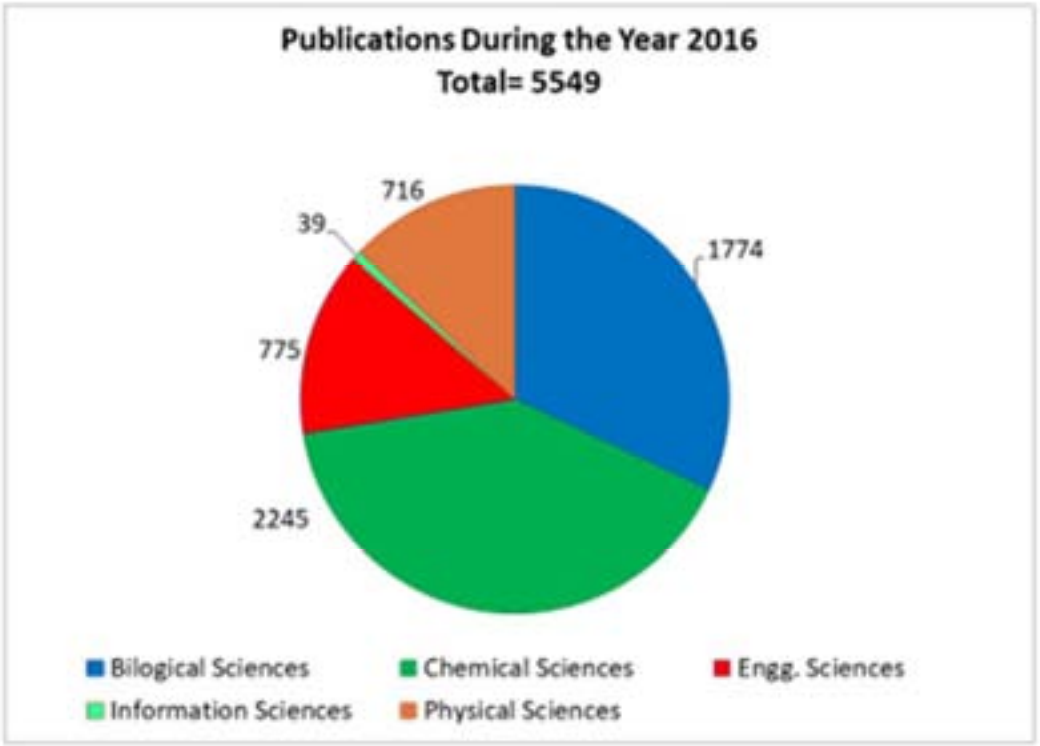
Another challenge was to achieve production of big replacement corms which was dependent on healthy growth of plants till end of April and production of sufficient amount of starch in the leaves, and its translocation to the developing daughter corms. In an earlier attempt, medium size replacement corms were produced. The corms once planted produce replacement corms and continue for 7-10 years; the corms from same greenhouse can be used for replanting and surplus can be sold. After flowering, which was synchronised as in Kashmir, the stigmas were collected from the flowers and dried to produce saffron.

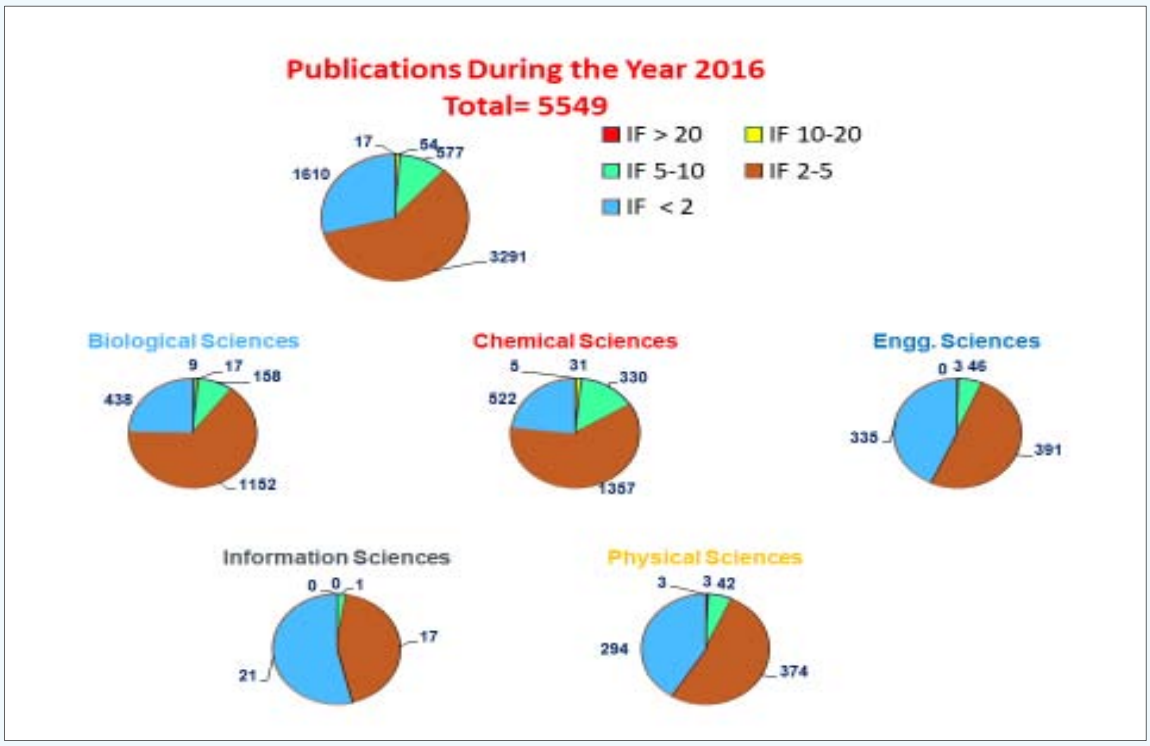
4.0 Scientific Excellence

CSIR has published 5549 research papers during 2016 in SCI journals of repute. The new knowledge generated from CSIR laboratories is reflected in terms of high average Impact Factor (3.227). Following Graph shows the trend of research over the last five years as well as cluster wise publications during the year 2016:



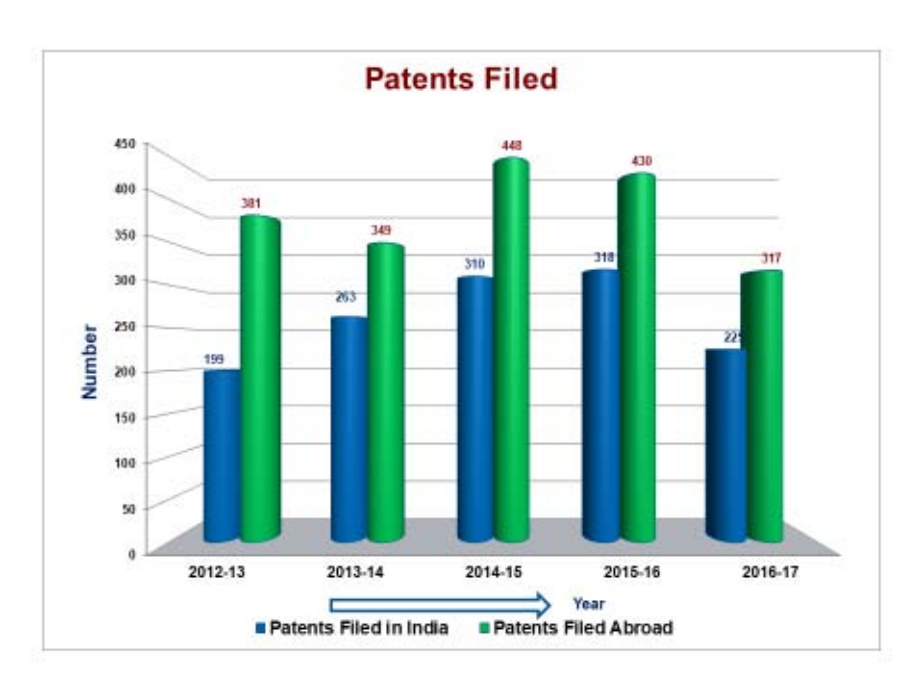

Average Impact Factor per Paper
Av.. IF per Paper
3.40
3.30
3.20
3.10
3.00
2.90
2.80
2.70
2.60
2.50
2.40
2.30
2.20
2.620
2.860
2.970
3.005
3.227
2012
2013
2014
2015
2016
Year

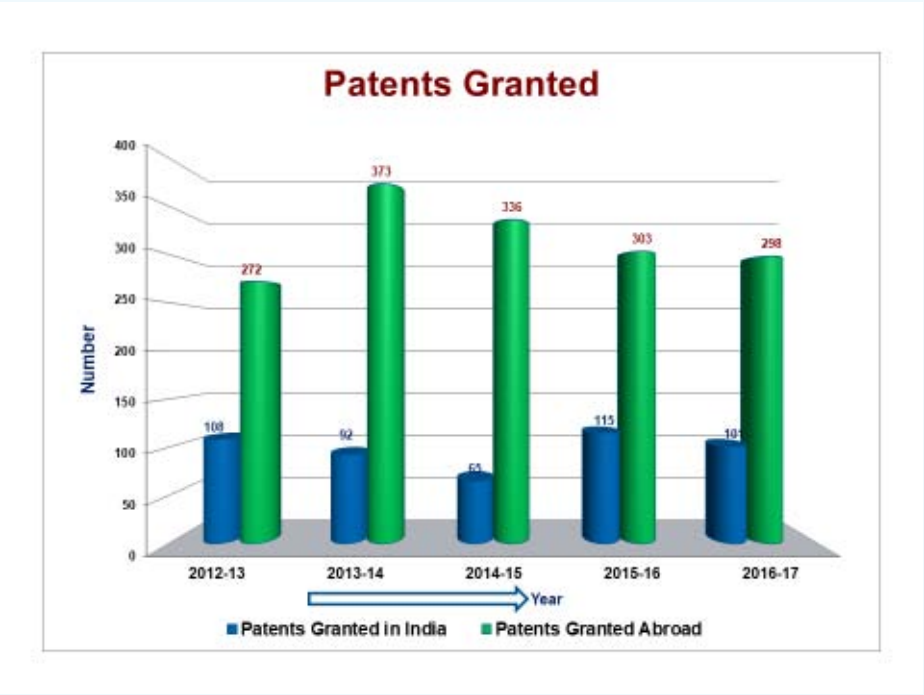

Publications During the Year 2016
Total= 5549
716
39
1774
775
2245
Bilogical Sciences
Chemical Sciences
Engg. Sciences
Information Sciences
Physical Sciences



Excellence in Intellectual Property

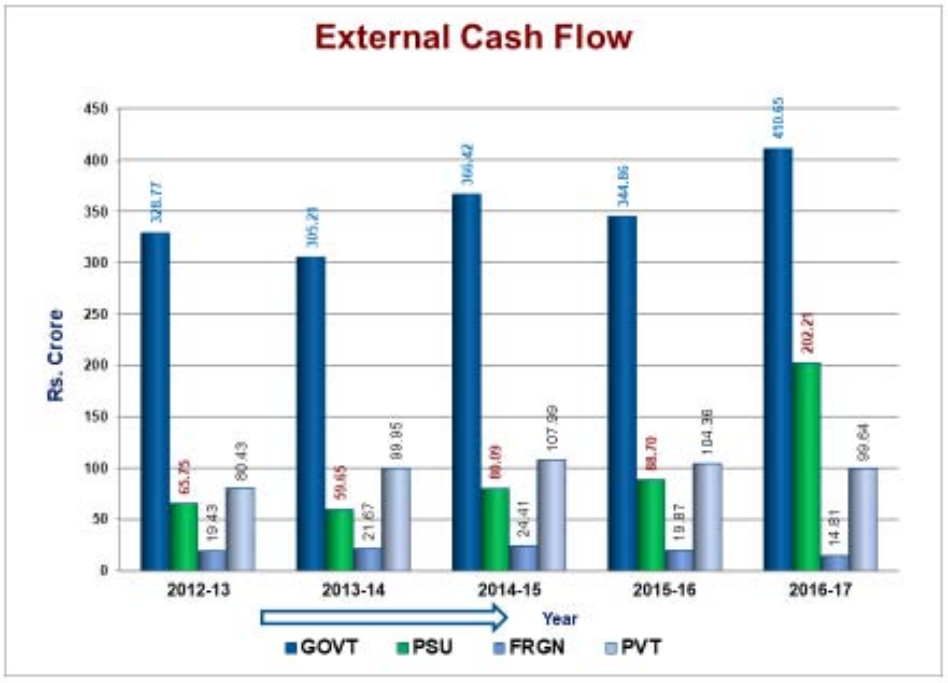
CSIR has filed 317 patents abroad and 225 patents in India during 2016-17, and it has been granted 298 patents abroad and 101 patents in India. Following graphs provide data on patents filed and patents granted over the last five years:

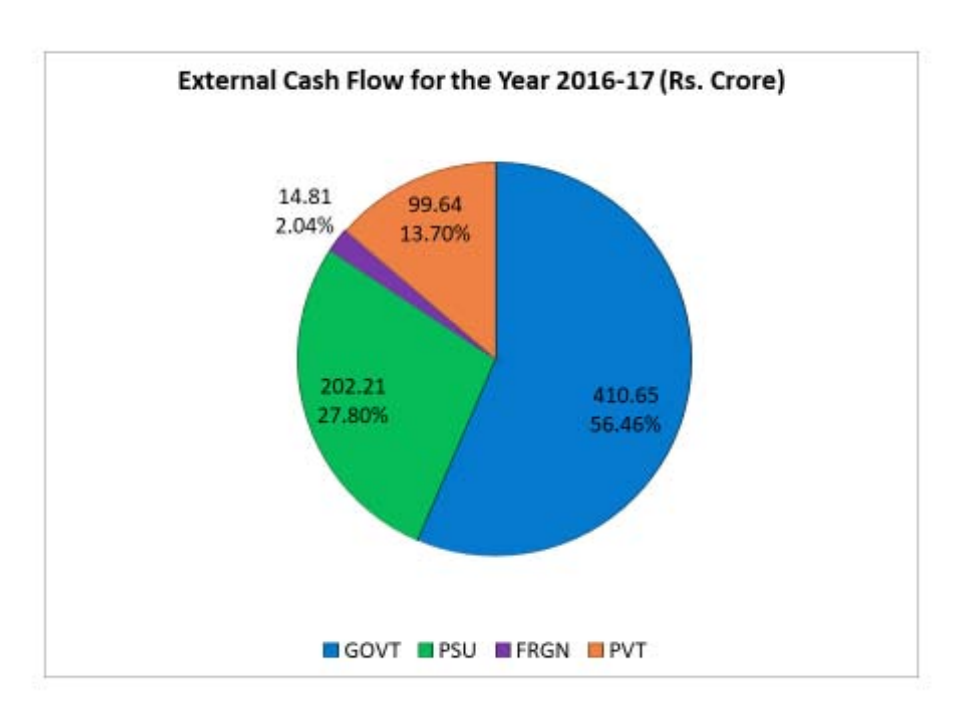




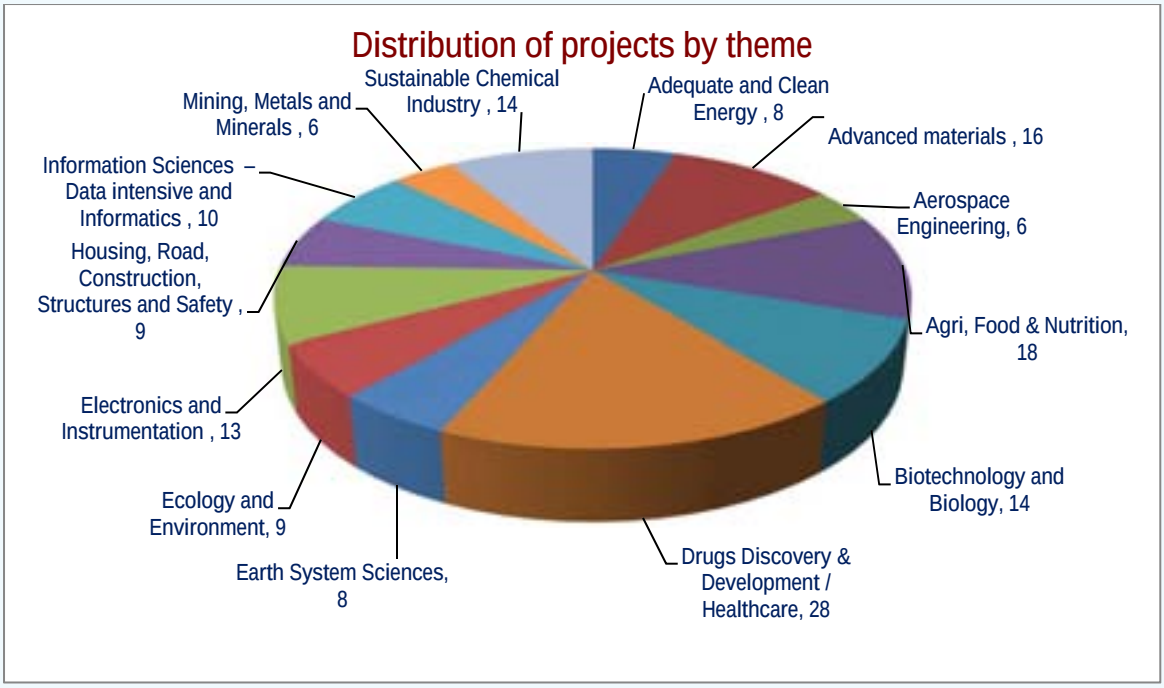
Value Generation through External Cash Flow (ECF)

CSIR has generated External Cash Flow of Rs 727.30 crore during 2016-17, through working with various Govt/non-Govt Indian and foreign organizations. Following graphs provide data on ECF generated over the last five years:

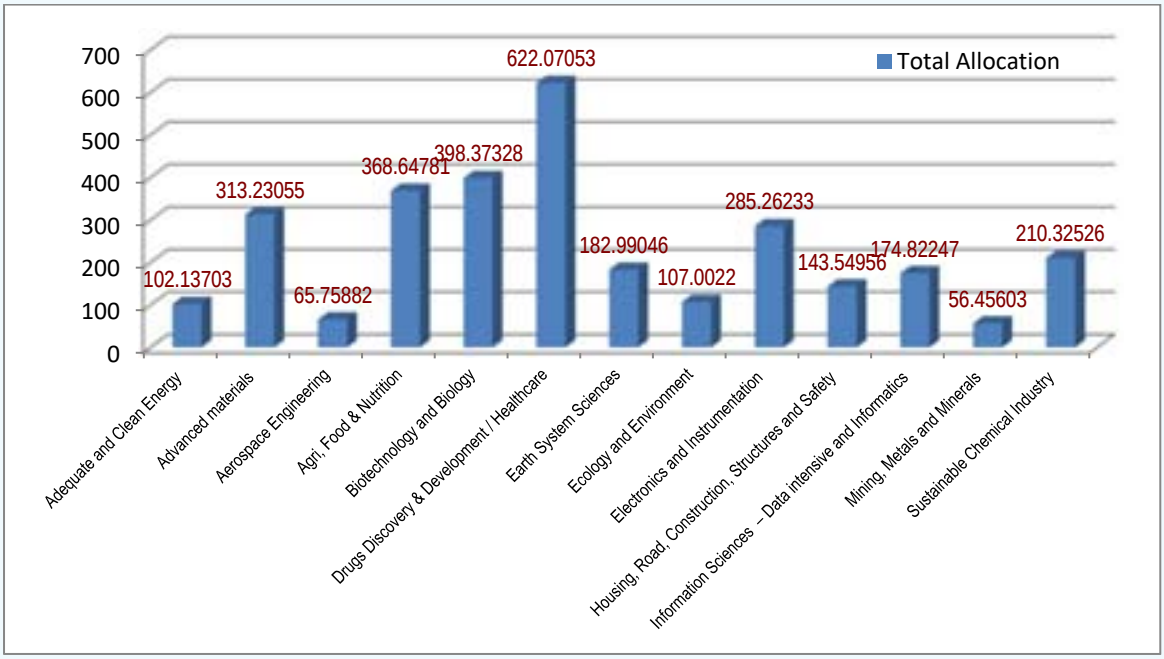




Distribution of Twelfth Five Year Plan Projects based on Theme



The theme-wise allocations


Total Allocation
700
600
500
400
300
200
100
0
102.13703
313.23055
65.75882
368.64781
398.37328
622.07053
182.99046
107.0022
285.26233
143.54956
174.82247
56.45603
210.32526
Adequate and Clean Energy
Advanced materials
Aerospace Engineering
Agri, Food & Nutrition
Biotechnology and Biology
Drugs Discovery & Development / Healthcare
Earth System Sciences
Ecology and Environment
Electronics and Instrumentation
Housing, Road, Construction, Structures and Safety
Information Sciences – Data intensive and Informatics
Mining, Metals and Minerals
Sustainable Chemical Industry

5.0 Cluster-wise Significant S&T Contributions

Integrative Benefits-Cluster wise

5.1 Strategic Impact

Biological Sciences

Good Laboratory Practices (GLP) compliant Test Facility- CSIR-IITR is the first laboratory in CSIR family and second in public funded organization to receive certificate of Good Laboratory Practices (GLP) compliance for toxicity, mutagenicity, environmental toxicity studies. The GLP studies are carried out as per OECD guidelines and the data generated is acceptable for regulatory submissions across the globe in more than 90 countries as all the National and International regulatory agencies require safety data of all new products prior to their launch into the market.

Bio-safety evaluation of smoke generated by Chilli grenade- CSIR-IITR undertook the safety evaluation of smoke generated by chilli grenade developed by Border Security Force (BSF), Tekanpur. This grenade is intended to be used as non-lethal measure for crowd control in troubled areas. The effect of chilli grenade smoke was found to be temporary and non-lethal.

Services through National Facility for Biological and Genomic Resources- CSIR-IGIB provides strategic services through National Facility for Biological and Genomic Resources to public and private institutions. The institute carries out tests for High Altitude Pulmonary Edema risk stratification for soldiers and provides services for the same.

Agro-technologies and new plant varieties- Technologies/products/services developed by CSIR-CIMAP are being popularized among medicinal and aromatic plants-based industries, growers and entrepreneurs engaged in the processing, manufacturing and export of these products through scientist-industry meets, participation in expo, trade fairs and international exhibitions.

Bacterial Blight resistant rice variety, Improved Samba Mahsuri (ISM)- CSIR-CCMB has developed Bacterial Blight Resistant Rice Variety, Improved Samba Mahsuri (ISM), the seeds of the same were provided to the farmers in Andhra Pradesh, Telangana, Chhattisgarh and Karnataka. ISM was also introduced to farmers in Uttar Pradesh for encouraging cultivation of ISM rice variety in the state. The institute supplied grafts of low chilling apple cultivars to NGOs, 360 local tribals/ farmers in a few villages of Andhra Pradesh, Telangana and Odissa for Apple cultivation in their states.

Microbial Type Culture Collection (MTCC) – MTCC is an International Depositary Agency (IDA), and as per the assurance given by the Govt. of India to World Intellectual Property Organization (WIPO), it has to be continued as a depositary for accepting the patent deposit of microbial resources, documenting the microbial diversity of the country. Genome sequencing of type strains and industrially useful microorganisms being undertaken to explore their potential for industrially important products.

Analytical Services to Food industries- As Referral Food Laboratory, designated by FSSAI, MoHFW, GOI, CSIR-CFTRI contributes in development and implementation of National Food Standards and Regulations for domestic food business as well as imports. The laboratory has a team of highly qualified and competent professionals supported with modern analytical infrastructure and state-of-art equipments. The laboratory is accredited to ISO 17025:2005 Quality Management System by NABL, DST, GOI for over 300 test parameters under chemical and biological discipline.

Chemical Sciences

Sustainable leather manufacturing through technology based solutions: CSIR-CLRI has developed a technology of Waterless chrome tanning process in which chrome tanning is carried out

without water by avoiding use of acid, salt and base, technology for a dispersing agent for the dry tanning process, completely eliminates the use of any medium for tanning the hides and skins, Zero waste water discharge using Electro-oxidation technique ensuring zero liquid discharge through reuse and recycling of water in the processing of leather to overcome the environmental challenges faced by the tanning sector.

Multi-layered Thermal Barrier Coatings (TBCs): CSIR-CECRI has developed multi-layer coatings using electroplating and plasma spray process with a temperature difference of 250°C at 850°C and surface roughness around 3 µm. These high temperature ceramic thermal barrier coatings find application for missile components.

Development of carboxylated butadiene nitrile latex: CSIR-IICT has developed carboxylated butadiene nitrile latex which finds application in defence sector. This is towards making India self-reliant in defense materials and also for "Make in India" programme

CSIR-IICT is also engaged in developing portable NMR based characterization methods to aid the DRDO's strategic missile programs. This experimental technique enables identification and characterization of the inner layers (composite polymers) of solid-rocket propellant based missile casings. Lead by this success, CSIR-IICT has continued to work in this area, particularly the interfacial aspects of the composite polymer layers. The knowledge thus generated so far, has enabled to understand the intriguing details of molecular dynamics in the layers of the polymer composite based missiles casings. This information is helpful for assessing the readiness of the missiles after their prolonged storage.

CSIR-IICT participated in 40th and 41st international proficiency tests conducted by the Organization for the Prohibition of Chemical weapons (OPCW), The Netherlands and obtained B and A grades respectively. This work is strategically important to our country from the view point of CWC treaty.

Engeneering Sciences

Utilization of Fly Ash through Geopolymer Technology in the Construction Sector: CSIR-CBRI has signed an agreement with NTPC Ltd. on June 7, 2016 for utilization of fly ash through geo-polymer technology in the construction sector (buildings/roads). The Institute undertook a systematic study on the development of heat and ambient cured geo-polymer using fly ash as a precursor. In view of variability in the constituents of fly ash, the property optimization of geo-polymeric pastes was carried out as a function of activator concentration and its dosage, water-geo-polymer solid ratio, curing time and curing temperature. Geo-polymerisation reaction, thermal stability, identification of bond linkages and micro structural features were analysed by various techniques such as quasi isothermal DSC, TGA, FTIR and FESEM. The durability of geo-polymer pastes/concrete was also studied in terms of aggregate reactivity and deterioration against acidic and sulphate attacks. The suitability of these geo-polymer pastes was assessed in making various geo-polymeric products such as mortars and concrete, bricks, solid and hollow blocks, insulation concrete, foam, sandwich composites and temperature resistant coatings. The technology is ready for commercialization. Considering the “zero waste objective”, geo-polymer technology is capable of utilizing huge amount of fly ash as it can be produced from the fly ash as a major constituent. The concrete is cured at ambient condition and also requires no water during curing. The main advantages of using geo-polymer concrete are its high early compressive strength, low permeability, good chemical resistance and excellent fire resistance behaviour. Because of these properties, geo-polymer is a promising candidate for producing building materials, concrete, structural elements etc.

Immobolisation of Nuclear Waste: CSIR-CGCRI has developed technology for making specialty borosilicate glass beads from five component borosilicate composition with the impurity level of chloride and sulphate less than 200 ppm, to immobolise the nuclear waste products generated by

various nuclear power plants of the country. Till date 56.5MT of material of varying compositions have been supplied to the various waste immobolization plants. The objective is to develope various different compositions of glass beads to immobolize the all possibles high level wastes (HLW) generated by nuclear industries and thereby obviating the need for imports substitution.

Silicon Nitride Electro Magnetic (EM) windows: The technology for producing reaction bonded silicon nitride Electro Magnetic (EM) windows to withstand high temperatures upto 1200°C and sustain erosion, corrosion, thermal and fatigue stresses while in use has been developed at CSIR-CGCRI for strategic application. The proposed product is of strategic importance in the Indian context. Two EM windows have been fabricated with negligible amount of flaws as revealed by ultrasonic NDT. Further development and machining studies are in progress.

High Density Radiation Shielding Window (RSW) glass: The technology of high density Radiation Shielding Window (RSW) glass derived from $PbO\text{-}SiO_2\text{-}K_2O$ system has been successfully developed in CSIR-CGCRI with an aim to meet the needs of the country's nuclear industry. CSIR-CGCRI has developed a pilot scale facility, produced homogeneous and defect free high density RSW glass blocks (ceria stabilized as well as un-stabilized) up to 400 × 400 × 100 mm^3 sizes and supplied 20 MT of RSW glass of different sizes to BARC/ DAE. Development and production of the higher size RSW glass blocks are in progress.

Development of Acoustic Based Hit Identification and Analysis System (ABHIAS): CSIR-NAL has taken up the development of Acoustic Based Hit Identification and Analysis System (ABHIAS) for marksmanship training in the subsonic range. It is primarily aimed at the strategic market consisting of the Armed Forces-Army, Navy and Air Force, CRPF, CISF, NSG, BSF etc. Considering there are more than 2000 firing ranges across India requiring at least 8 systems per firing range, this indigenous system has good market potential. The system currently under ruggedization with armed forces and MoU at final stage with BEL, Bengaluru for productionisation, marketing and after sales service. Apart from low maintenance cost this indigenous system is 60% of the cost of comparable imported system.

Fig: 5.1 ABHIAS

Certificate of Indigenous Carbon Fiber: During the year certification of airworthiness of indigenously developed standard modulus grade carbon fibre were tested by CSIR-NAL for the certification by the Centre for Military Airworthiness & Certification (CEMILAC) under inspection coverage by the Directorate General of Aeronautical Quality Assurance (DGAQA). The Ministry of

Defence (MoD) will be taking up this technology for establishing 100 TPA carbon fibre plant through MIDHANI.

Fig: 5.2 (a) Precursor Fibres

5.2(b) Carbon Fibres

support to ADA's LCA-Tejas Programme: CSIR-NAL continued its support to the ADA's LCA-Tejas Programme. CSIR-NAL continued to make contributions in the areas of design, fabrication and R&D of composite structures. During the year, three sets of fin and rudder assemblies were delivered from SP4 to SP6 aircraft. Four sets (10 parts/set) of MLG aft doors with fairings were delivered to SP4 to SP7 aircraft. Three out of seven centre fuselage parts were supplied to aircraft up to SP18. All parts of fin, rudder and 6 centre fuselage parts produced at TAML, Bengaluru under the QA coverage of CSIR-NAL. Further the National Control Law team for LCA-Tejas led by CSIR-NAL completed the control law design modifications for Final Operation Clearance (FOC) of LCA–Mk1 aircraft and trainer variant. Air data algorithms were developed for AIR - to- AIR refuelling mode. LCA Navy successfully completed 12 ski jumps with the modified SKI jump take off mode. All variants were flown during Aero India Show 2017.

Physical Sciences

CSIR-NGRI has carried out (i) Heliborne Surveys for Uranium Exploration: CSIR-NGRI carried out in collaboration with Atomic Mineral Directorate (AMD), Department of Atomic Energy (DAE) : 20000 line km in Satpura and Chhatisgarh Blocks (ii) **Seismic Hazard Assessment Studies for** : Citing of Nuclear Power projects – NPCIL, Comprehensive seismo tectonic and earthquake Hazard Assessment studies at the proposed Gorakhpur site in Hissar district of Haryana.

Diversity and activity of methanotrophic related bacteria in subsurface sediments of the Krishna-Godavari Basin, India: CSIR-NIO assessed the distribution, diversity and activity of aerobic methanotrophic related bacteria (MRB) dwelling in Krishna-Godavari (KG) basin, India. The counts of MRB ranged from non-detectable(ND) to 8.6 - 10^4 CFU gram dry weight of the sediment, with maximum counts at 24.2 m below seafloor. Greater methanotrophic bacterial abundance was at the surface/subsurface sediments of the core at station MD161-8 than at the bottom sediments. Identification of these isolates by 16S rDNA sequence analysis showed their taxonomic affiliation to *Alcanivorax, Methylophaga, Marinobacter, Joostella, Methylobacterium, Desulfovibrio* species and other uncultured bacterial clones. The isolates grew under optimum pH of 8, temperature of 28°C and salinity of 35, and on different carbon sources like yeast extract, D-glucose, ethanol and methanol. The addition of nitrogen sources like amino acids and yeast extract improved methanotrophic activity by the isolates. These results add to our understanding of MRB and their activity in modulating the emission of methane from gas hydrate -rich ecosystems like the KG basin.

Fig: 5.3 Simulator setup for LCA Naval version

Prediction of gas hydrate saturation throughout the seismic section in Krishna Godavari basin using multivariate linear regression and multi-layer feed forward neural network approach: Stepwise linear regression, multi-layer feed forward neural (MLFN) network method was used by CSIR-NIO to predict the 2D distribution of P-wave velocity, resistivity, porosity, and gas hydrate saturation throughout seismic section NGHP-01 in the Krishna-Godavari basin. Log prediction process, with uncertainties based on root mean square error properties, was implemented by way of a multi-layer feed forward neural network. The log properties were merged with seismic data by applying a non-linear transform to the seismic attributes. Gas hydrate saturation estimates show an average saturation of 41% between common depth point (CDP) 600 and 700 and an average saturation of 35% for CDP 300-400 and 700-800, respectively. High gas hydrate saturation corresponds to high P-wave velocity and high resistivity except in a few spots, which could be due to local variation of permeability, temperature, fractures, etc.

Seabed Resident Event Profiler (SREP): XIIth (2012-2017) plan Seabed Resident Event Profiler (SREP) has been developed by CSIR-NIO. The SERP was first tested onboard ORV Sindhu Sadhana. All initial testing was undertaken at 26 m water depth including the trial deployment and recovery. Deployment to a depth of 206m was undertaken during the same cruise. SREP was deployed as an in-line mooring with an anchor weight of about 200Kg. The profiler on SREP had a CTD, DO and chlorophyll-a sensor while the base unit is installed with the winch and winch controller, the controller for data mirroring through an acoustic modem link.

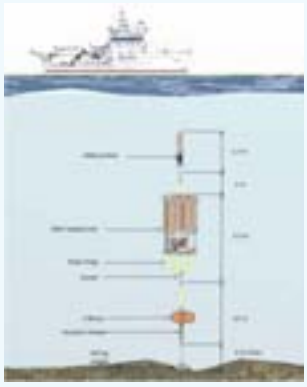


Fig:. 5.4 (a) SREP mooring configuration

Fig: 5.4(b) Base unit ready for deployment

Fig: 5.4(c) Profiler ready for attachment

Optical properties of oceanic waters

During the year extensive data was collected by CSIR-NIO under the Ministry of Earth Sciences funded SATCORE program. This was used to develop and fine tune the bio-optical algorithms for coastal and estuarine waters. The most significant achievement under this are the recommendations for OCM - 3 band suitability to detect *Trichodesmium.*

A new algorithm to determine the total spectral absorption coefficient of water and also the absorption due to phytoplankton. This method was used to determine the phytoplankton functional types and algal blooms.

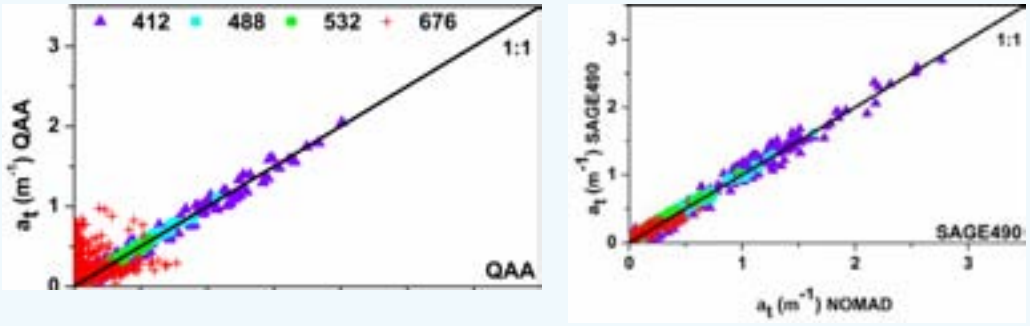


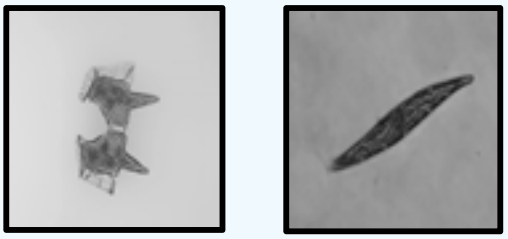
Fig:5.5 Graph to comparison of SAGE and QAA

Comparisons of method SAGE490 (bootom) with widely used algorithm, QAA (top): New algorithms have been developed by CSIR-NIO to derive underwater average cosine at 490 nm from the satellite data and is extended to derive spectral underwater average cosine algorithm to determine the underwater average cosine at 490 nm was to determine the underwater horizontal and vertical visibilities from satellite data.

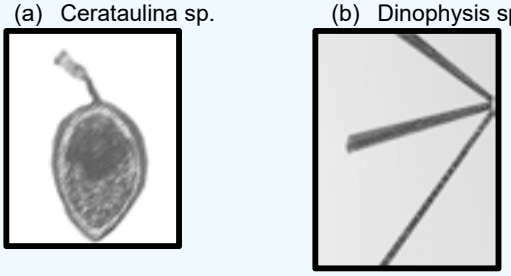
Phytoplankton genus and groups were identified for their temporal and spatial variations in the coastal and estuarine waters of Goa. Phytoplankton taxa of coastal and estuarine waters and understanding the bio-optical properties with regards to the phytoplankton functional types (PFT) and phytoplankton size classes (PSC). Phytoplankton species and their adaptability and acclimation under very low light and high light were studied. Minimum light levels required for the phytoplankton is about 2µmole/m^2/s and the studies of phytoplankton under low light conditions (< 50µmole/m^2/s) showed phytoplankton species which could adapt in low light, which were *Leptocylindrus* spp., *Thalassionema* spp.,*Chaetoceros* spp.,*Cerataulina* spp.,*Bacillaria* sp., *Navicula* spp.,*Nitzschia* spp.,*Pseudo-nitzschia* spp.,*Proboscia* sp.

Bio-optical algorithms have also been developed to derive optical parameters from the OCM-2 and MODIS satellite data such as underwater horizontal and vertical visibility.

A new spectral model has been proposed that can model the spectral variations of CDOM from the UV and visible regions. This will find applications in CDOM photo-bleaching, UV light levels and bio-optical models.

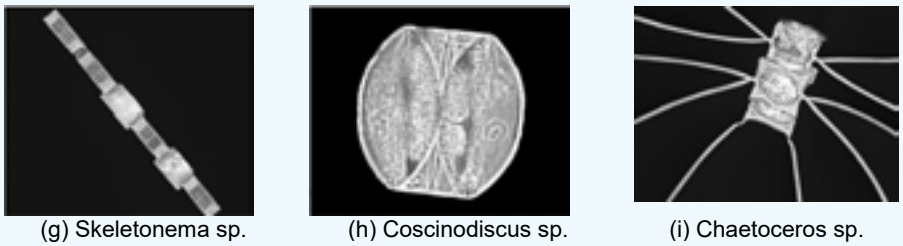


(a) Cerataulina sp. (b) Dinophysis sp. (c)Pleurosigma sp.



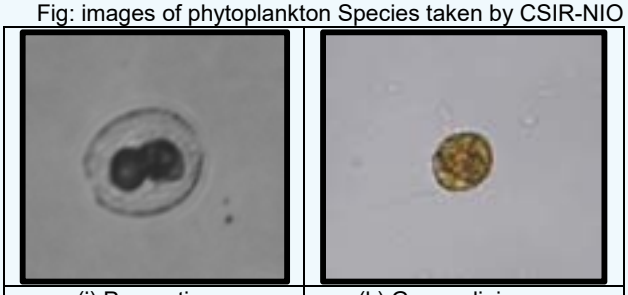
(c) Prorocentrum sp (e)Thalassionema sp. (f) Ceratium sp.

Images from SEM (Scanning Electrone Microscope) (TM3030)



(g) Skeletonema sp. (h) Coscinodiscus sp. (i) Chaetoceros sp.

Fig: images of phytoplankton Species taken by CSIR-NIO



(j) Pyocystis sp (k) Gymnodinium sp.

Fig: 5.6 Common Bioluminescent phytoplankton species in Mandovi Estuary

5.2 Societal Fulfillment

Biological Sciences

Drug pipeline: CSIR-CDRI has a rich drug pipeline in both single molecule and herbal (Indian traditional medicine) categories that are ready for licensing. These candidates include single molecules to treat dyslipidemia, thrombosis, malaria, post-menopausal osteoporosis and fracture, and several standardized herbal extracts/formulations that have hepatoprotective, cardioprotective and osteoprotective effects. In addition, CDRI pipeline contains formulations such as inhalable particles for delivering anti-TB drugs to lungs, enhanced oral bioavailability of an osteogenic phytochemical and self-microemulsifying delivery system consisting of multiple anti-malaria drugs. CSIR-CDRI is continuing the legeacy in the reporting year to carry out drug research in all its aspects and to build a strong scientific & technological base for the development of Pharmaceutical & Drug Industry in the country for societal benefits.

Inclusion of Centchroman and oral non steroidal contraceptive in the National Family Planning Program: Ministry of Health & Family Welfare, Government of India introduced Centchroman and oral non steroidal contraceptive developed by CSIR-CDRI as a recommended Contraceptive agent on 5 April 2016 during National Summit on Family Planning Programme and Included it in the National Family Planning Program. Now Government is providing it free of cost to the women all over India under the rechristened brand name '**Chhaya'**.

Cultivation of medicinal and aromatic: With the efforts of CSIR-CIMAP, an additional area of 30,000 ha is brought under cultivation of medicinal and aromatic plants in the country which produces the raw material worth of about Rs. 600 crores for industry. Through the cultivation of these crops in the rural areas, about 70 lakh man-days were generated worth of around Rs. 140 crores.

Genomic services for rare genetic diseases: CSIR-IGIB has implemented GOMED and GUARDIAN programs for genomic services to patients and doctors in common and rare genetic diseases. More than 5000 test shave been performed. The e-Health Centre program co-developed by CSIR-IGIB has led to half million patient visits

Commercial floriculture in Himachal Pradesh: CSIR-IHBT supported cultivation of commercial floriculture in Himachal Pradesh and demonstrated distillation of oil. About 220 farmers were

benefited due to this intervention. CSIR-IHBT promoted of tea farm mechanization of 30 ha area and provided training and demonstration on tea cultivation to farmers.

Cultivation of elite varieties of high value Medicinal and Aromatic Plants: CSIR-IIIM under its JAAG project has cultivated and processed elite varieties of high value Medicinal and Aromatic Plants in various districts of Jammu and Kashmir as per crop suitability to diverse agro-climatic conditions. It has enhanced the income and generated new employment opportunities for the rural farming community of the state over low valued traditional cropping system. Further introduction of MAPs has reduced the crop loss by wild/stray animals. Under CSIR-800 project CSIR-IIIM conducted various training and awareness programmes in 11 states of India, and more than 600 ha of wasteland, rain-fed and kandi areas brought under cultivation of MAPs.

CSIR - IIIM has taken large-scale cultivation of *Monarda citriodora* at Jammu and conducted multi-location trial at Srinagar(J&K) and Hardoi (UP) and developed the process for thymol crystal production at pilot plant; agro and processing technology for production of "cannabidiol" enriched drug for neuropathic pain in terminal cancer patients; and Nutraceutical (vitamin B12/E rich) product from seabuckthorn.

Identification of factors responsible for the unnatural deaths in the children: CSIR-IITR led to the identification of factors responsible for the unnatural deaths in the children of western Uttar Pradesh by hepatomyo encephalopathy (HME) due to consumption of *Cassia occidentalis* seeds. Further, the anthraquinone derivatives were found to be responsible for these toxic menifastations, which were prevented by Cyclosporine A. Creating awareness among the public of affected area has led to zero deaths of children in the region in the past three years.

Correlation of Acute Encephalopathy Syndrome (AES) with litchi consumption: CSIR- IITR has explained the correlation of Acute Encephalopathy Syndrome (AES) with litchi consumption by children of Muzzafarpur, Bihar. The studies revealed that the disease is due to the presence of MCPG in litchi pulp. Accordingly, awareness was created in the affected area (Muzaffarpur, Bihar) in this regard, there has been no mortality due to AES since 2015.

S&T Interventions to Combat Malnutrition in Women and Children - Seven nutrition dense food products developed by CSIR-CFTRI were used for 6-months feeding study to identified children of 12 anganvadi centers of Nanjangud taluk, Mysore district: 1) Spirulina chikki 2) Mango bar 3) Energy food 4) Sesame Paste 5) Rice-Milk Mix 6) High Protein Rusk 7) Nutri-sprinkle. Above food products, were specially formulated to cater the nutrition needs of malnourished children, in terms of RDA for specific macro- and micro- nutrients like protein, calcium, iron, zinc, B- group vitamins, Vitamin A and calories. Nutrition intervention study undertaken with support of Women and Child Development Department; Govt. of Karnataka, covered around 250 children including severely malnourished children of villages namely, Chamalapura hundi, Heggadahalli, and Ramapura. The 6 months feeding intervention program was conducted during February-September 2016. As efficacy of nutrition intervention, anthropometric and Hematological measurements (hemoglobin, ferritin, serum albumin and retinol) of children conducted after six months feeding program, when compared with respective base-line measurements clearly countered the degree of under-nutrition, which was reflected by improvement in weight for age and height for age indices. Post intervention, vitamin A status measured in terms of serum retinol too showed improvement. Above nutrition intervention demonstrated significant positive shift in iron deficient anemia, which was reflected in marked improvement in both storage and circulating iron levels. All the seven food products used in the feeding intervention were highly liked by children. Technologies of above nutri-foods have been transferred to multiple agencies. Results of above nutrition intervention with specially formulated foods as well as demand for other agencies for similar intervention, clearly indicated that implemented

project have great potential to serve as model towards large-scale out-reach in combating malnutrition among vulnerable population. A pilot scale study to assess the nutritional and safety of foods served under Mid Day Meal programme was conducted for Mysuru District. Total 272 schools covering all the 9 zones of Mysore District were selected for the MDMS survey and sample collection. The programme aimed at increasing awareness among students and the staff involved in MDM activities regarding hygienic practices as well as the significance of nutrition in school children.

S&T Interventions to help banana farmers- Banana varieties Cavendish and Robusta varieties are grown by farmers in the Nanjungud, Chamarajnagar, Mandya and Mysore districts of Karnataka. Bananas after attaining mature stage are harvested and transported to local fruit markets in trucks. CSIR-CFTRI had undertaken a strategy to protect farmers interest by adopting innovative practices. The CSIR-CFTRI brought out diverse value added products from banana such as banana nutri-bar with long shelf life, enriched with vitamins and minerals. In order to create a value chain, a new model, Farmers-Researchers-Industries-Govt. (FRIG) was made. CSIR-CFTRI initiated the FRIG model to enhance the productivity of farmers by direct market value facilities. A pictorial view of the model is listed below:

Fig: 5.7 FRIG Model

The Vision was to ensure the direct profit to the farmers by educating the farmers about modern technologies and motivating the farmers for the production of nutritionally enriched banana based by-products. A stakeholders meet was conducted at CSIR-CFTRI and various strategies were discussed. Ripened banana (Approx. 225 Kg) were converted to banana pulp and further nutria-banana bars were made. These bars were supplied to Aganwadi's through Women and Child Development of Karnataka Govt. under Balasanjivani program as a nutritional supplement. The idea for establishing a pilot scale production facility is being contemplated to support the farmers groups as well.

Chemical Sciences

High purity salt – with improved productivity and purity for domestic needs (both for edible and industrial needs), high purity salt has been developed by CSIR-CSMCRI.

Downstream processing of seaweeds to value added products- Enabling a new industry domain has been formulated by CSIR-CSMCRI on the complete valorization for seaweeds for agriculture, food, chemicals, nutraceuticals, pigments and for energy.

Seaweed Cultivation- CSIR-CSMCRI is creating an alternative livelihood for coastal women populace of India**.** The institute is **i**mproving the earning potential of agarias through enhanced purity of salt production in the salt pans and also providing clean drinking water in the water starved/affected areas in India in particular during natural disasters (for example proving over 0.5 million litres of water in the severely drought affected Latur, Maharashtra in 2016-17).

Improved gur Bhatti- Gur and Khandsari are among the major agro processing industries found in rural sector of our country. Nearly 50% of total sugarcane produced in the country is used for manufacture of about 8 million tonnes gur which is known as the most nutritious agent among all sweetners. After conducting long experimental trials on one of the conventional bhatti, an improved

bhatti was set up by CSIR-IIP. The improved bhatti is based on the popular design normally found in Dehradun and nearby U.P. / Uttarakhand state areas. The improvement is stressed mainly towards the better design of furnace and chimney which would improve the combustion performance of bagasse, resulting in about 10% reduction in bagasse consumption and lesser smoke through chimney. By using fire bricks in the furnace, its life has been increased considerably. In addition to it, about 20% increase in gur production, of better quality, has been observed. With all these improvements, the profit of gur bhatti owner has increased. Cost of the improved bhatti is higher but due to additional profit, the gur bhatti owner can recover the extra cost incurred, within 2 to 3 gur production seasons. CSIR-IIP has installed 35 no. of gur bhattis in the Uttarakhand and Uttar Pradesh region with this technology.

Improved Biomass Chullha- With the aim to improve the quality of life of rural masses, CSIR-IIP has developed a fuel efficient and low emissions biomass Chullha (cooking stove). Since the level of indoor air pollution was extremely high in the small rural kitchens where biomass is burnt in traditional stone Chullhas, there was a great need of scientific intervention to improve the design of Chullhas. In context to it, two designs of biomass stove, one with higher thermal efficiency and one with extremely low emissions were developed at CSIR-IIP. After a detailed lab scale trails, these stoves were also tested in actual rural kitchens. Nearly 10% of thermal efficiency was observed in the improved Chullha with significant improvement in indoor air pollution level (PM2.5 and Total Suspended Particulate matters).

Energy Saving Vessels (“SONA” ESV) for energy efficient cooking application- “SOANA” ESV (Energy Saving Vessel) is a fuel saving cooking vessel made with aluminum, which when used with a domestic and commercial burner saves fuel. It is essentially designed by CSIR-IIP to have jacket around the body of a conventional cooking vessel. The hot flue gases which gets dispersed into the atmosphere, now travel through the annular passage between the outer wall of the vessel and the inner wall of the jacket before getting dispersed into atmosphere through gas vent holes. With this, heat content of the flue gas is partially recovered.

Nanohybrid material based capacitor- CSIR-IICT has Synthesized “nanohybrid material based capacitor” cell which has demonstrated remarkable energy, power, and cyclability performance as an electrochemical capacitor electrode and scaled them up for large-volume material production and further applications in many other electrochemical energy storage devices.

Thermal insulation coatings- CSIR-IICT has successfully developed two types of thermal insulation coatings for different substrates and scaled it up. The coating has shown the surface temperature difference of 16-31°C based on thickness of coatings. Several new molecules, dyes, polymeric materials, nanomaterials, quantum dots, small organic molecules etc has been developed for third generation dye sensitized solar cell and organic/polymerc/hybrid solar cells.

“Jalabhishek - Eco-Friendly Immersion of POP Ganesh idols”- Large number of Plaster of Paris (POP) based idols worshiped and immersed during various festivals in India is a major issue of concern to society due to the water pollution caused by insoluble POP especially in the situation of water scarcity. In Pune city every year around 5 - 6 lakh POP Ganesh idols are immersed in rivers/lakes during the Ganesh festival. To address this issue CSIR-NCL has worked out an eco-friendly, very simple solution without hurting the sentiments of the devotees by using food grade salt to dissolve POP based idols. In this process food grade ammonium bicarbonate (ABC) dissolved in water is used to immerse POP Ganesh idol which converts POP into water soluble fertiliser (ammonium sulphate) and cement additive (calcium carbonate). This project was successfully implemented during Ganesh festival in 2016-17.

A new class of self-expandable stents- CSIR-NCL in collaboration with a start-up has developed a new class of self-expandable stents based on a novel scroll design. These stents have been made with simple polymer-metal composites unlike the shape memory alloy based stents. The novel design allows these stents to meet the characteristics of shape memory alloy based stents. These stents could be made a much lower costs than the currently available ones.The currently available self-expandable metal stents are priced in the range of 1100 – 2600 USD. These stents are made of shape memory alloys such as nitinol which is a major component of cost. In addition, these stents are fabricated using expensive techniques such as precision cutting using lasers, followed by electropolishing. CSIR-NCL stent designs are based on radically different approach where we neither require expensive materials nor processes to manufacture. Thus the stents developed are expected to be available at lower costs but still possessing the characteristics of self-expanding stents. Apart from filing an Indian Patent application (owned by CSIR) CSIR-NCL has signed a research collaboration agreement and signed an MoU with a Pune based start-up company Embryyo Technologies Pvt. Ltd.(Embryyo), Pune to take this project forward. As 80% of the bio-medical devices (including implants) are being imported, co-developing these products with start-up companies could fulfil the requirements of GOI missions like ‘Swasth Bharat’ and ‘Make in India’.

Industrial Wastewater Treatment for Environmental Pollution Control- A patented hydrodynamic cavitation technology was developed by CSIR-NCL using vortex diode for the removal of refractory pollutants. The technology is effective in the treatment of dye wastewaters for removal of variety of dyes, fertilizer industrial wastewaters and has immense potential for other wastewater treatment applications. It can also be combined with other conventional processes such as anaerobic biological treatment for increased energy recovery, especially useful for Distillery Industry.

Appropriate Technologies of CSIR-NEIST' for the benefit of unemployed youths, women entrepreneurs- Five (5) nos of training programms were organized to demonstrate technologies for production of Low dust Chalk, Banana fibre, Liquid Deodorant Cleaner, Solid Deodorant and wood care formulation for the entrepreneurs of different places of Assam and other NE states. More than 1100 beneficiaries were benefited by the trainings.

Engineering Sciences

Metallic Composite Fire Door- CSIR-CBRI, Roorkee has developed the technology for the manufacture of a ‘Metallic Composite Fire Door’ for up to two-hours fire resistance rating. Uninterrupted spread of fire in buildings is one of the major issues responsible in increasing the quantum of direct and indirect fire losses. Door openings, by necessity breach compartment walls allowing failure of integrity and insulation causing fire to spread uninterrupted. It is therefore essential to restrict spread of fire to achieve the required degree of containment. Failure to do so may cause considerable loss of life and property. A fire door with a specific fire-resistance rating is used as part of a passive fire protection system to reduce the spread of fire from one compartment to other and to enable safe egress from occupancy. The Fire-Resistant Door developed by the Institute meets all the three criteria i.e. stability, integrity and thermal insulation of fire resistance rating as per BS 476 Pt. 20 & 22, IS 3614 Pt 2. It has low thickness and the materials used in the development are indigenously available. The major application of the Technology is in buildings and industries for the confinement of fire and providing fire safe escape routes to the occupants. The Fire-Resistant Door is a powerful societal impact with its usefulness in fire loss minimization in different types of occupancies and in the reduction of the fatal injuries to occupants by providing safe escape routes.

Design & Development of Rural Housing Typologies for Thirteen States - CSIR-CBRI has review of plans submitted by UNDP in terms of architectural and structural validation of drawings and

developed housing designs with appropriate rural technologies and construction techniques by Suggesting alternatives using locally available materials

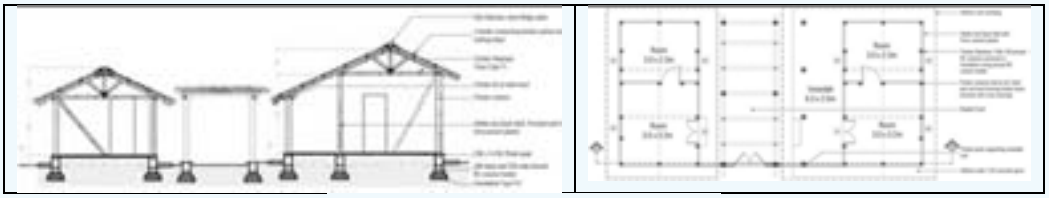


Fig. 5.8 (a)Prototype Zone Chattisgarh

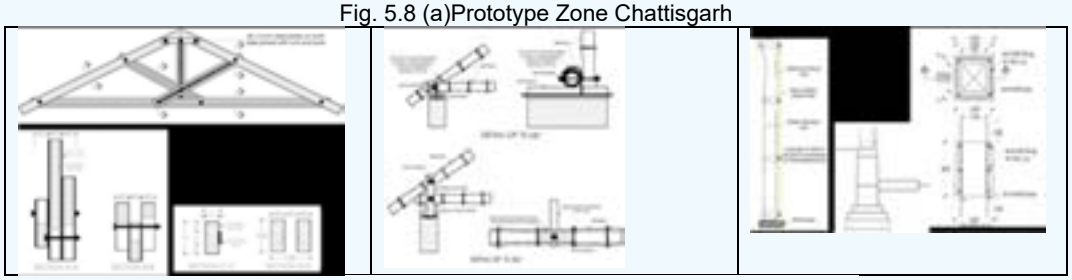


Fig: 5.8(b) Proposed construction techniques and technologies

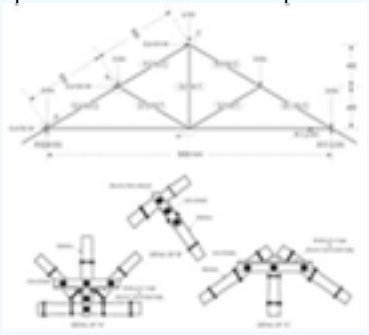


Fig: 5.8(c) Construction techniques and fixing details

Further CSIR-CBRI has carried out design development and details of 09 housing typologies of Chhattisgarh, and 08 housing typologies of Jharkhand. Design development of 11 states in pipeline are: Assam, Bihar, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Odisha, Sikkim, Tripura, Uttar Pradesh and West Bengal.

Dissemination, Training, Demonstration & Improvement of Appropriate Rural Housing Technologies- The ancient constructions in Himalayan regions are the finest examples of the traditional architecture, providing sufficient thermal comfort and earthquake resistant construction under extreme geo-climatic conditions of the region. These indigenous construction practices include the use of locally available materials such as wood, stone etc. The construction technique that has been practiced in the state of Uttarakhand architecture is created with a mesh of interlocking horizontal sleepers and is dressed or raw stones are packed without any mortar. The designs of such houses are best suited for the harsh geo-climatic conditions of the region. The present state of knowledge reveals that usage and construction of such houses are not in practice due to non-availability of timber and modern architecture. However, such kind of houses can be strengthened and preserved by deploying affordable S&T inputs. In this regard, CSIR-CBRI has undertaken the following:

- About 60 traditional architectural styles of rural houses in Uttarakhand have been studied and documented. Subsequently, S&T interventions are being suggested to strengthen and maintain the traditional architecture of rural houses based on the gaps identified.

- About 700 officers/grass root level functionaries of different states have been trained/demonstrated on the innovative rural housing technologies developed by the institute for its implementation at local levels.
- Two days Mass awareness programme on Low Cost Housing and Skill Development for Masons conducted at Mandi, was organized on the request district Administration and read cross society of Mandi in Himachal Pradesh.

Fig: 5.9 Training Programme at Mandi 1

- The training programme at Bharatpur was organized on the request of Lupin Human Welfare and Research Foundation, that has done many developmental, employment generation, income enhancing and health related programmes in the rural areas of the District. As a skill development initiative, the programme was organized in a village in Pahari Tehsil for working masons. The programme was meant to sensitize the masons about good construction practices and train them in the construction of earthquake resistant houses using locally available materials and construction of sanitary latrine in villages.

Fig: 5.10 Training programme at Barthapur

- A two-day Training Programme on Design and Construction of Earthquake Resistant Houses in Kangra region of Himachal Pradesh was organized at Palampur, Kangra, HP, jointly with the HP State Council of Science, Technology and Environment (HPSCST&E).

Removal of Heavy Metals from Water Using Fly Ash & Its Subsequent Use in The Production of Value Added Building Components - Removal of heavy metals from waste water is one of the most challenging environmental problems faced by several researches around the world. Some of these heavy metals are very toxic even in low concentration. Copper, the metal considered in this study by CSIR-CBRI, is widely used in various industrial process such as electroplating, paint, pulp &paper mill, printed circuit board and the fertilizer industry. A recent study showed that too much consumption of copper throughout life may cause Alzheimer's disease. That's why it is very much essential to treat copper containing waste water before it was discharged into the environment. Because of these reason world health organization and Indian standard recommends the maximum permissible concentration of copper in drinking water is 1.5 mg/dm3 (IS 10500: 2012). In present work, fly ash collected from Renu Sagar, Uttar Pradesh has been used as adsorbent for removal of copper ions from contaminated water. Then this adsorbed fly ash can be utilized to developed unconventional building component so that the possibility of leaching can be avoided. In this way the altered sludge can be safely disposed.

Iron and Arsenic removal water treatment- The Iron and Arsenic removal water treatment technology of CSIR-CGCRI based on ceramic membranes has been implemented through Public Health Engineering Dpartment, to supply clean drinkable water in many places of the eastern region including geographically challenging areas of Sunderban and riverine areas. With the help of funding of Govt. of West Bengal, CSIR-CGCRI has been able to install about 10 plants of 8 Qubic Meter/Hour capacity each, near India-Bangladesh frontier.

Wind Solar Hybrid (WiSH) for societal benefit- The renewable energy initiative launched by CSIR-NAL along with its industrial partner M/s Aparna Renewable Energy Systems (ARES) has culminated in installing 1 kW WiSH at science and technology educational institutions in Bangalore.

Fig: 5.11 NALWIN Wind Turbine (1 KW)

Physical Sciences

Backtrack modeling to locate the origin of tar balls deposition along the west coast of India - Tar ball (TB) deposition along the West Coast of India (WCI) is a common phenomenon during the southwest monsoon season, particularly along the coast of Goa and Gujarat, and it is a major concern to the stake holders. Earlier studies by CSIR- NIO has showed that the source oil for the TBs deposited on the Goa coast in August 2010 is the tanker wash, and the source for subsequent TBs deposited on the Gujarat coast during July 2012 and June 2013 and Goa coast in May 2013 is from Bombay High (BH) oil fields. In the present study, the TBs that were deposited during May 2013 and May 2014 on the Goa coast were backtracked through a trajectory model, primarily to simulate their pathways and identify the reason for the occurrence of TBs only in May, and eventually to identify the

origin and the source. The backtracking results re-confirmed that the TBs deposited in 2010 were originated from the tanker routes and that of both 2013 and 2014 TBs from the BH oil fields. The climatology of wind and surface circulation showed that the TBs deposited on the Goa coast during May/June only are from the oil fields and those during August from the tanker route. The residence time (in water) of TBs that deposit (on the coast) in the month of May could be as much as 7 months, and could be around one month if deposit in August, primarily because of winds and hydrodynamic conditions of the Arabian Sea.

Influence of 2015 flood on the distribution and occurrence of microplastic pellets along the Chennai coast, India- The sources, distribution, surface features, polymer composition and age of microplastic pellets (MPPs) in surface sediments along the Chennai coast during March 2015 (pre-Chennai flood) and November 2015 (post-Chennai flood) were characterised by CSIR-NIO using a Stereoscopic microscope and FTIR-ATR spectroscopy. White MPPs were the most abundant, and specifically polyethylene (PE) and polypropylene (PP) were the dominant polymer types of MPPs found on the coast during both the times. The abundance of MPPs in November 2015 was three-fold higher than those found in March 2015, confirming that huge quantity of fresh MPPs washed through Cooum and Adyar rivers from land during the flood. The winds and surface currents during November were the driving forces for the transportation and deposition of MPPs from the sea to beaches. The results of this study by CSIR-NIO will be useful to formulate beach MPPs litter management policies to effectively create long-term solutions.

5.3 Environmental Impact

Biological Sciences

Environment Conservation- CSIR-IHBT supplied important bamboo species such as *Phyllostachys pubescens, Dendrocalamus hamiltonii, Bambusa bambos, B. multiplex, Sasa auricoma etc* to various government and non-government agencies including Directorate of Horticulture, Govt. of Sikkim, State Forest Department of J&K, H.P., Punjab, Haryana, Uttrakhand, Mizoram, M.P., A. P., Manipur, HP Agriculture University, State Department of Science and Technology of West Bengal and Indian Army Cantt of Ferozepur, Palampur and Alhilal, individual farmers and other non-government enterprises to cover more than 100 ha of land.

Protecting the environment through conservation of endangered plot species - Natural populations of Himalayan medicinal plants have dwindled due to continuous extraction and indiscriminate exploitation. As a result, many plants have become endangered and require urgent rehabilitation in natural habitats. Therefore CSIR-IHBT carried out activities to replenish the depleting resources of threatened plants *like Picrorhiza kurroa, Dactylorhiza hatagirea, Trillium govanianum, Fritillaria roylei, Rhodiola imbricata, Arnebia euchroma, A. benthamii, Malaxis acuminata* and endangered *Dendrobium* species in nature through micropropagation.

Assessment of Air Quality to facilitate policy decision - CSIR-IITR has carried out the assessment of Air and noise quality of Lucknow city biannually since 1997 for Respirable Particulate Matter (RSPM or PM10), Fine particles (PM2.5), sulphur dioxide (SO2), oxides of nitrogen (NOx) and trace metals lead (Pb) and nickel (Ni) and noise level at nine representative locations categorized as residential (4), commercial (4) and industrial (1) areas. The data generated through the assessment is being released as a report twice in a year pre-monsoon on 5th June, The World Environment Day and post-monsoon on 4th November, The Annual Day of CSIR-IITR. The reports have been useful to the policy makers like district, state level administration and regulatory agencies. Assessment of air quality are also being conducted before, during and a day after Diwali celebrations and the data reported.

Climate change studies- Long-term climate change monitoring studies were undertaken by CSIR-IHBT in three highest summit point (HSP) in the Indian Himalayan region. The sites were surveyed for lichens, and lichenometry analysis in and around Kabi and Tingda area of north Sikkim was undertaken. Studies on impact of climate change on agriculture and forest ecosystems resulted in several significant leads in terms of identifying potential plant and microbes for bioremediation of arsenic, and organic and non-organic pollutants such as anthracene and total petroleum hydrocarbons.

Biodiesel from fish processing discards/waste oil- India is one of the largest producers of fish in the world. Fish processing operations at fish domestc markets and fish-processing factories generates a large amount of by-products as wastes/discards. Due to lack of proper waste management system, the disposal of this abundant fish processing wastes creates severe environmental and social isues. Volarization of these by-products is an important cleaner production opportunities. CSIR-CFTRI developed a viable process for biofuel (biodiesel) production from fish visceral waste (both fishwater as well as marine). Development of biofuel from fish byproducts approach could minimize the disposal and pollution problems associated with fish industry/fish domestic market waste and also significantly in improve the economy of processing plants due to sustainable applications of fish processing wastes.

Chemical Sciences

Electrochemical Remediation of Industrial Effluents and Recovery of Chromium - An electrochemical reactor based on the principle of electro-dissolution of iron was designed and developed by CSIR-CECRI to reduce and convert carcinogenic hexavalent chromium to relatively benign trivalent chromium. Based on the results, reactor was scaled up to a capacity to treat synthetic 200 ppm Cr6+ 50 L/d under continuous mode.

An electrochemical reactor based on the principle of electrooxidation was designed and developed to remove color and reduce COD of effluents from textile industries. These reactors were scaled up to a treatment capacity of 300 L/d.

Technological solutions to the environmental issues- CSIR-CLRI has undertaken several consultancy projects and provided in-process and end-of-the-pipe technological solutions to the environmental issues. The consultancy services provided to the industry in this regard include Total Dissolved Solids (TDS) reduction through in process control measures, water management, low sulphide unhairing process, establishment of UASB plant, design and installation of bio-methanation plant. CSIR-CLRI has been providing technological services for monitoring, assessing and modernizing common effluent treatment plants (CETP) throughout India. This enabled the leather industry to attain environmental compliance continuously and ensure uninterrupted production activity. Treatment of wastewater discharged from Industrial and domestic sectors with minimum generation of sludge through Immobilized Oxidation Reactors(IOR) and Sequential toxic-anoxic bio reactor (SOABR) technologies. The continuous support of CSIR-CLRI for the Indian Leather sector in pollution reduction through in plant process control measures and end-of-pipe measures have created a significant impact in ensuring the environmental sustainability of the sector.

Converson of waste plastics to fuel and aromatics- CSIR-IIP putting up 1 ton per day capacity plant jointly with GAIL at IIP Dehradun. The novelty of this technology lies in exclusive production of any one of the products viz. gasoline, diesel or aromatics along with simultaneous production of LPG in each case.

Bioremediation of degraded soil- CSIR-NEIST has addressed few of the environmental degradation problems of the regions (North-East India), in particular coal mining and oil degraded environment. Here, the integrated bioremediation technology comprised of using native selected microbes to

degrade, sequester, mineralize and immobotize the contaminants and subsequent plantation. The culmination gives a complete tertiary state of succession.

Engineering Sciences

Waste utilization technologies for local ceramic industries- CSIR-CGCRI outreach centre at Khurja, UP, has taken up an activity to establish a center for development of waste utilization technologies for local ceramic industries. Under this programme different kinds of wastes generated by the local pottery industries shall be converted to usable products, the different hazardous gasses liberated from kilns used during pottery making shall be monitored and a technology to mitigate the same shall be developed to protect the local environment and maintain the regional ecology .

CSIR-NEERI provided a following range of solutions to persistent industrial pollution problems- CSIR-NEERI provided Environmental Impact and Risk Assessment Studies to the Industry for their expansion/new proposals for obtaining environmental clearance from statutory authorities and also carried out the following:

- Recycle and Reuse based waste management solutions for achieving zero discharge norms
- Range of environmental consultancy services for meeting the compliance norms. Third party evaluation on various environmental issues referred by courts/NGT.
- The impacts of climate change and river quality management issues are directly and indireclty related with the surrounding environment. Such studies are very much useful for climate and environmental sustainability.

Physical Sciences

Handheld and pocket size detection system- CSIR-CEERI has developed handheld and pocket size VOC detection system, MEMS based Ammonia Gas Sensor, Arsenic detection system.

Assessment of contaminant migration, seepage and water quality- CSIR-NGRI has carried out assessment of contaminant migration, seepage and water quality using hydrogeological studies and mass transport model in parts of Talangana, Karnataka and Rajasthan states.

OCEAN FINDER program- India has a vast Exclusive Economic Zone (EEZ) representing different types of ecosystems, which range from those in the open ocean or shelf regions to the inter-tidal or sub-tidal ecosystems and estuaries. OCEAN FINDER program of CSIR-NIO deals with living marine resources in the open oceans as well as estuaries and inter-tidal regimes. Highlights of the contributions from this program for the year are:

- Model studies of the processes determining the difference in chlorophyll production between the northern and southern parts of the northeastern Arabian Sea show that poleward advection of slightly fresher water by the West India coastal current leads to lower chlorophyll in the southern part.
- Natural marine biofilms provide signatures of the events that occur over a period of time and can be used as bio indicators of environmental changes. Evaluation of biofilm communities response to warming and acidification point out that cascading effect of the changes can influence build-up of macrofouling community.
- Estuaries are hotspots of anthropogenic activities. Observations from a tropical monsoon influenced estuary (Zuari, Goa) points out that interplay of riverine discharge and tidal amplitude, sediment re-suspension mediated increase in suspended particulate matter significantly regulate bacteria populations, including those associated with the rise in pathogenic *Vibrio spp*. in the changing climatic scenario.

- Characterization of microbial communities using Next Generation Sequencing for the first time points out that even within geographically close habitats, the microbial population structure is significantly influenced by localized interactions. The signatures obtained from sediments can thus be used to reconstruct habitat characteristics and serve as biomarkers.
- Two new species of *Pseudomorphan tanaidaceans, Pagurapseudopsis kochindica* and *Ctenapseudes indiana* were described as new to science.

6.0 Contribution to GOI Mission

6.1 Swasth Bharat

Comprehensive diagnosis of genetic diseases- CSIR-CCMB has developed diagnostic tests for detection of postnatal and prenatal chromosomal abnormalities

Centchroman and oral non steroidal contraceptive in the National Family Planning Program: Ministry of Health & Family Welfare, Government of India introduced Centchroman and oral non steroidal contraceptive developed by CSIR-CDRI as a recommended Contraceptive agent on 5 April 2016 during National Summit on Family Planning Programme and Included it in the National Family Planning Program. Now Government is providing it free of cost to the women all over India under the rechristened brand name '**Chhaya'**.

Pipeline of Candidate Drugs / Leads under Advanced Stages of Development for various disease conditions few of these are as below:-For Diabetes & Dyslipidemia, Candidate drug-CDR134D123 (Anti-hyperglycemic): Phase I Clinical trials completed. Awaiting clearance from DGCCRAS New Expert committee for inclusion of the plant in the Extra Ayurvedic Pharmacopia to avail marketing permission in herbal mode.

For Malaria, Candidate drug- 97-78 (Antimalarial): Phase-I Multiple dose Clinical Trial studies along with Human PK studies to be conducted at PGIMER, Chandigarh. Human Pharmacokinetic studies are to be carried out at CSIR-CDRI on the samples collected at PGIMER.Multiple dose studies are planned to be conducted at the Centre in Chandigarh'. Permission from DCGI received on 17 March 2017

For Osteoporosis, Candidate drug- 99-373 (Anti-osteoporotic): Phase-I single and Multiple dose Clinical Trial studies are planned to be conducted at KEM Hospital Mumbai. Permission from DCGI received on 14 March 2017. Human Pharmacokinetic studies are to be carried out at CDRI.

For Osteoporosis, Candidate drug-CDR2492C003(Osteoprotective): Licenced to Pharmanza Herbals Pvt Ltd, Gujarat on after establishing preclinical efficacy for osteoarthritis. Neutraceutical launch expected by end of the year. For Osteoporosis, Candidate drug- CDRI219/C002-F(Osteoprotective): Licencing negotiation on with interested industries

Leads under Pre-clinical studies are: For Malaria, Candidate Drug-S011-1793 (Antimalarial); For Osteoporosis, Candidate Drug-CDR914K058 (Osteogenic); For Osteoporosis Candidate Drug- S007-1500 (Rapid fracture healing); For Thrombosis, Candidate Drug-S002-333 (Antithrombotic): and For Diabetes & Dyslipidemia, Candidate Drug-CDR267F018 (Antidyslipidemic).

The compound NCL-240 was identified by CSIR-NCL as a second generation PITENIN class of anti-cancer lead and examined its pharmacological properties.

More than 70 analogues of hunanamycin were prepared by CSIR-NCL towards lead optimization and all of them are protected in the form of patents (WO 2015/004687 A2; US 20160152616 A1; EP 3019498 A2). NDS-100548 as potential lead compound with 8-fold improved potency with respect to

the natural product (MIC: 1 µg/mL) was identified. Interestingly, NDS-100548 works through riboflavin synthase inhibition which is an attractive antibiotic target as humans lack this enzyme.

OR-NCL-CVR-34 (anti-Parkinsonian effect): In the high throughput screening assays for assessing anti-Parkinsonian effects the compounds OR-NCL-CVR 34 and 35 were found to protect dopaminergic cells from 6-Hydroxydopamine induced cell death at 10 mM concentration. The above compounds were found to exhibit a dose and time dependent protection in both 6-hydroxydopamine and MPP^+ (both are known compounds that induced Parkinson's symptoms in mice) induced dopaminergic cell death in vitro. OR-NCL-CVR-34 displayed good anti-Parkinson's activity in both *in vitro* cell based assays as well as *in vivo* animal model studies.

A novel polyhedral formulation based on Ayurvedic therapeutic strategy- CSIR-CIMAP has developed a polyhedral formulation based on Ayurvedic therapeutic strategy which is effective in cough of shorter duration and allergic origin with no side effects. The syrup balances the Kaphaj-Vataj-dosha, reduces the frequency and severity of cough, sputum quantity and suppresses the symptoms associated with allergic cough.

Antineoplastic enzyme- CSIR-IHBT has identified an antineoplastic enzymes, asparaginase from a bacterial source having a very low glutaminase activity.

Ready To Eat Food - CSIR-IHBT has viewing demand for safe "ready-to-eat" foods developed. A canning technology for the production of "ready-to-eat", preservatives and chemicals-free-foods having a shelf life of seven months. The canned products retained its taste or fl can even after seven months of preservation. The technology was transferred to M/s Sai Foods at Baijnath, H.P. for commercial production.

Crispy Fruits- CSIR-IHBT has developed 'Crispy Fruits' that retain original colour, texture, taste as well as aroma with added advantage of prolonged shelf-life. Being a healthy product, 'Crispy Fruits' can serve as a healthy substitute for unhealthy snacks, currently prevailing in the market.

Production of DHA- CSIR-IIIM has developed Microbial fermentation process for the production of DHA (docosahexaenoic acid) DHA. Docosahexaenoic acid is an omega-3 fatty acid known to have beneficial nutrient properties including development of brain function in infants. It forms as an essential component of infant food formulations.

Low arsenic rice variety- CSIR-NBRI has developed a Low arsenic rice variety -CN 1794-2 (Muktashree), which is a milestone contribution towards the Mission Swasth Bharat

S&T Interventions to combat malnutrition in women and children- a basket of food products developed by CSIR-CFTRI, including the *Spirulina* fortified Nutra Chikki, was supplied to the identified Anganwadis of Nanjangud Taluk, Mysore District. Around 230 children of 12 Anganwadis in Three villages were convered. The six months feeding programme clearly indicated encouraging outcome of nutritional intervention in terms of combating malnutrition, reflected by enhanced levels of hemoglobin, serum retinol and ferritin. Further anthropometric data (reflected in terms of BMI) of children covered under feeding intervention programme was higher, when compared with control group of children.

Foot Care solutions- CSIR-CLRI has developed Foot Care solutions for the obese, those with flat feet, ankle foot orthosis and diabetic patients and the Foot Care for the diabetic available in the market as Diastep through which 15,000 people impacted. Ulceration avoided in ~5000 patients; amputation % dropped from 29 to 17% Wound/burn dressing materials/sutures - Collagen based biomaterials for wound dressing

Flat Sheet Ultra-Filtration and Thin Film Composite (TFC)- CSIR-CSMCRI has developed Flat Sheet Ultra-Filtration and Thin Film Composite (TFC) Reverse Osmosis membranes and spiral module making technology. Ultrafiltration membranes are useful for water purification and disinfection by removing suspended particles, bacteria and virus. TFC-RO membranes are used for brackish and sea water desalination to produce potable water. The deployment of mobile RO van in water parched and drought affected Latur District (Marathwada region) for supply of RO water.

Solar powered electrodialysis- CSIR-CSMCRI has installed a solar powered electrodialysis plant for providing drinking water in Hatab village near Bhavnagar. The ED unit size is 40 cm X 80 cm and uses 95 pieces of each type of polyethylene interpolymer based CEM and AEM of capacity (400 l/hr). It is operated from 8:00 am to 6:00 pm to provide the drinking water to around 100 houses in the village.

Pharma grade triglycerides- CSIR-IICT has developed process for the preparation of pharma grade triglycerides from common edible oils, sunflower, soybean, palm, mustard and rice bran oils employing adsorption chromatographic techniques.

Validation of 'Thailamurcchanam' in Ayurveda - CSIR-NIIST has scientifically validated a process in classical Ayurveda "Thailamurcchanam" for M/s Arshaveda wellness Pvt Ltd, Aluva,which is a preprocessing technique adopted for raw fats & oils used in classical medicated oil manufacture. The different samples provided by the industry were investigated through chemical finger printing, shelf life / stability, antioxidant properties. The comparative evaluation of the samples is applied to validate the process in terms of solvency efficacy, enhancement in polyphenol/ flavonoid content, better antioxidant properties etc.

Devices and analysers- CSIR-CEERI has developed (i) Plasma-based Mercury Free VUV/UV source for water disinfection (ii) Acoustic Milk Analyser (iii) Infrared Milk Fat Analyser, Rapid Milk Analyser (iv) Arsenometer for measuring Arenic levels in drinking water and (iv) Handheld water quality monitoring system for water quality assessment.

6.2 Swachh Bharat

Technology for reuse of the offered flowers- CSIR-CIMAP has developed technology for reuse of the offered flowers in the temples for making incense sticks. In this mission, total 4 training cum-demonstration programmes were organised in different places i.e. Lucknow and Hardoi and 184 women participants were trained. These programmes were organised in CSIR-CIMAP's Woman Entrepreneurial Training Facility (WETF) which is established at Chandrika Devi Temple at Bakshi Ka Talab, Lucknow.

Fig: 6.1 Street vending cart

Design and development of eco-friendly street vending cart- Energy-efficient solar-powered modular street vending cart was launched by CSIR-CFTRI with the idea of giving strength to the "Swachh Bharat Mission," to ensure enhanced hygiene in the street food arena with quality mobile infrastructure, which can be adopted pan-India for street food vending and preparation. In an effort to empower street food vendors to deliver hygienic food, the premier institute has developed 'SmartCart', an energy-efficient solar-powered modular street vending cart. The developers claim that the four-ft wide and six-ft long cart makes it easier to cook, hold and serve the food.

Feasibility studies on removal of nutrients and organic pollution load from pulp and paper mill effluent by microalgae in open outdoor ponds- A mixed culture of microalgae, *Scenedesmus* species, was analysed by CSIR-CFTRI to determine its potential in coupling of pulp and paper mill effluent treatment and microalgal cultivation. The studies suggested that 60% wastewater was optimum for microalgal cultivation in open outdoor ponds leading to 82% and 75% removal of BOD and COD respectively. A 65% removal of NO3-N and 71.29% removal of PO4-P was observed. The results suggest that pulp and paper mill effluent could be used effectively for concomitant removal of nutrient load from pulp and paper mill effluent and production of microalgal biomass for value added applications.

Technologies for treatment of solid & liquid wastes of leather industry and value generation - CSIR-CLRI has developed electro-oxidation(EO) based Zero waste water discharge-Treatment of waste streams through electro-oxidation and appropriate reuse of treated waste streams; Immobilized Oxidation Reactors (IOR) for Wastewater Treatment - Treatment of wastewater discharged from Industrial and domestic sectors with minimum generation of sludge; Utilization of solid waste generated from Tanning Industry - Preparation of compost from animal hair waste, Activated carbon for preparation of soles from fleshings waste, Preparation of gelatin from raw trimmings waste, codigestion of solid wastes for biogas generation, Leather thread and fabric from solid wastes, Preparation of leather auxiliaries from protein and keratin based wastes of leather processing industry.

Process for recovery of Potash from alcohol distillery spent wash- CSIR-CSMCRI has developed and demonstrated a process for recovery of Potash from alcohol distillery spent wash with simultaneous environmental mitigation of effluent – organic removal through pre-treatment facilitates compliance with environmental regulations (ZLD) and can potentially generate 0.5 mn t potash across the distillery sector. Process was demonstrated at M/s Kamrej Sugar Mills at validation level of 2.5 kL/batch scale with engineering assistance from M/s Chem Process Systems, Ahmedabad.

The Dyer's Association of Tirupur has 8 CETP's wherein treatment of 150 MLD per day of effluent waste takes place. The solar evaporation of effluent generates solid waste which is a mixture of sodium sulphate and sodium chloride. CSIR-CSMCRI has developed a process for separation of sodium chloride and sodium sulfate from this waste. Both the salts recovered have significant commercial value and reduce environmental load.

Novel materials for oxycombustion of coal and CO2 reforming of methane - Novel materials were developed at CSIR-NCL for use in the area of CO2 utilization and value addition and more particularly, in the areas of oxycombustion and CO2 dry reforming. It deals with enrichment of O2 in coal combustion by separating it from N2 in air feed at high temperatures. This process utilizes waste CO2 from flue gas for production of syngas which is a platform for many downstream chemicals.

Industrial wastewater treatment - A hydrodynamic cavitation technology was developed by CSIR-NCL using vortex diode for the removal of refractory pollutants. The technology is effective in the treatment of dye wastewaters for removal of variety of dyes, fertilizer industrial wastewaters and has immense potential for other wastewater treatment applications. It can also be combined with other conventional processes such as anaerobic biological treatment for increased energy recovery, especially useful for Distillery Industry.

Bioprocess for Treating Perchlorate (Rocket Fuel) - Perchlorate (Rocket fuel) is a persistent, endocrine disrupting pollutant known to cause thyroid dysfunction in human. In the recent past high level ground water contamination of perchlorate and associated high incidence of hypothyroidism was reported in Kerala. Therefore, it is very important to control the environment release of perchlorate especially from places where it is handled in bulk. CSIR-NIIST is the pioneer in environmental

monitoring and remediation of perchlorate in India, has developed a bioprocess to detoxify perchlorate contaminated water as well as soil to ensure public health and to protect environment.

The Bioprocess is eco-friendly and economic, where it uses a specific microbial system capable of converting perchlorate into non-toxic chloride and oxygen. The process was tested successfully in a pilot scale unit for treating both water as well as soil. The removal efficiency was almost 100% without any secondary treatment. Being anaerobic, it requires less energy input and no secondary treatment.

The bioprocess was demonstrated in a pilot scale unit (150 lit capacity) capable of treating 720 lit contaminated water in a day. Similarly, demonstration of contaminated soil treatment was done at 750 kg level per batch. In soil treatment, perchlorate in contaminated soil will be completely extracted in water and the water will be treated in the bioreactor (regenerated) for cleaning subsequent soil lots. This approach cleans up soil much faster, compared with more time consuming composting or in-situ remediation approaches practiced in other countries.

The major beneficiaries of CSIR-NIIST bioprocess will be agencies (like VSSC) or industries (cracker) that either produce or consume perchlorate in bulk. Perchlorate in contaminated soil or wash water (except high strength brine) can be directly treated with this process in short a period of time.

Design improvement & performance evaluation of CSIR-NIIST food waste digester cum biogas plant for field installation - The compact kitchen waste digester cum biogas plant was one of the major developments under CSIR-800 activity in CSIR-NIIST. Design improvement and performance evaluation of the scale-up version of the digester for treating large quantity of organic waste was one of the activities during 2016-17 period. A demonstration scale modified unit was established in CSIR-NIIST and it was continuously operated for nearly 8 months. Compared with the previous model, the revised design was more mechanical with automatic control system for more efficient biogas production and its utilization. The 40 Kg food waste/day unit was generating around 7 M3 biogas daily (average biogas was 160-180 L/Kg food waste, methane content >60%). The total solid loading into the digester was around 4.6 Kg/M3.day. Installation of Food waste digester in government schools has been carried out.

To contribute to the Swachha Bharat mission and to attain the Millennium Development Goal sustainable development (MDG 7), field installation of the newly developed food waste digester cum biogas plants was done during 2016-17 period. The compact food waste digester developed by CSIR-NIISTwas installed in two government schools to provide a sustainable solution for the problem. The first installation was done in Dec 2016 at Govt. LP school in Poojapura, whereas the second installation was done in February 2017 at Govt. UP school Thycaud. The major beneficiaries of the digester installation in the school are the students who are mainly from poor economic background. Installation of the food waste treatment units helped the school authorities to maintain a cleaner and odour free environment for the students.

Analyses and Harnessing of Marine Biodiversity for Bioremediation - CSIR-NIO has screened many marine bacteria, fungi and microalgae for bioactivity potency for pollutant degradation and detoxification during 2012-2017 under the project “Analyses and Harnessing of Marine Biodiversity for Bioremediation of Aquaculture and Other Industrial Effluents (PSC0206)”. The most promising marine strain *Shewanella soehensis* (deposited in CSIR-IMTECH with an accession no.MTCC #25079] capable of decolorizing at 5g l^{-1} concentrations of most hazardous textile azo dyes (reactive black (RB) and reactive green (RG) both individually and in combination; and 14 other marine bacterial strains decolorizing one or two of these dyes individually. A set of six marine microalgae and five uniquely marine bacterial strains capable of tannery wastewater detoxification by substantially reducing the loads of BOD, COD, Cr (VI) etc; Bioremediation efficiency superior by our microalgae consortium than individual algal efficiency. One of the strain *Chlorella vulgaris* is very

promising in bioremediating 50% diluted Kanpur effluent and the microalgae remediated effluent were non-toxic to *Artemia* cyst hatching and nauplii survival. Marine microalgal strains brought down the BOD, COD, NO_3, PO_4 and many other hazardous pollutants to safe discharge limits from some of the most hazardous, mixed industrial effluents.

6.3 Sashakt Bharat

Activities for Empowering farmers-

- CSIR-CCMB has distributed of seeds of ISM rice variety to farmers in the states of Andhra Pradesh, Telangana, Karnataka, Chhattisgarh and Tamil Nadu to help the farmers grow rice crop that is resistant to bacterial blight (BB) disease and thus, evade losses due to the onslaught of BB disease.
- CSIR-CCMB also distributed Apple grafts to local tribals/ farmers in a few villages of Andhra Pradesh, Telangana and Odissa, to encourage apple cultivation in these areas and thus help in improving their socioeconomic status.
- CSIR-CIMAP conducted 35 awareness/training-cum-programmes at different parts of the country to educate farmers and entrepreneurs for production and primary processing technology of economically important medicinal and aromatic plants for income enhancement besides utilization of underutilized and marginal land. From these programmes, more than 3072 participants got benefitted in different parts of the country.
- CSIR-IHBT has developed new varieties of ornamentals: Rural empowerment through promotion of floriculture was one of the major achievements of the year and two new cultivars, 'Him Sumukh' and 'Him Shweta' of calla lily *(Zantedeschia aethiopica)* and five new cultivars 'Him Saumya, Him Gaurav, Him Aabha, Him Apoorva and Him Keerti' of gerbera *(Gerbera jamesonii)* were developed. The cultivars were released by the Hon'ble Prime Minister of India and President of CSIR, Shri Narendra Damodardas Modi on the occasion of 75th Foundation Day of CSIR 2016.
- **Human Resource for Drug discovery and research-**CSIR-CDRI has contributed to Shashakt Bharat through shaping the Human Resource for Drug discovery and research. Total 101 PhD students completed their degree and, a total of 121 Post-graduate students from 48 Colleges/Universities and their affiliated colleges from all over the country were selected on merit basis and were imparted training in various disciplines of drugs and pharmaceutical research for 4-10 months duration.
- **Sustainable way to enhance agricultural yield with low carbon footprint-** CSIR-CSMCRI has developed a sustainable way to enhance agricultural yield with low carbon footprint-seaweed based bio-stimulants: The Kappaphycus seaweed based technology for production of LSF (or bio-stimulant) leads to enhanced agricultural productivity of several crops (by 13 to 37%) and provides self-reliance/enhanced livelihood security of costal fisher communities. Further, the use of this bio stimulant has the potential to reduce consumption of chemical fertilizers by up to 25% (validated by Indian Sugarcane Research Institute, Lucknow).
- **Development of technology for simultaneous production of U.S Grade Gasoline-** CSIR-IIP-RIL developed technology for simultaneous production of U.S Grade Gasoline and High Purity Benzene from C6 Heart Cut of FCC Gasoline
- **NEERDHUR for rural india-** CSIR-NEERI has designed and developed improved Cookstove NEERDHUR for rural india. The Environmental impact and sustainability studies involving industries mobilizes the developmental programmes and developed the Rapid Composting

technology which is useful for development of rural entreprenureship thereby improving rural and urban emplyments status.

6.4 Make in India

A step towards making self-sustainable to unemployed and poor- CSIR-CIMAP organised 4 training courses during the year benefitting 184 women for making incense sticks using discarded or used flowers for self-employment activity. Based on the feedback received after training, it is estimated that about 30% women who took part in these trainings have started making of incense sticks and selling in the local market.

Efficient and stable cellulolytic enzyme from high altitude bacteria of trans-Himalayan region - Cellulolytic enzymes have been the area of interest for researchers worldwide, owing to its applications in diverse industries such as pulp & paper, textiles, food industry, pharmaceuticals and fermentation industry etc. Although, fungal cellulases have been in the market for over 30 years; but, they have limitations to address underlying intricacy like low stability, low efficiency and costly downstream processing. Cellulolytic enzymes of bacterial origin from high altitude regions have potential to overcome these bottlenecks. CSIR-IHBT has discovered a catalytically efficient cellulase of bacterial origin from high altitude regions of Indian-Trans Himalayas. The extracellular enzyme is produced by bacterial fermentation using low cost carbon sources. The enzyme has broad pH and temperature stability, which is desirable and compatible with chemical pretreatment processes of cellulosic biomass valorization.

MO-Check strip-A handy, quick, easy and affordable spot adulteration test paper strip (MO Check) coated with chemicals has been developed by CSIR-IITR to monitor the adulteration of mustard oil with Butter Yellow with detection limit of 0.001% (10 ppm).

MTCC is also contributing the savings of foreign exchange- MTCC is the Certified Reference Microbial (CRM) cultures provider of the Indian Pharmacopeia commission. CRM's are needed for for various testing purposes in industry. Most of the industries earlier used to procure the CRM's from other culture collections centres abroad. By providing the CRM's to industry, MTCC is also contributing the savings of foreign exchange.

Amla grating machine developed by CSIR-CFTRI- Amla is an extensively used herb in making ayurvedic medicines and many other products such as juice, candy, dried or raw form. During processing of raw Amla fruit, the seeds need to be removed for proper conversion into either juice or to powder. There are no methods available for separation of seed and hand removal takes much time and at the same time consumes much manpower, and the techniques available are not sufficient to get desired end point material. A hand operated grating cum seed separation machine has been developed which is useful for grating of Amla and removing Amla seeds. It will help the tribal/rural communities and also for small-scale industries for value addition of the forest produce.Preparation of design drawings has been completed and has been sub contracted for manufacture.

Fig: 6.2 Amla grating machine

Design and Development of Continuous Ragi Mudde Making Machine and Ball Making Unit- Ragi Mudde making machine was conceptualized and materialized by CSIR-CFTRI. Unique features of the Machine include:

- It is fully automated Machine
- It is steam cooked inside the machine.
- It is untouched by human elements. Ragi flour and water is added to the machine, ragi balls come out as continuous discharge with consistent shape and weight.
- It can discharge 200 to 250mudde/ hr. (200gm each ball weight).
- This machine is very useful in big restaurants, hostels, industrial canteens, defence canteens, jails, airport restaurants etc. Ingredients required are ragi flour and water. Steam quality and other working parameters of the machine is maintained within the range by the control system of the machine. Unit is easy to clean and has provision for CIP (Clean in position) ensuring quality and hygiene.

Fig:6.3 Ragi Mudde Making Machine and Ball Making Unit

- **Leather Goods-** Leather goods from ray fish, emu skin & in combination with NE based natural fibres has been developed by CSIR-CLRI.
- **State-of- art Li-ion pouch cell / 18650 cylindrical cell fabrication facility-** CSIR-CECRI has installed State-of- art Li-ion pouch cell / 18650 cylindrical cell fabrication facility in Chennai. New anode material for lithium ion cell achieved ~ 700 mAh/g. Demonstrated 3.6 V / 650 mAh Li-ion cells for Solar Lanterns and hats successfully.Energy density of ~ 42 wh / kg has been achieved in a 6 V / 5 Ah fabricated lead acid battery
- **Production of potash from mixed salt in Little Runn of Kutch-** (potash is an extremely important fertilizer presently all of which is imported). CSIR- CSMCRI is presently helping National Fertilizers Limited (NFL) to set up a 8000 TPA Muriate of Potash (MOP) production plant

Ecofriendly, high yielding furfural synthesis from biomass derived sugars- Synthesis of furfural, 5-hdyroxymethylfurfural (HMF) from components of agricultural waste derived sugars would help mitigate crop burning problems and also India be self-sufficient in making chemicals from locally available resource. The patented and published work by CSIR-NCL on careful selection of homogeneous/heterogeneous catalysts for the synthesis of HMF from glucose via fructose formation has attracted industry interest. HMF, can be further processed to make polymers, fuels, and other industrially important chemicals. The HMF yield of up to 70% has been obtained with concentrated substrate solutions as per the Industry needs using recyclable catalysts.

AutoCAST X1- FLOW+Software Technology:The Story continues- Virtual Casting is a software package for the simulation of the solidification process of industrial castings and was developed by CSIR-NIIST. In 2011, the Virtual Casting Solver Technology was transferred to 3D Foundry Tech Pvt. Ltd. (3DFT), a company incubated in the Indian Institute of Technology Bombay and in 2012-13, it was integrated into Auto CAST an easy-to-use software package for casting method design, solid modeling, and simulation under the name Auto CAST X1-FLOW+. From 2013-17, Auto CAST X1-FLOW+ has been showcased at five Indian Foundry Exhibitions. During 2016-17, 24 new customers were added, taking the total number of licenses transferred to individual foundries, foundry clusters and educational institutions to more than 150. A new MoU has been signed during January 2017, for rendering technical support to the private industry 3D Foundry Tech Pvt. Ltd., Mumbai for a period of five years starting from April 2017 This collaboration between a CSIR Laboratory, IIT and industry has led to one of the most commercially successful 'Made in India' engineering software products.

6.5 Namami Gange

CSIR-IITR participation in National Mission for Clean Ganga (NMCG project with CSIR-NEERI)- CSIR-IITR's role is to monitor Ganga river water quality in terms of physicochemical parameters, poly aromatic hydrocarbons, pesticides, and metals at 7 locations from Bijnor to Mirzapur of Uttar Pradesh, India.

Documentation of the plant and lichen diversity of river Ganga- CSIR-NBRI documented the plant and lichen diversity (algae to angiosperms) along selected flood zone areas of River Ganga around Haridwar and Bhimgoda.

The microbial communities present in the river water and sediments are extraordinarily diverse and complex modulated by a variety of factors that affect the local environment, therefore in order to study such an ecosystem, along with traditional culture based approach, we also applied metagenomics and sequenced the community DNA from the sites including Bijnor, Narora, Kannauj, Kanpur, Allahabad, Triveni Sangam, Mirzapur and Varanasi targeting the V3-V4 region 16S rRNA gene. The study revealed significant bacterial diversity of the water and sediment samples collected from the river Ganges.

6.6 Startup India

- **CCMB-iHUB -**CSIR-CCMB has entered MoUs with 9 start ups/ organizations who can avail state-of-the-art infrastructural facilities in the CCMB-iHUB and seek scientific advice from the CSIR-CCMB scientists.
- **CSIR-IHBT technology support to industry-** CSIR-IHBT transferred technology to M/s. Himalayan Natural and Herbals Products, Palampur for Processing of dry stevia leaves and its value added products. The institute also transferred know how to M/s Dexter Retail distribution Pvt. Ltd., New Delhi for seeking ready to eat persuing free khichri product.

- **Centre for Innovation and Translational Research (CITAR)-** CITAR set up at CSIR-IITR provides an ecosystem to researchers, innovators and entrepreneurs from academia and industry as well as access to state of the art platform technologies and mentorship in a multidisciplinary collaborative environment.
- **CSIR-CLRI technology support & start-up company-** Dry Tanning (Dispersing Agent) -Multiple benefits relating to in-process abatement of effluent problem, curtailing process steps, huge water conservation, time economy and cost saving - licensed to a start-up company, N S Eco solution Private Limited, a joint venture by Naser Group and Saba Group.
- **Providing Post training intervention for initial financial assistance and business link-up for the weaving activities-** As a part of the post training intervention by CSIR-NEIST the trained weavers were provided with the financial linkages through a NABARD (National Bank for Agriculture and Rural Development) scheme, where JLGS (Joints Liability Groups) are framed by completing all the legal formalities and loans are provided to the JLGS. Out of the 55 weavers trained, 35 weavers willing to avail the bank loan facility to improve their production and accordingly 7 JLGS are formed. In the month of March, 2017 each JLG is producing approximately 300 nos of "Gamuchas" and selling price to the dealers is Rs. 150.00 per Gamucha. The total sales value in a month by all the group is Rs. 315000.00 (Rupees three lakhs and fifteen thousand). A brand has been launched in the registered name of "Mohura" and presently all the products are produced under this brand name and sales in the local market.
- **CSIR-NML Technology Business Innovation Centre –** The Technology Business Innovation Centre at CSIR-NML has been registered under Section 8 of the Companies Act, 2013 to promote entrepreneurship, startups and new ventures by way of mentoring, translating innovative knowledge, training and providing other value-added services that necessary needed to nurture and develop a complete innovation ecosystem for incubation related activities. The centre supports the initiation of high-tech industry and nurture innovative research by supporting novice entrepreneurs at the earliest stages of technological entrepreneurship in the areas of Minerals, Metals and Materials and encourage new science based industries.

6.7 Skill India

- CSIR contributes significantly towards development of Skilled Human Resources. A glimpse of few skill development activities is as follows:
  - CSIR-CCMB carried out skilling courses in the areas of Cell Biology, Wildlife Forensics and Bioinformatics; Research Methodologies for Medical Students. As part of the CSIR-KV Sangathan Jigyasa: Scientist Student Science Connect Programme, efforts were made to invite school children to visit the lab and interact with the scientists.
  - CSIR-CDRI initiated various certificate courses (Basic/ Advanced) in Skill Development as a part of CSIR Integrated Skill Initiative under the aegis of Skill India, Government of India Program. These Certificate courses are in the areas of : Advanced Spectroscopic (NMR, MASS, UV/IR) techniques; Microscopy (Electron Microscopy, Confocal and Intra vital Microscopy) and Flow Cytometry ; Regulatory Safety studies and Animal experimentation; and Skill Development in Computational Approaches to Drug Design & Development.
  - CSIR-CIMAP organised 04 Skill-cum-Technology Up-gradation Programmes on "Cultivation and Primary Processing of economically Important Medicinal and Aromatic Plants" during the year 2016-17 at different locations of the country. Two Programmes were organised at CSIR-CIMAP, Lucknow, one at CSIR-NEERI, Nagpur and one at CSIR-IGIB, New Delhi. In these programmes, 328 farmers/entrepreneurs participated from different parts of the country.

- MTCC regularly organizes training courses as part of its skill development initiatives. “Microbial systematics and preservation” 20th to 25th March 2017.
- CSIR-CFTRI conducts a 10 month course on Flour Milling at its International School of Milling Technology (ISMT). This year 24 persons received the certificate in Milling Technology after completion of this course.This school is one of its kind in the world and the course attracts many students from India and abroad every session. CSIR-CFTRI takes pride in saying that most of the mills in India and some countries abroad are run by the alumni of this school.
- CSIR-CFTRI conducted around 30 regular training programmes including the custom made programs every year, encompassing all the major areas in Food Science and Technology. These courses are of short duration, but intensive and packed with lectures and demonstrations. These courses are handled by faculty members having vast experience in specific areas of Food Science and Technology. The demonstrations and practical classes were conducted as part of the training programme.
- Realizing the importance of linking economic development with the human resource and the Indian youth, CSIR-IITR conducted Skill Development programmes related to environment, regulatory toxicology and computational biology where skill development is either inadequate or almost lacking. The objectives of these programmes are to skill the youths in such a way that they get employment.
- CSIR-NBRI imparted training to various stakeholders on different subjects, including taxonomy, gardening, floriculture, agro-techniques, bio-fertilizers, dehydration of flowers and floral crafts, betelvine cultivation, and cultivation of medicinal and aromatic plants.
- CSIR-CLRI in association with National Scheduled Castes Finance and Development Corporation (NSFDC), Delhi has organized skill training programmes in different leather trades pan India for candidates belonging to Scheduled Castes whose annual income does not exceed the double poverty line limit. Apart from arranging for placement, small start-ups through formation of self-help groups have been enabled where the trained candidates take up job work and manufacture of small leather goods.
- CSIR-CSMCRI has provided Hands-on training in the area of agarophyte cultivation technology to around 1000 coastal, fisher community people in Ramanthapuram District of Tamil Nadu. Farmer Training programmes were organized for Salicornia cultivation at different coastal locations in Gujarat and the total number of beneficieries was 125.
- Extensive HRD activities undertaken by CSIR-CSMCRI- With the aim to create scientific temperament in the young minds short term exposure visits were organized for 741 students and 35 teachers (from 12 schools and engineering & pharmacy colleges). More than 350 students from various schools and colleges participated in the Vigyan Darshan exhibition organised during Bhavnagar IISF, held in November 2016 and actively interacted with the scientists to get a feel of the research being done in the laboratory.
- CSIR-CECRI organized 6 Industry Oriented Technology Courses in Cathodic protection and pipeline corrosion; Paints for corrosion protection; Electrochemical Power Sources - Lead Acid Battery; Electrochemical Power Sources - Li-ion Battery; Electroplating and anodizing - principles and practices; Surface coatings by PVD / CVD and surface analysis; The courses are structured in such a way that they include theory and hands on experiments / demo each lasting 5 days. 88 participants from various organizations attended the courses during 2016-17.

- CSIR-CECRI also organized the following tailor made programmes as per the needs of industries; Lead Acid Battery for Hella India Automotive Pvt. Ltd., Pune; Electroplating and anodizing for Maruthi Suzuki, Gurgaon; Paints and coatings for corrosion protection for Skill updating institute for industrial training (SUIIT), Trivandram, Kerala.
- CSIR-IIP has conducted Skill Development Training Programmes:- Hands on Glass Blowing; Refrigeration & Air Conditioning; Analytical Chemistry - Tools & Instrumentations.
- The technology for high-purity solar salt production has been disseminated by CSIR-CSMCRI amongst to 500 salt manufacturers in LRK region, Gujarat; 155 in Maliya region, 150 in Rajula in Amreli Dist. & Santalpur in Patan Dist., 50 in Adesar region, Kutch Dist. and several small scale salt manufacturers of Didwana, Rajasthan. This has been undertaken under cluster development programs.
- CSIR-CSMCRI conducted 8 farmer training programs in different places within Gujarat wherein the farmers living in coastal areas (with prevalent saline lands) were trained on the cultivation and economic benefits of *Salicornia brachiate*. About 195 farmers attended the trainings.
- CSIR-IICTorganized a three-day refresher course on “Processing and Analytical Methodologies of Oils & Fats”. The uniqueness of the course is that it is designed for the skill development of the representatives of industries, R & D institutions and academia with both theoretical discussions and practical demonstrations and 34 participants attended this refresher course.
- CSIR-IICT had conducted the first certificate course on “Process Plant Drafting using AutoCAD”, which is a one month duration program as part of the Skill Development activity. The program focusses mainly for mechanical/chemical engineering graduate students who are in their final year of study or have just passed out.
- CSIR-IICT has trained 200 tasar farmers on various activities of silkworm rearing, disease & pest management at Chinnor area of Adilabad district of Telangana through workshop, demonstration at the field and Krishi Mela. These farmers got averagely Rs.11,000/- each additional income during 2016-17.
- The skill development training program on basic welding was provided by CSIR-NEIST in two batches and at two rural places of Jorhat district, namely Baghchung and Borbamchungi. A total of 51 numbers of rural women weaver were traine. The institute also conducted training program on basic plumbing practices. Training was provided in two batches and at two rural places of Jorhat district, namely Silikhabari and Borbamchungi.
- CSIR-NISCAIR trained more than 200 participants through its training programmes on Library Automation & Networking, Patent Drafting, Open Publishing, Data Analysis, Intellectual Property Management, Content Management, Science Communication.
- CSIR-NGRI has conducted customized training programs on Geochemical Analysis (44 Research Scholars from various universities and 29 scientific officials from Geological Survey of India) Imparting lectures by scientists under INSPIRE program and other academic programs. Outreach activity on awareness about earthquakes (About 1 Lakh school students in India). 19 participants working in the area of “pollution monitoring and control” in CPCB and SPCBs were provided hands on training on "Sophisticated Instruments and GC/GC-MS Operation".

- Fisheries are a sunrise sector with varied resources and potential, engaging over 14.50 million people at the primary level and many more along the value chain. The development of human resources, both in quality and quantity, is pivotal to sustaining the aquaculture industry in the new millennium, especially so in the climate of changing paradigms affecting the sector. With considerable experience and complementary skills and expertise in aquatic resource management, CSIR-NIO,Goa obtained affiliation from Agriculture Skill Council of India (ASCI) (Affiliation Certificate No. ASCI/GN/G/398/17-01) to offer three Qualification Packs (QPs) and National Occupational Standards (NOS) for the job roles published as QP/NOS set by the Agriculture Skill Council of India (ASCI) with an aim to address the growing demand for the need of skilled workforce and to provide employment opportunities for youth of the country.

7.0. Important Technological Contribution against sustainable development goals

Biological Sciences

CSIR-CCMB has extended initial findings on the molecular mechanism of how D-aminoacyl-tRNA deacylase (DTD) removes D-amino acids mischarged on tRNAs and is involved in enforcing homochirality in proteins. Using nuclear magnetic resonance (NMR) spectroscopy-based binding studies followed by biochemical assays with both bacterial and eukaryotic systems, they have demonstrated that DTD effectively misedits Gly-tRNAGly. They also provided direct evidence that DTD is an RNA-based catalyst, since it uses only the terminal 2'-OH of tRNA for catalysis without the involvement of protein side chains. This represents a unique paradigm of enzyme action for substrate selection/specificity by DTD, and explains the underlying cause of DTD's activity on Gly-tRNAGly. It also gives a molecular and functional basis for the necessity and the observed tight regulation of DTD levels, thereby preventing cellular toxicity due to misediting.

Development of New Bone Anabolic Agent CDRI S-008-399 to Combat Osteoporosis and Accelerate Bone Fracture Repairing

CSIR-CDRI S008-399 is a potential bone anabolic agent that promoted osteoblast differentiation and mineralization at dose as low as 1 pM via activation of ER/P38MAPK/BMP-2 pathway. The compound increases bone mineral density (BMD), mineral apposition rate (MAR) and bone formation rate (BFR), compared with control at 1 mg/kg/body weight and 10 mg/kg/body weight by oral administration in adult female osteopenic rat model.. The compound improves bone quality and restores trabecular micro-architecture in ovariectomized osteopenic rats. S008-399 treatment led to a decrease in ovariectomy induced increase in bone resorption marker like CTx, a collagen breakdown product. The compound is devoid of any uterine estrogenicity thus eliminating the risk of endometrial carcinoma and safe for consumption. Further developmental studies on CDRI S-008-399 for the treatment of osteoporosis and bone fracture repairing will be conducted jointly by the CSIR-CDRI and M/s Ortho Regenics Pvt. Ltd., Hyderabad.

Standardized Extract of *Dalbergia sissoo* for accelerated fracture healing & management of post-menopausal osteoporosis

CSIR-CDRI found that the Novel and abundantly present marker Compound CAFG in the standardized extact *Dalbergia sissoo* increases chondrogenic differentiation of cells. Studies on adult female osteopenic rat model showed increased mineral apposition and bone formation rate thus increased bone mineral density. DS ethanolic extract, evaluated in rat rapid fracture healing model, stimulated callus and fracture healing at dose as low as 250.0 mg/kg body weight. CAFG was evaluated in mice in postmenopausal model for osteoporosis & rapid. fracture healing model (1 & 5

mg/kg body weight). It stimulated fracture healing by activating Wnt/â catenin signalling pathway. CAFG is devoid of uterine estrogenicity, thus is safe for consumption.

Development of L-asparaginase with low glutaminase activity for therapeutic applications

L-Asparaginase is well known for its chemotherapeutic properties. Currently, L-asparaginase from bacteria such as *E. coli* and *Erwinia* are commercially used. The presence of glutaminase activity in the L-asparaginase limits its use as potential therapeutic, thereby causing immunogenic and several associated side effects.Therefore, it is desirable to search for robust/engineered L-asparaginase having novel properties with less adverse effects. Therefore, CSIR-IHBT screened the bacterial diversity of unexplored western Himalayan regions in Himachal Pradesh (India) for L-Asparaginase with novel properties and less adverse side effects. Important parameters unique to the development are:

- An efficient Asparaginase enzyme from Himalayan microbial source has wide temperature functionality.
- Has applications in the treatment of acute lymphoblastic leukemia (ALL, childhood blood cancer), pancreatic carcinoma and food processing.
- Very low glutaminase activity.

Process for substituted cyclohexane-1,3-diones synthesis

First time a long existing problem of substituted cyclohexane-1,3-diones by CSIR-IHBT synthesis from unreactive acetone through consecutive Michael-Claisen process has been solved. The practical applicability of the patented process was tested for new as well as commercially known compounds up to kilogram scale successfully. Low production cost and easy scalable process are the added advantages of the process for commercial development of the unreactive acetone.

Fig: 7.1 Processing unit for unreactive acetone protection

Nanobiocomposites (NCs) for wound healing

Biomaterial nanobiocomposites (NCs) containing plant Cellulose nano crystals (CNCs) functionalized with green AgNPs were developed in ointment and film form and their wound healing potential in mice was studied by CSIR-IHBT. Plant CNCs were found suitable as an alternate to bacterial cellulose for developing wound dressings for rapid skin repair. Briefly, NCs were found to significantly enhance *in vivo* skin tissue repair by decreasing production of inflammatory cytokines and increasing fibroblast proliferation, angiogenesis, and finally tissue neo-epithelization and regeneration in less than 14 days by favouring collagen deposition.

Fermentation Technology for production of metal Gluconates

CSIR-IIIM has developed a technology to convert glucose to gluconates using a fungal strain i.e. *Aspergillus niger* with a productivity of 5-6 kg *Kl-1 h-1* under certain specifically defined physico-chemical conditions. A final product recovery of 90- 95% can be achieved at 120-150g *l-1* glucose concentration within 72h.

Gluconates have several established pharmaceutical, agricultural and other industrial applications. Calcium, copper, ferrous and zinc salts find use in oral metal supplements for humans, animals and agricultural applications. Sodium gluconate being an excellent sequestrant, finds application as metal or bottle cleaning agent. For its ability to slow the process of polymerization of cement at highly reduced moisture conditions, very large quantity of sodium gluconate is used as an additive by cement industry in Europe and Japan.

Fermentation Technology for Decosahexaenoic Acid(DHA)

CSIR-IIIM has developed fermentation process for DHA production using a marine isolate, *Schizochytrium sp.*(SC-1). Under optimized conditions, about 30-40% DHA is produced in total oil contents (10-15g/L fermented broth). The process for DHA production has been developed at 300L fermentation scale and is available for the clients for technology transfer.

DHA or Docosahexaenoic acid is an omega-3 fatty acid known to have beneficial nutrient properties including development of brain function in infants. It forms as an essential component of infant food formulas. It is also now being used as food additives and animal feed. DHA has a positive effect on diseases such as hypertension, arthritis, atherosclerosis, depression, adult-onset diabetes mellitus, myocardial infraction, thrombosis, and some cancers. Therefore, indigenous technology for DHA production has great commercial value for Indian market. This would provide cheaper and affordable DHA in the market, which is currently very expensive.

Fermentation Technology for Bio fertilizers and Bio-control Agents

CSIR-IIIM has developed microbial strains of *Rhizobium, Azatobacter, Azospirillum* and further cultivated under certain specifically defined physico-chemical conditions at 300L scale. The fermentation product can be used . for nitrogen fixation to increase crop yields. Similarly technology on production of biocontrol agents by submerged and solid state fermentation (SSF) has been developed transferred to various Indian industries. A strain of *Trichoderma viride* has been developed which profusely sporulate under submerged fermentation conditions at certain specifically defined physico-chemical conditions. The process has been scaled up to 300L fermentation scale.

Oneer- a novel solution for safe drinking water for domestic and community purpose.

Water is one of the most essential requirements of life. As per WHO estimate, nearly 80% of the diseases are caused directly or indirectly by the consumption of unsafe water due to poor or lack of sanitation. In India, 15-20% of infantile mortality has been reported to be due to gastroenteritis. A number of technologies are available in the market for disinfection of water to make it potable. The existing technologies are mainly based on microfiltration, UV irradiation or Reverse Osmosis which are expensive to install and maintain for community supply purpose

CSIR-IITR has developed device based on the principle of anodic oxidation. The device is particularly useful for the treatment of drinking water supplies that have microbial contamination to disinfect pathogenic microorganisms and to provide safe drinking water to communities as per National and International standards [World Health Organization (WHO) and Environmental Protection Agency (EPA) USA] prescribed for potable water. This has high disinfection efficiency of >8 Log reduction of bacteria (E coli) and is maintenance-free. It is a low-cost water disinfection device that can even treat

brackish or turbid water unlike UV technology. Cost of treated water is less than 1 paisa per litre. Domestic device can supply 10 litres of water for homes and small establishments while the online version can supply 450 litres of safe water for communities.

Portable Water Analysis kit

The portable Water Analysis kit developed by CSIR-IITR has been designed for the assessment of drinking water quality in remote areas and can be operated by a person with minimum training. The kit is composed of an incubator and the chemicals for bacteriological (fecal and total coliform) and chemical tests (pH, conductivity, fluoride, iron, nitrate, chloride, residual chlorine, hardness, total dissolved solids).

Argemone Oil Detection Kit (AO Kit)

Mustard oil constitutes a prime dietary component of various households. Consumption of mustard oil adulterated with *Argemone Mexicana oil* is known to cause an epidemic popularly referred to as Dropsy. Several outbreaks have been reported in the past. The dropsy incidence at Delhi in August 1998 appears to be the largest reported in the country involving over 2500 victims with more than 60 deaths. Consumption of Argemone oil contaminated edible oil, even at low levels of adulteration for short duration, causes toxicity. Hence presence of Argemone oil even in trace quantities needs to be ascertained.

CSIR-IITR has developed AO-kit which is used to detect Argemone oil adulteration in Mustard oil. The kit consists of a paper strip and a small instrument for the visualization of fluorescence. The test is easy to perform and takes about 20 minutes. The test is very sensitive with a minimum detection limit of 0.01% (100ppm).

MO Check Strip (Color Detection Strip)

Extraneous addition of any artificial color in any edible oil is not permitted under The Prevention of Food Adulteration Act, 1954 and rules thereunder. Deliberate coloring of comparatively cheaper light colored oils with an artificial fat soluble yellow color i.e. Butter Yellow is sometimes adopted to make these oils look and smell like mustard oil. Butter Yellow has been reported to be toxic and carcinogenic in laboratory animals.

To check the adulteration of Butter Yellow in mustard oil, a handy, quick and easy spot test using a paper strip has been developed by CSIR-IITR. The strip is coated with chemicals to facilitate the monitoring of mustard oil to safeguard the health of consumers.

Technology for Herbal Products

CSIR-NBRI has developed following technologies for Herbal Products: The technology for Sindoor Stick has been developed with herbal colours, vegetable oils, aroma and bees wax as base material. The product is non-toxic, without any heavy metals (like red lead oxide) or chemicals. The other herbal products developed by CSIR-NBRI are as follows:

- Herbal Antioxidant Formulation: A bio-combination comprising Ayurvedic plant ingredients was developed for the management of ROS stress and chemotherapy of cancer patient by quenching free radicals and by enhancing endogenous antioxidant system.
- Herbal Hand Sanitizer: The hand sanitizer is made from a combination of essential oil emulsions of medicinal plants as herbal ingredients. The formulation keeps the hands supple and soft. The selected essential oils are mixed in different ratio in polymer-based gel and developed into a acceptable gel-based formulation which is useful in killing germs of hand and skin.

- Herbal Toothpaste: A herbal toothpaste was developed jointly by CSIR-NBRI and CSIR-CIMAP. This is a polyherbal formulation containing known Ayurvedic medicinal plants has been developed. The toothpaste is effective in preventing tooth decay caused by *Streptococcus mutans*, provides natural mouthwash effect, and also exhibits strong antioxidant activity. The product is fluoride free.

Pedal operated millet dehuller

Small millets are the staple food of millions. Their slow digestability and nutritive value makes them one or most preffered commodity among health conscious population. A few important small millets are foxtail millet, kodo millet, little millet, banyard millet and proso millet. Farmers growing these millets consume it themselves since there are no small scale mills. With an aim to empower them to dehusk these millets, a pedal operated millet dehuller was developed by CSIR-CFTRI. Being manually operated, this system is most suited for the rural sector. This system has dehusker and an aspiration system to separate the husk from the mixture and all components are available locally. In addition, different types of millets require different speeds for maximum dehusking and there was no system to indicate the speed of the impeller. Hence, a speedometer was retrofitted onto the system which indicated the speed of the impeller in km/h. With this simple gadget in place, studies were conducted on different millets at different speeds to determine the optimum condition for maximum dehulling efficiency.

Fig: 7.2 Pedal operated millet dehuller

Formulation of weaning food based on sweet potato fortified with vitamins

Weaning food was prepared using sweet potato pulp and other ingredients like sweetener, milk solids and vitamins. The drum dried weaning food had a moisture content of 5.27% and total sugars of 32g/100g.

Fig: 7.3 Baby Foods

Soluble Whole *Spirulina* Powder

A novel process for preparation of a Soluble Whole Spirulina Powder has been developed by CSIR-CFTRI. A patent application to protect the IPR of the novel process is being processed. Spirulina has been recognised and notified by the FSSAI, Govt. of India as a Nutraceutical. The soluble Spirulina powder would pave the way for wide application of *Spirulina* for fortification of foods and for its usage as Nutraceutical food ingredient.

Moringa seed protein for usage in water clarification

A process for water purification using moringa seed protein has been developed by CSIR-CFTRI developed. Moringa seed protein isolate (MPI) was prepared from defatted moringa seed flour at optimum conditions to get a final product having >90% protein with 60-62% yield. The prepared protein isolate presented good coagulant activity showing that it can be used as an alternative to alum in potable water treatment. 15 mg of the protein isolate was sufficient to reduce 97% of the turbidity in one liter of synthetic turbid water of 375 NTU or mud water of 150 NTU similar to that of alum activity. The TDS and conductivity remained unchanged for both alum and moringa seed protein treated water. A process entitled “Moringa seed protein isolate as flocculant” for water purification has been developed and released to industry for commercial exploitation.

Chemical Sciences

Waterless Chrome Tanning Technology (WCTT)

The process technology of WCTT developed by CSIR-CLRI provides near zero waste in chrome tanning and avoids pickling and basification operations thereby enabling reduction in TDS from identified streams. In addition, there is a significant savings in water, time, energy and thereby processing cost. The significant benefits of the technology are:

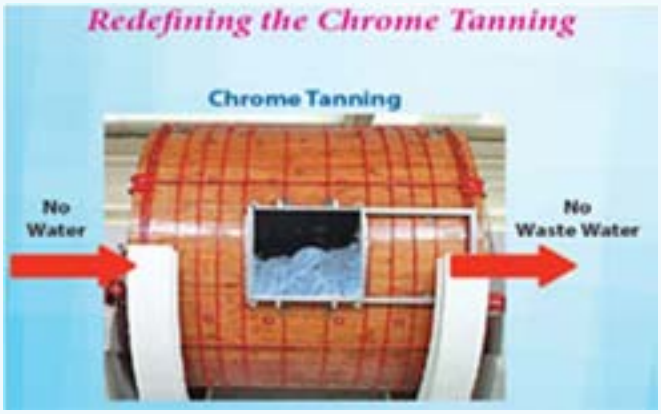


Fig: 7.4 Redefining the Chrome Tanning

Dry Tanning (Dispersing Agent) - Multiple benefits relating to in-process abatement of effluent problem, curtailing process steps, huge water conservation, time economy and cost savings

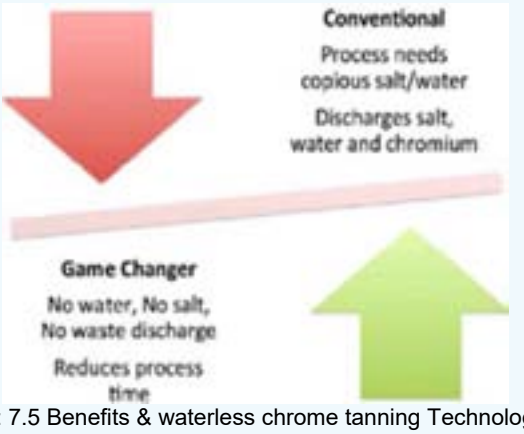


Fig: 7.5 Benefits & waterless chrome tanning Technology

Product technology to enable dry tanning; Time saving to the extent of about 30%; Delimed skins treated without addition of any water or any other liquid medium; Reduces number of unit operations; No requirement of any additional infrastructure; Reduces the requirement of conventional chrome tanning agent by about 50%; Potential saving of 15 Million Liters of water per day when adopted by the entire country

EO based Zero wastewater discharge process -Treatment of waste streams through electro-oxidation and appropriate reuse of treated waste streams

The uniqueness of the present technology is the segregation of waste streams, treatment and reuse of the treated streams. The waste streams are not discharged and the inorganic contaminants in the waste streams are utilized.

Distillery spent wash management technology

Potash organics, water & ZLD: Spent wash, effluent from alcohol distilleries, is slightly viscous, dark brown coloured liquid with unpleasant odour and very high pollutant loading. This effluent, if allowed to discharge into surface water / river untreated, will cause severe damage to the ecosystem, including destruction of flora & fauna. This problem is likely to worsen in future particularly in view of rising demand of fuel ethanol. Currently in-vogue protocols (viz., ferti-irrigation, bio-methanation, composting etc.) operate on the premises of getting rid of the problem (spent wash). However, spent wash contains appreciable amount of potassium – an important agri-nutrient. CSIR-CSMCRI's spent wash management technology enables remunerative utilisation of spent wash through recovery of value added products (potash fertilizer, organics for feed / fuel application) along with water (for recycling) while ensuring compliance with regulatory Zero Liquid Discharge norms.

Spent wash from diverse geographical locations of the country (viz., distilleries located in Karnataka, Maharashtra, Gujarat & Uttar Pradesh) was evaluated to ascertain efficacy of the process.

Key features of the process are:

- Commercially competitive cost of production for potassium nitrate.
- Major raw materials consumed: nitric acid, sulphuric acid, lime, magnesia, etc.
- Potash fertiliser produced: KNO3, K2SO4, KH2PO4 etc. (meeting FCO specification)
- Valorization of by-products, viz., animal feed, activated carbon etc. from organic sludge
- ZLD through downstream processing of lean spent wash
- Estimated payback period (for ca. 60 klpd distillery): 2.5 -3 years

Hollow Fibre membrane based gravity assisted ultrafiltration membrane technology

Safe drinking water for common man has emerged as one of the major challenges of this century. HF ultrafiltration membrane process is one of the most efficient processes in the treatment of turbid water with pathogens and other microorganisms. CSIR-CSMCRI has developed hollow fibre ultrafiltration membranes for treatment of contaminated water which results in 6 log reduction of bacteria, 4 log reduction of virus and > 99.9% reduction of NTU. CSIR-CSMCRI has targeted to develop second generation HF membranes with 2-3 times higher productivity over the current membrane developed by CSIR-CSMCRI and other HF membranes available in the market. And at the same time the target is to develop HF membrane based high-flux domestic water filter which can be driven by simple gravity-assisted separation without any electricity for water clarification and disinfection producing water free of pathogens and suspended particles.

Double Fortified Salt (DFS)

CSIR-CSMCRI has developed an innovative process for fortification of salt with iodine and iron using inorganic matrix compound. This inventive process helps in retaining the white colour of the salt and preserving the effective concentration of iodine and iron intact over a long period of time for an extended shelf-life.

The process comprises of preparation of magnesium precursor using bittern containing magnesium, iron precursor using iron compound such as FeCl3, mixing the precursors and subjecting the slurry to hydrothermal treatment under alkaline condition to prepare iron containing matrix. The slurry is filtered, washed, dried and pulverized. The matrix is used to intercalate iodine in the structure using potassium iodate.

A consolidated biomass process for integrated production of multiple products from fresh marine macroalgae *Gracillaria dura*

This alga has been found to yield high value phycocolloid called agarose (and several other high value products) based on CSIR-CSMCRI patented process. This alga occurs scantily in nature limiting its commercial exploitation. This limitation has provided impetus for developing feasible cultivation methods for its farming the sea.

The farming of *Gracillaria dura* seaweed has been initiated following tube net method at Simar (near Una), Gujarat. The quick multiplication was carried out on monolines suspended in the field. The harvesting of fresh biomass was made after 45-50 days depending upon the growth to obtain 25-30 kg biomass fresh from single tube. Two harvests were taken, one in December 2016 and second in February 2017. The daily growth rate (DGR) of 1.95 ± 0.32 day^{-1} and 3.35 ± 0.24 day^{-1} respectively was recorded. Scale-up processing of integrated extraction of plant nutrient rich sap, pigments, lipids, agarose and cellulose at 10 kg fresh macroalgal feedstock per batch has been successfully carried out.

Cell Adhesion Resistant Polymers for Intraocular Lens Application has been developed by CSIR-IICT: Patients afflicted with cataract suffer vision loss due to opacified intraocular lens (IOL) in eye. Most preferred treatment for this is replacing the diseased natural lens with artificial polymeric lens. Following surgery, many times, a secondary cataract (Posterior capsular opacification, PCO) occurs due to proliferation of remaining endothelial cells which attach to the lens and thus compromise vision. There have been many studies to make novel materials and other methods that prevent this from happening. CSIR-IICT found that addition of Zinc oxide nanoparticles to a transparent polymer drastically reduces the number of fibroblast cells that are attached to it otherwise. At a 5 pph concentration, the polymer showed dramatic reduction in cells attached. These ZnO polymer nanocomposites have all other optical, physical, chemical, processing and handling

properties required for manufacture and use of IOLs. These polymers are expected to result in realization of IOLs with far less incidences of PCO.

The hydrazine hydrate process developed by CSIR-IICT: The process has been successfully demonstrated to Gujarat Alkalies and Chemicals Limited (GACL), Vadodara at Bench and Pilot Scale. Bio-active intermediates for agrochemicals, pharmaceutical products, polymer industry, as anticorrosion agent for boiler water treatment, in refining of precious metals etc. The 10000TPA hydrazine hydrate commercial plant vetted by LTHE, Mumbai, is proposed to be constructed and commissioned by 2019: for which the Basic Engineering Package was submitted by CSIR-IICT. GACL is in the process of engaging a Detailed Engineering Consultant for execution of the commercial plant.

Indigenous development of new materials and successful demonstration of Li-Ion Battery technology by CSIR

CSIR-IICT has made significant contribution in the domain of 'electrolytes', an integral component in Li-ion battery. The device performance, lifetime and safety under operational conditions primarily depend on the electrochemical characteristics and functioning of the electrolyte used. In this context, new liquid electrolyte compositions and four classes of novel polymer electrolyte matrices along with appropriate intellectual property are the major contributions from CSIR-IICT. Materials and Processes Technology Development:

Synthetic Aviation Lubricants

Indigenous technology for synthetic aviation lubricants was developed for the first time in the country by CSIR-IICT in collaboration with five other organizations using indigenously available renewable raw material to a major extent. Thus a new knowledge base has been created successfully in the country which will help in import substitution of aviation lubricants catering to defence and civil sectors. The developed lubricants have passed all the mandatory tests. With this landmark development, India will join the select group of countries having capabilities in aviation lubricant technologies. Moreover, Indian aviation sector is growing at a very rapid pace with many small and big players entering the market. One of the developed lubricant is also used extensively in civil aircrafts. The developed formulations for aviation lubricants SVS-11 & SVS-21 meet the stringent specifications of MILPRF-23699FDEF-STAN 91-98. The lubricant passed Ryder test at US NAVAIR. After successful completion of phase-I activities of the project, inflight testing with the indigenously developed lubricants is initiated as Phase–II activity in collaboration with, HPCL and IAF, 3BRD, Chandigarh.

Solvent free/High solids thermal insulation coatings

- CSIR FTT PROJECT: CSIR-IICT has developed the process technologies for platform thermal insulation coatings providing surface temperature difference of 15-30°C depending on thickness (0.5 to 1 mm) using high solids epoxy and PU binders for Galvanized Iron (GI) sheet. the following are the important features of the technologies:
- Low volatile organic content (VOC), Non Toxic & Eco- Friendly
- Using locally available and also renewable materials
- Low heat dissipation & thermal conductivity and enhanced reflectivity
- Good adhesion, flexibility and toughness
- Resistant to chemicals and humidity.
- Long term corrosion protection
- Restrict formation of condensate and mold

- Thermal Insulation Coatings for Inner Surface of the GI / Steel Roofing

High yielding variety of Citronella (Jor Lab C-5)

Citronella or Java Citronella (Cymbopogon winterianus, Jowitt) is a high yielding variety developed by CSIR-NEIST is a perennial grass belonging to the family Poaceae. The plants are 2-2.5 m in height, perennial herbs with fibrous root system. The Citronella oil is used extensively as a source of perfumery chemicals such as citronellal, citronellol and geraniol. These chemicals find extensive use in soap, candles and incense, perfumery, cosmetic and flavouring industries throughout the world.

High yielding variety of Lemongrass (Jor Lab L-8)

Lemongrass *(Cymbopogon flexuosus)* a high yieldign variety developed by NEIST is one of the traditional essential oil bearing plant belonging to the family poaceae. The oil is obtained from certain species of grasses of the genus *Cymbopogon*. The genus consists of about 80 species, 10 to 12 of which are known to occur in India. The value of Lemongrass oil depends entirely upon its citral content. Lemongrass is a plant of the humid tropics. Lemongrass oil is one of the important essential oils used in fragrance and flavour industries. The oil has high market demand in India and abroad.

Herbal Mosquito Repellent Candle

Mosquito repellent candle is another product developed by CSIR-NEIST which is effective in repelling mosquitoes and as well as produces subtle fragrance while burning.oil has high market demand in India and abroad. This is a 3 in 1 product which provides light, fragrance and helps in repelling mosquitoes. The candles can be used in indoor and outdoor conditions. The Potential customers may include Bio-pesticide companies, MSME and other interested companies

Technology for extraction and purification of Oxyresveratrol

Oxyresveratrol is an important organic compound with multi-faceted uses. It is naturally found in the bark of *Artocarpus lakoocha* Roxb. Oxyresveratrol has potential anti-cancerous as well as neuroprotective properties against neurodegradation in Alzeimer's disease. It can be used as skin brightener. CSIR-NEIST has developed a process for production of oxyresveratrol as trans isomer with a purity of 99%. The process involves use of indigenously developed membrane and a green solvent. It is cost effective and environmentally benign process. It is a well known fact that high purity products (Trans-isomers) has greater demand in chemicals and pharma market.

Modular Brick from Brahmaputra River Bed Sand

Modular bricks are generally used in construction of building structures, boundary wall and foundations, etc. They can be used as an alternative building material in place of traditional burnt clay bricks. CSIR-NEIST has developed a unique process for production of modular bricks using Brahmaputra River bed sand. The process utilizes Brahmaputra River bed sand as main constituent and Ordinary Portland Cement (OPC) as binding material. The process is fuel saving [process and it does not require any coal and wood for burning unlike traditional burnt clay bricks. The bricks have high compressive strength, heat resistant, light weight and less water absorption. The Potential customers may include Brick manufacturing companies, construction companies and other interested companies.

Herbal Anti-Arthritis Formulation

"CSIR-NEIST developed an Anti-Arthritis formulation from rich biodiversity of NE India, which is proven to be very effective in managing arthritic problem of a wide section of people in different parts of the country. CSIR-NEIST transferred herbal Anti-Arthritis technology for commercial production to

M/s Kudos Laboratories India, New, Delhi M/s Altis Life Sciences Himachal Pradesh and M/s Multani Pharma Ltd. New Delhi.

Salient technical features:

- Effective against osteo and rheumatoid arthritis
- No adverse side effects have been found
- Active ingredients derived from plant sources
- Eco-friendly process

Liquid Deodorant cleaner Technology

CSIR-NEIST has developed an improved Liquid Deodorant Cleaner. The formulation is herbal based for use in cleaning floors, tiles, etc. and at the same time produces good fragrance. Developed with easily available ingredients, the process is simple and suitable for semi-skilled entrepreneurs and small scale industries; Can be adopted as cottage scale technology in rural areas; No sophisticated machineries involved• No highly skilled labors required; No by-product generation• Low cost investment. CSIR-NEIST transferred Liquid Deodorant cleaner Technology to M/s DSP Agro foods & Chemical Industries, Bhubaneswar. Salient technical features:

- Effective for repelling mosquitoes
- Safe to use
- Can be used in indoor and outdoor conditions
- Three in one product for providing light, fragrance and repelling mosquitoes

Wood Care Formulation Technology

CSIR-NEIST has developed a number of formulations useful for different applications. One among them has been found potential to prevent the damage of wood and bamboo from fungal and insect attack enhancing the durability and strength. The product is developed from easily available raw materials and involves a simple process for production. CSIR-NEIST transferred Wood Care Formulation Technology to M/s DSP Agrofoods & Chemical Industries, Bhubaneswar.

WASTE MANAGEMENT SOLUTIONS FOR SOCIETY

Design improvement & performance evaluation of food waste digester cum biogas plant for field installation

The compact kitchen waste digester cum biogas plant was one of the major developments under CSIR-800 activity in CSIR-NIIST Design improvement and performance evaluation of the scale-up version of the digester for treating large quantity of organic waste was one of the activities during 2016-17 period. A demonstration scale modified unit was established in NIIST and it was continuously operated for nearly 8 months. Compared with the previous model, the revised design was more mechanical with automatic control system for more efficient biogas production and its utilization. The 40 Kg food waste/day unit was generating around 7 M^3 biogas daily (average biogas was 160-180 L/Kg food waste, methane content >60%). The total solid loading into the digester was around 4.6 Kg/M^3.day.

Fig:7.6 Food Waste Digester

Demonstration scale (40 kg/day) food waste digester cum biogas unit operating in CSIR-NIIST campus

In a continuing effort to improve the digester performance, making it more compact and efficient in terms of waste degradation and methane production, more in-depth microbial ecology of the system was studied. Molecular (QPCR) Genomic tools (NGS)were applied to understand the community profile during adverse VFA build up leading to digester failure. A mixed microbial system with hydrolytic bacteria (cellulolytic, proteolytic and lipolytic) was developed and batch experiments confirmed enhanced hydrolytic activity of food wastes augmented with this consortium. All these scientific inputs will help to redesign the digester with a better performance, which is in progress now.

Kitchen waste composting unit

The development of a compact kitchen waste composting unit was another activity carried out by CSIR-NIIST. This is a based on a new concept, “Waste to Wealth and Food”, ideal for urban as well as rural areas with limited space constrains for disposing putrifiable household wastes. The aerobic waste sludge based inoculum initially added to the systemspeeds up the aerobic composting process. The specially designed aerobic composting unit converted food waste into good quality compost. During the composting the temperature gone up to ~60 °C and the maturation period required was only two weeks. Two batch operations were already completed and the results are highly promising. Compared with existing composting units, advantages of this unit are there is no need of repeated addition of EM solution (bacterial inoculum), no fly or smell issues. The 220 L capacity composting unit was able to treat ~45 kg food waste in 30 days period.

Fig:7.7 Kitechen Waste Composter

This can be an ideal system for income generation for women groups like the Kudumbasree. The operators can income from both waste collection points (houses) as well as by selling the compost. Moreover, organic vegetables can be cultivated using the compost prepared from the food waste.

Vegetables grown in the food waste composting unit show better growth and yield. ICAR-CPCRI (Central Plantation Crop Research Institute, Kayamkulam Kerala) has expressed interest to test this unit in field for preparing compost from agro residues as well as food wastes. This will be a part of village adoption programme of ICAR in Alapuzha district in Kerala.

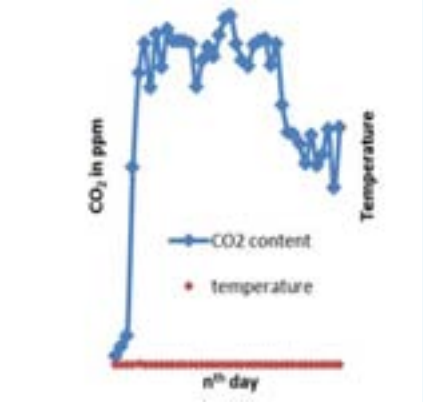


Fig: 7.8 Odour control system at 500 tpd MSW mechanical biological treatment plant at KCDC, Bengaluru. Exhaust ducting from plant (on the right) to biofilters (on the left).

Fig:7.9 Gas biofilters under construction at 500 tpd municipal solid waste treatment facility. Installation of exhaust ducting.

Pilot plant scale trials on upgradation of low grade ilmenite by VV Minerals:

Based on the encouraging results of earlier laboratory scale and higher scale of studies on metallisation and rusting of 2 low grades of ilmenite, CSIR-NIIST and VV Mineral came forward to set up a pilot plant facility to process about 700 metric tonnes (350 tonnes each) of 2 grades of ilmenites (45% TiO_2 and 55% TiO_2). It was also planned to hire a commercial sponge iron rotary kiln of suitable capacity for the metallisation of ilmenite and set up a pilot plant at the premises of M/s. VV Titanium Limited, Tuticorin for further chemical processing such as rusting and leaching of metallised ilmenite. An agreement between CSIR-NIIST and VV Mineral was signed on July 07, 2016 to this effect.

During the period under report, services were rendered to VV Mineral in identifying commercial sponge iron rotary kiln facility for ilmenite metallisation. In view of the ease of logistics and also the capacity of rotary kiln, M/s Popuri Steels with 2 Number of 50 tonnes per day capacity commercial rotary kiln was selected for the metallisation campaign. Discussions were also held prior to the actual campaign regarding selection of reduction parameters, modification of rotary kiln parameters suitable for ilmenite in view of its lower iron content and smaller particle size compared to iron ore feed.

CSIR-NIIST actively participated in the metallisation campaign held at M/s Popuri Steels Limited, Bellary, Karnataka for about 10 days. During the campaign, NIIST associated with the monitoring of the reduction parameters, rotary kiln temperature regime, product quality in terms of metallisation and

the separation of kiln discharge. During the campaign, about 350 metric tonnes of 45% TiO_2 containing TVP ilmenite and 330 metric tonnes of HT grade (55% TiO_2) ilmenite was processed. Both the rotary kilns of 50 Tonnes per day capacity were used simultaneously. About 450 metric tonnes of metallised ilmenite of both the grades with metallisation in the range 83-88% was produced.

Fig: 7.10 View of 50 TPD capacity commercial DRI Rotary kiln used for metallisation of ilmenite

Rusting of metallised ilmenite and its subsequent leaching in the pilot plant: Aeration Rusting

A stirred tank reactor of 14 M^3 volume capacity to handle 5 tonnes of metallised ilmenite /batch with a pitched blade agitator was designed by CSIR-NIIST for the pilot plant and got fabricated and commissioned at M/s. VV Titanium Ltd., Tuticorin, Tamil Nadu. The material of construction of the tank was rubber lined MS. The reactor had also provision for steam purging for raising the temperature during rusting.

Initial rusting experiments were carried out at 2 metric tonnes per batch and the solid to liquid ration was maintained at 1:2.5 (w/v). Freshly prepared ferrous chloride was used as the catalyst. After the solution containing the required quantity of catalyst is heated to about 60 ° C , the metallised ilmenite was added with air being purged at the bottom and agitator running at 100 rpm. The initial pH of the solution was adjusted to around 4 by adding required quantity of HCl. The reaction was allowed to continue for 10-12 hours after which the slurry from the reactor was pumped out into a holding tank for dilution and separation of beneficiated ilmenite from iron oxide slurry.

Fig:7.11 Photograph of 5 tonnes /batch rusting reactor

A stirred tank reactor with a capacity of 2 tonnes/batch was designed, fabricated and commissioned at the pilot plant for carrying out acid leaching of rusted ilmenite. The reactor was lined with FRP and was provided with steam injection facility for heating. The agitator is again 4-bladed pitched blade design.

The reactor was loaded with rusted product slurry from the holding tank after several washings and separation. After assessing the solution level in the reactor, the quantity of HCl to be added is

calculated in order to make the final acid concentration of 20% for leaching. The contents in the reactor was heated to about 90-95 ° C by purging steam and the reaction was allowed to continue for 8 hours. When the contents in the reactor is sufficiently cooled, it was diluted and pumped into a holding tank for washings and separation. During the period under report, about 250 metric tonnes of metallised product has been processed in the pilot plant. While the rusting of metallised ilmenite resulted in beneficiated ilmenite product containing 84- 86% TiO_2, subsequent leaching of the beneficiated ilmenite in HCl yielded synthetic rutile with more than 91-92% TiO_2.

Fig:7.12 Photograph of 2 tonnes/batch leaching reactor

High Strength Aluminum Alloy Product Developments for Next Generation Automotive Applications

Reducing emission, improving fuel economy and earning carbon credits has been the compelling needs for the auto industries to seek innovative approaches in design and selection of materials of very high performance. In order to achieve weight savings in vehicles, the automobile original equipment manufacturers (OEM) and component suppliers are increasingly using ultra-high-strength steel, aluminium, magnesium, plastics and composites. In the present context, development of new alloys, efficient casting methods and heat treatment techniques, which improve the material properties and functional requirements, offer the potential for growth that could significantly expand the usage of aluminum alloys in the whole range of automotive vehicles from lighter to heavy vehicles.

CSIR-NIIST endeavours to replace heavier components such as gear box casings, fly wheel housings, load bearing components such as suspension control arms and high temperature components such as piston by using Al-Si alloys, strengthened by alloying elements such as Cu, Mg, Ni etc.This high strength Al-Si-Cu/(Mg, Ni) alloy with improved properties. This can be achieved by minor addition of alloying elements and transition elements to the existing Al-Si-Cu alloys and processing it by gravity casing or squeeze casting techniques followed by heat treatments.

Manufacture of Prototype piston component

For the manufacture of Al-Si alloy piston for the strategic applications, dyes have been designed, fabricated and assembled in the squeeze casting machine (indigenously developed) and tested for its operations by CSIR-NIIST in collaboration with GVJ Engineering, Coimbatore. The Al-Si alloy was melted and processed in the industrial scale by following the process steps of the melt treatments (such as alloy additions, degassing, modification and grain refinement etc.) developed for the lab scale process. Alloy billets (100x100x120 mm) and Piston components were cast and heat-treated for the T6-condition by following the same heat treatment schedule adopted for the billets developed in the lab scale process.

Fig: 7.13 Ai-Si Alloy Piston Component

Biofuel Pilot Plant

CSIR-NIIST Work on biofuels has led to the first of its kind plant for handling different biomass feedstock basically agricultural residues such as rice straw, Sugarcane trash, Sorghum Stover, cotton stalk etc to ethanol conversion. The integrated process envisaged will be another step forward towards the Nation's plans on alternative transportation fuels. The process developed shall serve as basis to fine tune unit operations towards a cost effective future technology. Successful future technology will help sustainable and renewable fuel production and will be beneficial to society and environment as well. 70 kg/batch operation was demonstrated at pilot scale for bioethanol production. All the unit operations are exclusively studied for mass and energy balances at pilot scale, Scale-up parameters have been studied which shall eventually lead to process economics and will provide a vast knowledge on plant operational, safety and maintenance requirements in future.

Fig: 7.14 Unit operations in the Biofuel Pilot Plant

Engineering Sciences

GMR based gear tooth position sensor

A giant magnetoresistance (GMR) based gear tooth position sensor was successfully developed at CSIR-NAL. The developed speed sensor module (NAL GSTM-14xx) as per the system required specification (SRS) provided by TVS motor Limited, Tamilnadu. NAL GSTM-14xx was certified by Automotive Research Association of India (ARAI), Pune and the vehicle test was covered more than 10000 km. The accelerated test was conducted by TVS Motor Ltd and they were very much satisfied with the performance. CSIR-NAL is in the process of transferring the technology to MSMEs. The India automotive sensors market is expected to grow to $1.51 billion by 2018 at a CAGR of 11.64% over the period 2015-2020. Further, as there are only handful of companies worldwide which make these sensors, there is a good opportunity to export these sensors to companies across the globe.

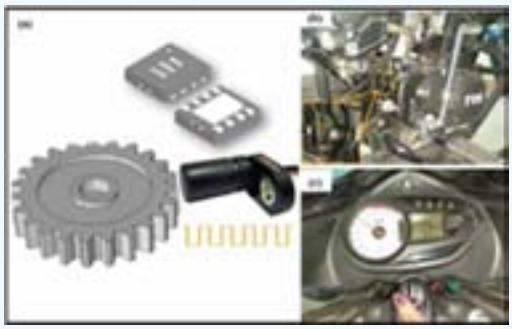


Fig: 7.15 (a) Ferrous gear, Sensor IC and speed sensor module along with 0 to 5 Volt output pulses. (b) CSIR-NAL Sensor mounted in the TVS Victor motorbike, and (c) Odometer reading with vehicle speed of 75 km/hr.

NiTi shape memory alloys

The technology development for production of NiTi shape memory alloys in 20-40 kg melt capacity has been successfully transferred by CSIR-NAL to MIDHANI, a Defence Public Sector on March 4, 2017. It is expected that the engineering products like sensors & actuators, frangibolt, pin-puller, pipe coupling, vibration dampeners etc., would be commercially available from MIDHANI by the end of 2017.

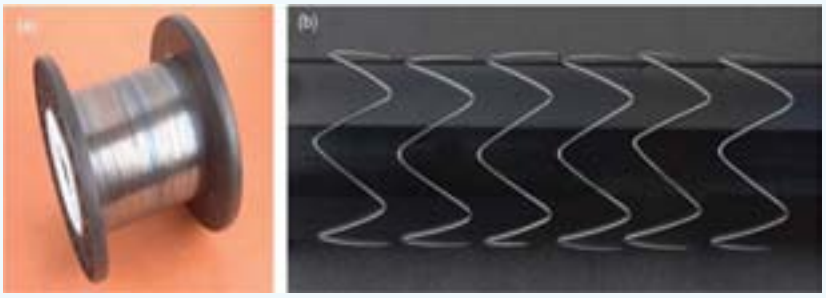


Fig: 7.16 Super-elastic NiTi SMA products: (a) strip, and (b) rings for fabrication of stent grafts

Ventilation Management System of Shree Jagannath Temple, Puri, India

CSIR-CBRI carried out Studies on"Ventilation Management System of Shree Jagannath Temple, Puri, India" to avoid malfunctioning and failure of the exhaust fans provided at top of the temple, approximately 61m high from the ground was carried out. To overcome this problem, a wireless sensor network based ventilation management system in compliance with IEEE 21451 and ASHRAE 62 standards is developed. The ZigBee communication module for transmitting the real-time data to control room is used. The machine-to-machine communication of the exhaust fans and PC with the sink node is implemented. The developed system is capable of real-time monitoring of exhaust fans running information parameters such as air flow, vibration, rpm, and load, etc. Visual Studio C# language is used in the development of Graphical User Interface (GUI) apps. The exhaust fans real-time information and environmental parameters values are displayed on the GUI. The system is low cost, energy efficient, and easy to operate with high accuracy.

Performance of Confined Masonry Buildings under Quasi-Static Condition

Since the dawn of civilization, masonry is the most commonly used material in building industries, especially for low to medium rise buildings due to several advantages such as resistance, acoustic and thermal insulation, simple and economic construction etc. However, Unreinforced masonry (URM) buildings, have proven vulnerable in seismic events, with significant building damage and numbers of fatalities, world-over. To improve the seismic resistance of masonry buildings, different methods have been attempted by CSIR-CBRI over the years, and led to the concept of reinforced masonry (RM) and confined masonry (CM) systems.

To study the seismic performance of different masonry building typologies, an experimental study was performed on full-scale single room masonry buildings measuring 3.01 x 3.01 m in plan and 3.0 m in height with similar geometry, material properties and construction practices for all the building typologies. Unreinforced (URM), reinforced (RM) and confined masonry (CM) were tested under quasi-static cyclic loading and data was recorded in terms of displacement capacity at corresponding load. CM building performed significantly well when compared to URM and RM buildings demonstrating high displacement capacity, along with high initial stiffness, ductility, energy dissipation with relatively lower structural damage. Through experimental results, it can be concluded that the retrofitting of CM using mesh of plastic cement bag was more effective technique for masonry buildings.

The process technology developed for making customized glass modules in the form of spherical beads of 2-3 mm diameter with strigent physical, chemical and mechanical properties to encapsulate and immobilize high level nuclear waste

Phytorid-SWAB

The knowhow developed by CSIR-NEERI involves a constructed wetland exclusively designed for the treatment of municipal, urban, agricultural and industrial wastewater.

The system is based on the specific plants such as Elephant grass (Pennisetumpurpurem), Cattails (Typha spp.), Reeds (Phragmites spp.), Cannas pp., Yellow flag iris (Iris pseudocorus) normally found in natural wetlands with filtration and treatment capability. Furthermore. some ornamental as well as flowering plants species such a Golden Dhuranda, Bamboo, Nerium, Colosia, etc. can be used for treatment as well as landscaping purposes.

The Phytorid Technology can be constructed in series and parallel modules/cells depending on the land availability and quantity of wastewater to be treated.

The Phytorid Technology treatment is a subsurface flow type in which wastewater is applied to cell/system filled with porous media such as crushed bricks, gravel and stones. The hydraulics is maintained in such a manner that wastewater does not rise to the surface retaining a free board at the top of the filled media.

The treated effluent shall be useful for municipal gardens, fountains and irrigation. The know how is useful for the total area required for the system is approximately 35 sq. m. for 20 M3/Day and the construction cost of treatment system is approximately between Rs. 1.20 to 1.30 lakh. The demonstration plant was set up at CIDCO Panvel to treat the sewage flow of 20 M3/Day for period of two years and second plant at Mumbai University Campus, Kalina for capacity 25 M3/Day for one year and shown the envisaged results.

Electrolytic Defluoridation (EDF)

The EDF process developed by CSIR-NEERI is effective to remove excess fluoride and also bring down the bacterial load of the raw water. The defluoridation process is based on the principle of electrolysis, using aluminium plate electrodes placed in the raw water containing excess fluoride. During the electrolysis, anode gets ionized and fluoride is removed by complex formation, adsorption, precipitation, coagulation and settling.

Direct Current required for electrolytic process is generated either by, conversion of AC electric supply by DC conversion unit of required capacity or by solar photovoltaic system consisting of solar panel, charge controller and tubular battery. Salient features:

- Removal of fluoride by active species of hydroxide of aluminium produced by passing DC power through aluminium electrodes

- Simple to fabricate, easy to operate with minimum maintenance
- Suitable for treatment of raw water with fluoride concentration upto 10 mg/L
- Produces potable water with palatable taste as against the other available chemical treatment methods
- Quantity of sludge produced is much less (60-70%) than conventional treatment methods
- Simultaneous reduction in bacterial contamination in treated water
- Capacity : 2000 L per batch in 3- 3.5 hours

Neerdhur: Multi-Fuel Domestic Improved Cookstove (Natural Draft)

The salient features of NEERDHUR developed by CSIR-NEERI includes:

- High combustion efficiency with solid fuels, through improved combustion chamber designs and other improvements
- Use of low cost Insulation for reduced heat losses
- Better safety with use of effective insulation. The outer body temperature is around 60°C
- Improved adjustable fuel grate to efficiently utilize the heat output of the stove, by adjusting the volume of combustion chamber
- Improved adjustable fuel grate, which allows use of different fuels like coal, wood chips, fire wood, briquettes etc.
- Supports top and front fuel loading
- Significantly lower emissions compared to Traditional Cook stoves (TCS)
- Fuel saving of more than 50% compared to TCS
- User friendly
- Improved safety and durability.

Fig: 7.17 NEERDHUR

Hand pump attachable iron removal plant for community water supply

Water containing excessive iron is not acceptable to human beings due to aesthetic reasons. It is observed that, whenever, iron concentration is more than 2 mg/L, the hand pump is abandoned. Due to these reasons it became necessary to devise systems to remove iron from the installed hand pumps water.

Precipitation of soluble iron by oxidation with air followed by sedimentation and filtration is a relatively simple process used for removal iron from groundwater. Based on this process CSIR-NEERI has designed hand pump attachable iron removal plant with 1 m3 per hr. hydraulic loading with following features:

- Continuous operation system with 1 cu m/hour hydraulic loading
- Oxidizes the dissolved iron : 1-30 mg/L
- High Removal Efficiency and easy to operate
- Single Unit System can provide 40 lpcd iron free water to 250 persons and can be installed on existing hand pumps.

Fig:7.18 Hand pump attached iron removal plant

'Wind Augmentation and Purifying Unit (WAYU)

IIT Bombay, NEERI, MPCB have developed a device called 'Wind Augmentation and Purifying Unit (WAYU) to improve the air quality at traffic intersections, these has been installed in several traffic juctions at Mumbai

Fig: 7.19 WAYU

The Rapid composting Technolgy convert waste to fertlizer. The use of such organic fertilizer improves the texture of the agriculture field soil. The technology facilitate waste management leading to hygiene and health of urban and rural public as well.

The technology is easy to fabricate, easy to operate, do not need energy and very useful particularly in rural India for waste processing to fertlizer.

The multifunctional bioreactor for wastewater treatment has been developed and demonstrated for wastewater treatment, water recycle and reuse and biogas generation from wastewater.

The biomethanation technology; For conversion of municipal wastes to biogas.

A novel dielectric barrier discharge (DBD) based portable UV/VUV source for water disinfection. For disinfection of water, there is a continuing need for the development of effective, cheap and environmentally friendly processes. With this new technology, plasma is generated coupling energy to a gaseous medium, leading gases to lose their dielectric properties and turn into a

conductor. Highly reactive species are generated in-situ by the plasma gas, preventing the addition of toxic chemicals.

Plasma-based sources can emit intense beams of UV & X ray Radiation or electron beams for a variety of environmental applications. For water disinfection, intense UV emission disables the DNA of microorganisms in the water which then cannot replicate. There is no effect on taste or smell of the water and the technique only takes about 10 seconds. This plasma-based UV method is effective against all water-borne bacteria and viruses. Intense UV water purification systems are especially relevant to the needs of developing countries because they can be made simple to use and have low maintenance, high throughput and low cost. Plasma-based UV water treatment systems use about 20,000 times less energy than boiling water. The mercury free prototype with UV sources was developed by the collaborative effort of CSIR-CEERI and CSIR-NEERI for evaluation of bacterial disinfection rate. The developed prototype shows 100% bacterial count reduction in less than 10 sec. This is the very significant outcome of our study. The technology has great potential and may provide a new alternative for disinfection.

Development of geopolymer cement

Geopolymer cement has been developed by CSIR-NML from Tata Power fly ash. The properties of these cement are at par with the Portland pozzolana cement. Also the techno-economics have shown their commercial viability. Encouraged by the results, Tata Power has awarded this project for technology demonstration. In this project, geopolymer cement in two parts, the dry part consisting of fly ash and additives, and the liquid part consisting of activator solution, has been produced. At our pilot plant, we have produced 20 tons dry cement and 8 tons activator solution and supplied to Tata Power to make a demonstration unit. Under the supervision of CSIR-NML, a geopolymer concrete road equivalent to M30 grade has been constructed in Tata Power, Jojobera plant. The road has achieved its final strength in 2 weeks' time and was able to take the weight of a loaded truck.

Textile Reinforced Concrete Panels

TRC panels developed by CSIR-SERC are light weight, non-corrosive and durable. Formwork is not required for TRC panel casting. Any shape can be customized without using moulds. Speedy execution and economically better compared to conventional. TRC panels are aesthetically appealing with attractive design and no additional cost is incurred for this during fabrication.

Fig: 7.20 TRC Panels are innovative pre-cast solutions that can be used for rural and urban infrastructure advancements. Panels are suitable for constructing non-load bearing walls. Suitable for rapid and cost-effective toilet construction

Construction of Toilet Unit with Precast Thin Segmental Elements

In fulfilling the Swachh Bharat Mission, CSIR-SERC, has developed precast thin concrete segmental panels for mass construction of low cost toilet units. These panels are designed in such a way that it can be jointed one above the other with perfect bonding and through connecting rods. The roof slab is designed as two parts for easy lifting which provides confinement to the wall panels by preventing

lateral movement. The construction of septic tank for the toilet is also with the same precast thin concrete segmental panels.

Precast concrete segmental panels are light in weight and can easily be handled by two persons. The panels are non-corrosive and durable. They are ecologically safe and sustainable sanitation. Assembling/erection of the panels for the construction of toilet can be completed within 3-4 hours without use of cranes and with less manpower.

Construction of Water Tank Using Flow-able Cement Mortar

The water tanks are for domestic needs and are cost effective and durable. The tank can be easily constructed with flow-able cement mortar without the involvement of highly skilled person of artisan types. To avoid lifting mechanisms for the water tank to place at roof terrace, evolved technology to construct water tanks with thin pre-cast concrete panels.

Durable and provides thermal insulation. Simplified process and can be made in different sizes. No machineries required for lifting for the tank constructed using thin precast concrete panels. Total weight of the tank is very less as compared to RCC and masonry tanks. Replacement alternative to plastic tanks and relocation of tank is possible. Tank can be assembled in 30 minutes with thin precast concrete.

Information Sciences

Greenhouse Gas Reference Station in IIA Hosakote

CSIR-4PI has set up a Greenhouse Gas (GHG) reference station in the CREST campus of IIA at Hoskote. The station is equipped with 6 primary standards from NOAA as well as working standards covering a range of concentrations of the gases CO_2, CH_4, N_2O and CO. The instruments and the cylinders are connected through a computer-controlled multiport valve-system (Valco). Ambient air is drawn from a 32 metre tower with a flushing pump, dehumidified by passing through a cooling system and fed to the one of the ports of the Valco box. The secondary working standards were first calibrated against the primary standards using a NOAA-approved procedure. All GHG measurements done at this site are now traceable to NOAA primary standards.

Physical Sciences

Acoustic and Infrared Milk Anlayser

The Acoustic Milk Analyser has been developed by CSIR-CEERI which capable of measuring milk contents like butterfat (%), solid nonfat(%), proteins (%), lactose (%) density and added water (%) in milk. The infrared Milk Fat Analyser is capable of measuring butterfat contents in raw milk, skimmed milk and cream.

Rapid Milk Analyser (KSHEER-ANALYSER)

A rapid milk analyser based on green technology was developed by CSIR-CEERI. The milk analyser has the capability of measuring milk contents like and percentage of butterfat, solid non-fat, proteins, lactose, added water and density of milk, IT uses multisensory fusion systems (acoustic-optic method) measurement principle. The targeted application areas of the system are village Milk Analysers

Design and Engineering of Molecular Terahertz Tags Motivation

Indian currency has several overt and covert security features to protect against counterfeiters. 10% of the note printing cost goes into the imported covert M-feature. Using indigenous technologies can potentially save more than 1000 crores of rupees every year. CSIR-CEERI has developed custmiable Terahertz Tags. Incorporation of novel covert molecular Terahertz Tags with unique resonances in

currency notes can be an effective anti-counterfeiting measure. Molecules with unique THz resonances are significantly more difficult to replicate as the vibrational modes in this frequency region is primarily due to bulk vibrational modes of the molecular cluster in comparison to vibrational modes in the MIR range which are bond specific. Moreover, very few known molecules exist which have prominent resonances in the low THz region (< 1 THz).

Handheld VOC Detection system

A handheld embedded system prototype has been developed by CSIR-CEERI for in-situ developed tin oxide based gas sensor. Developed embedded system prototype consist of highly accurate reconfigurable digital temperature control, wide range front end readout circuit based on resistance to frequency conversion scheme. Developed system has been tested for different VOC's such as methanol, ethanol, acetone and TCT and it has been observed that fabricated sensor is highly selectivity towards alcohol family (100 ppm in 1.2 second (response time) for methanol

RO Plant status monitoring unit

An RO plant status monitoring station has been designed, developed and installed by CSIR-CEERI at five different villages of Rajasthan such as Pilani, Deepalsar, Shivpura, Raboodi and Maliser till now. Developed systems have facility to monitor flow rate of product water, different water quality parameters (pH and TDS), alarm related to power failure and high power in real time. Developed embedded monitoring units have internet connectivity to transfer real time data on server. A dedicated webpage has been designed to monitor real time data of different RO plant modes, water quality parameters and features like flow, power failure etc. Developed monitoring unit have HDMI based touch screen for human interface with ARM 11 based processing and control unit for multi-sensor connectivity. Overall system consist of an ARM based embedded monitoring unit with actuation unit for relay installed for water quality sensing chamber. Power failure, overvoltage and under voltage conditions have been monitored based on phase failure relay unit feedback to embedded monitoring unit..

8.0 Important Scientific Achievement – (Academic Impact)

Biological Sciences

MicroRNA 874-3p Exerts Skeletal Anabolic Effects Epigenetically during Weaning by Suppressing Hdac1 Expression

Embryonic skeletogenesis and postnatal bone development require the transfer of calcium from the mother to the offspring during pregnancy and lactation. Therefore, bone resorption in the mother becomes elevated during these periods, resulting in significant maternal skeletal loss. There follows an anabolic phase around weaning during which there is a remarkable recovery of the maternal skeleton. However, the mechanism(s) of this anabolic response remain(s) largely unknown. CSIR-CDRI identified eight differentially expressed miRNAs by array profiling, of which miR-874-3p was highly expressed at weaning, a time when bone loss was noted to recover. CSIR-CDRI reported that this weaning-associated miRNA is an anabolic target. Therefore, an agomir of miR-874-3p induced osteoblast differentiation and mineralization. These actions were mediated through the inhibition of Hdac1 expression and enhanced Runx2 transcriptional activation. When injected *in vivo*, the agomir significantly increased osteoblastogenesis and mineralization, reversed bone loss

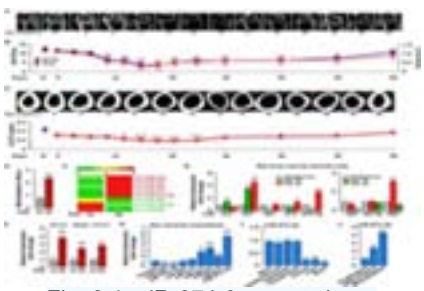


Fig: 8.1 miR-874-3p exerts bone anabolic effect

caused by ovariectomy, and increased bone strength. It is speculated that elevated miR-874-3p expression during weaning enhances bone formation and that this miRNA may become a therapeutic target for conditions of bone loss.

Macrophages Promote Matrix Protrusive and Invasive Function of Breast Cancer Cells via MIP-1β Dependent Upregulation of MYO3A Gene in Breast Cancer Cells

The potential of a tumor cell to metastasize profoundly depends on its microenvironment, or "niche" interactions with local components. Tumor-associated-macrophages (TAMs) are the most abundant subpopulation of tumor stroma and represent a key component of tumor microenvironment. The dynamic interaction of cancer cells with neighboring TAMs actively drive cancer progression and metastatic transformation through intercellular signaling networks that need better elucidation. Thus, current study CSIR-CDRI planned for discerning paracrine communication networks operational between TAMs, and breast cancer cells with special reference to cancer cell invasion and dissemination to distant sites. CSIR-CDRI reported role of MIP-1β in enhancing invasive potential of metastatic breast cancer MDA-MB-231 and MDA-MB-468 cells. In addition, the poorly metastatic MCF-7 cells were also rendered invasive by MIP-1β. *Ex ovo* study employing Chick-embryo-model and *in vivo* Syngenic 4T1/BALB/c mice-model further corroborated aforementioned *in vitro* findings, thereby substantiating their physiological relevance. Concordantly, human breast cancer specimen exhibited significant association between mRNA expression levels of MIP-1β and MYO3A. Both, MIP-1β and MYO3A exhibited positive correlation with MMP9, an established molecular determinant of cancer cell invasion. Higher expression of these genes correlated with poor survival of breast cancer patients.

Diastereoselective Synthesis of 5-Heteroaryl-Substituted Prolines Useful for Controlling Peptide-Bond Geometry

A versatile diastereoselective Friedel–Crafts alkylation reaction of heteroaryl systems with a cyclic enecarbamate for the preparation of 5-heteroaryl-substituted proline analogues in good yields has been developed by CSIR-CDRI. These heterocyclic tethered cyclic amino acid building blocks constitute important structural motifs in many biologically active molecules. The impact of the substitution on proline cis/trans isomerization was explored by carrying out solution conformational studies by NMR on 5-furanyl-substituted proline-containing peptides. Conformational analysis revealed that the peptide bond is constrained in an exclusively transconformation

A thaumatin-like protein of *Ocimum basilicum* confers tolerance to fungal pathogen and abiotic stress in transgenic Arabidopsis.

Plant responds to fungal pathogens by expressing a group of proteins known as pathogenesis-related proteins (PRs) which is mediated through pathogen-induced signal-transduction pathways that are fine-tuned by phytohormones such as methyl jasmonate (MeJA). CSIR-CIMAP identified a *Ocimum basilicum* PR5 family member (ObTLP1) from a MeJA-responsive expression sequence tag collection which encodes a 226 amino acid polypeptide and showed sequence and structural similarities with a sweet-tasting protein thaumatin of *Thaumatococcus danielli* and also with a stress-responsive protein osmotin of *Nicotiana tabacum*. Recombinant ObTLP1 protein inhibited mycelial growth of the phytopathogenic fungi, Scleretonia sclerotiorum and Botrytis cinerea; thereby, suggesting its antifungal activity. Ectopic expression of ObTLP1 in Arabidopsis led to enhanced tolerance *to S. sclerotiorum* and *B. cinerea* infections, and also to dehydration and salt stress. Thus, ObTLP1 might be useful for providing tolerance to the fungal pathogens and abiotic stresses in crops.

Fungal endophytes of *Catharanthus roseus* enhance vindoline content.

Little information is available regarding the mechanism of endophyte-mediated induction of secondary metabolite biosynthesis in *Catharanthus roseus*. CSIR-CIMAP reported two fungal endophytes, *Curvularia sp*. CATDLF5 and *Choanephora infundibulifera* CATDLF6 were isolated from the leaves of the plant that were found to enhance vindoline content by 229-403% without affecting the primary metabolism. The maximum quantum efficiency of PSII, net CO2 assimilation, plant biomass and starch content of endophyte-inoculated plants were similar to endophyte-free control plants. The expression of terpenoid indole alkaloid (TIA) pathway genes; geraniol 10-hydroxylase (G10H), tryptophan decarboxylase (TDC), strictosidine synthase (STR), 16-hydoxytabersonine-O-methyltransferase (16OMT), desacetoxyvindoline-4-hydroxylase (D4H) and deacetylvindoline-4-O-acetyltransferase (DAT) were found to be upregulated in endophyte-inoculated plants. The gene for the vacuolar class III peroxidase (PRX1), responsible for coupling vindoline and catharanthine, was also up-regulated upon inoculation.

De Novo sequencing and analysis of lemongrass transcriptome provide first insights into the essential oil biosynthesis of aromatic grasses.

Aromatic grasses of the genus Cymbopogon (Poaceae family) represent unique group of plants producing diverse monoterpenes rich essential oils. Illumina-based high-throughput sequencing, de novo transcriptome assembly and analyses of *Cymbopogon flexuosus* (lemongrass) was carried out by CSIR-CIMAP as first step toward understanding the essential oil biosynthesis. Mining of transcriptome data and subsequent phylogenetic analysis led to the identification of terpene synthases, pyrophosphatases, alcohol dehydrogenases, aldo-ketoreductases, carotenoid cleavage dioxygenases, alcohol acetyltransferases, and aldehyde dehydrogenases, which are potentially involved in essential oil biosynthesis. SSR repeats linked to terpene pathway genes including the genes potentially involved in aroma biosynthesis were also identified.

1-Methyl-4-propan-2-ylbenzene from *Thymus vulgaris* attenuates cholinergic dysfunction.

Cholinergic dysfunction is manifested in a plethora of neurodegenerative and psychiatric disorders such as Alzheimer's, Parkinson's, and Huntington's diseases. An elaborate investigation was carried out by CSIR-CIMAP to study the potential of thyme oil and its individual components in curtailing cholinergic deficits. Thyme oil augments neurotransmission by modulating synaptic acetylcholine (Ach) levels and nicotinic acetylcholine receptor activity through up-regulation of genes cho-1, unc-17 and unc-50. Studies on individual components revealed para-cymene (1-methyl-4-propan-2-ylbenzene) as the active component of thyme oil, contributing its effects through upregulation of cho-1, cha-1, unc-17 and unc-50, while down-regulating ace-1 and ace-2. Thymol and gammaterpinene which although were devoid of any activity individually, exhibited significantly enhanced synaptic Ach levels and nicotinic acetylcholine receptor (nAchR) responsiveness, when administered in combination.

New plant varieties developed:

- During the year 2016-17, CSIR-CIMAP has released new varieties of *Vetiveria zizanioides* (CIM-Samriddhi), *Curcuma longa* (CIM-Pitamber) and *Ocimum basilicum* (CIM-Surabhi and CIM-Snigddha). The characteristic of these developed varieties are as below:
- CIM-Samriddhi: It is a high yielding Khusilal-rich (>30%) variety of Vetiver. This variety is able to produce 35 Kg/hectare of essential oil as compared to 25 Kg/hectare produced from the currently popular variety CIM-Vriddhi.

- CIM-Pitamber: It is a high yielding variety of turmeric with rhizome yield potential of 60-65 tons/ha containing 12.5% curcuminoides in a relatively short duration of 180-190 days.
- CIM-Snigddha: It is a methyl cinnamate-rich (78.7%) high essential oil yielding variety of O. basilicum. The potential herb yield of this new variety is 221 q/ha and oil yield of 190 Kg/ha.
- CIM-Surabhi: It is a high linalool-rich, high essential oil yielding variety of sweet basil (O. basilicum).

Development of nano-composite as low cost catalyst in organic synthesis:

Polymer stabilized palladium (Pd@PS) nanoparticles (NPs) developed by CSIR-IHBT, catalyzed α-alkylation of acyclic, cyclic, and aliphatic ketones with methanol, ethanol, and long chain alkyl and benzyl alcohols. The heterogeneous catalyst, Pd@PS, was found to be highly active for most challenging small chain alkyl alcohols such as methanol and ethanol in alkylation reaction following oxidation, condensation, and reduction approaches.

Fig: 8.2 Polymer stabilized palladium nanoparticles catalyzed alkylation of ketones

Software system to identify wrong *de novo* genome assembly

With the advent of short-reads-based genome sequencing approaches, large number of organisms are being sequenced all over the world. Most of these assemblies are done using some *de novo* short read assemblers and other related approaches. However, the contigs produced this way are prone to wrong assembly. So far, there is a conspicuous dearth of reliable tools to identify mis-assembled contigs. Mis-assemblies can result from incorrectly deleted or wrongly arranged genomic sequences. In the present work, CSIR-IHBT assessed various factors related to sequence, sequencing and assembling for their role in causing mis-assembly by using different genome sequencing data. Finally, some mis-assembly detecting tools were evaluated for their ability to detect the wrongly assembled primary contigs, the present work, proposes a simple unsupervised learning-based novel approach to identify mis-assemblies in the contigs which were performing reasonably well when compared to the

already existing tools. The proposed methodology may work as a complementary system to the existing tools for enhanced accuracy.

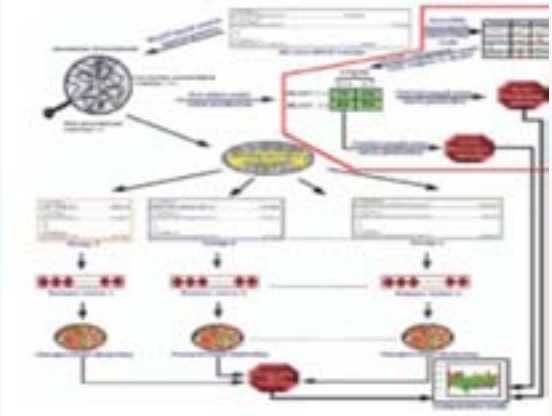


Fig: 8.3 Software system to identify wrong genome assembly

Exploration of secondary metabolites from medicinal plants of Himalayas

Studies on regulation of secondary metabolites in the medicinal plants of Himalayas, the secondary metabolite pathway in *Picrorhiza kurroa* was deciphered by CSIR-IHBT. Therefore, a study was undertaken to gain insights into key regulatory molecules underlying the differential regulation of picrosides by temperature. miRNA libraries were prepared from leaf and rhizome tissues of *P. kurroa* plants exposed to different temperatures and a total of 286 identified miRNAs. Out of these, several of bioinformatically validated miRNAs were found to belong to different biological pathways including plant hormone signal transduction, plant pathogen interaction, phenylpropanoid, stilbenoid, cysteine and methionine metabolism and pentose and glucuronate pathways. The results suggest an important role of miRNAs at different temperatures in regulating expression of the targeted genes/transcripts. Furthermore, the genome of P. kurroa was sequenced for the complete understanding of genes involved in the picroside biosynthetic pathway. Since, the information on whole genome sequence of *P. kurroa* is also not available in public domain, whole genome sequencing of *P. kurroa* was also initiated. The genomic libraries were prepared from the leaf tissues and sequenced using two NGS platforms: Illumina GA IIx and Pacific Biosciences. The assembly of draft genome sequence of P. kurroa is under way. The outcome from such studies has far reaching implications in the metabolic engineering of plant secondary metabolism and synthetic biology.

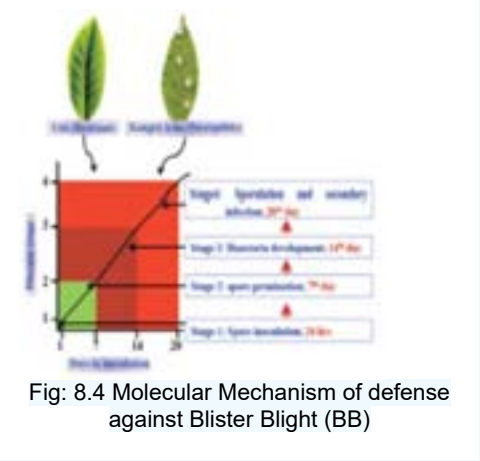


Fig: 8.4 Molecular Mechanism of defense against Blister Blight (BB)

Unravelling the molecular mechanism of defense against blister blight (BB)

Blister Blight (BB) disease caused by the basidiomycetes obligate biotrophic pathogen, Exobasidium vexans Massee is amongst the most serious leaf diseases significantly affecting the commercial production of tea. Besides affecting the quality of tea significantly, it causes more than 40% total yield loss. Therefore, it is important to breed tea plants resistant to blister blight. Marker assisted breeding can be of particular importance in this regard. However, while candidate markers are required for implementation of markers assisted breeding as tea suffers from the non-availability of such markers. Therefore, a study was undertaken by CSIR-IHBT to unravel the molecular mechanism of defense

against BB for combining traits in high yielding quality tea clones. In the study, key candidates were identified to analyze BB interactions with resistant and susceptible tea genotypes using genome-wide RNA-seq during ~20-day disease cycle. From the study, approximately 69 million high quality reads were assembled de novo and 37,790 unique transcripts including 149 defense related transcripts were identified. Further, confirmation of abundant expression of well known RPM1, RPS2 and RPP13 in quantitative Real Time PCR indicated the possibility of salicylic acid and jasmonic acid mediated synthesis of antimicrobial compounds required to overcome the virulence of E. vexans. The findings can serve as important esource for unravelling the possible regulatory mechanism(s) of immunity against various biotic tresses in tea and other crops.

Global Burden of Disease 2015 and 2016 update program

The global burden of diseases (GBD), injuries and risk factors study is the most comprehensive effort to date to measure epidemiological levels and trends worldwide. GBD 2015 analysed 249 causes of death, 315 diseases and injuries, toll of early deaths and disability and 79 risk factors in 195 countries and territories between 1990 and 2015, published in one special issue of Lancet. At the Institute for Health Metrics and Evaluation (IHME), University of Washington in 2007 under the leadership of Prof. Christopher J.L. Murray, MD, DPhil, researchers began gathering rigorous and scientific evidence on health to launch a new era of independent, objective assessments to diagnose the world's health problems and identify the solutions to address them. Data for the project are collected, analyzed and critically reviewed by 1,870 collaborators. Role of CSIR-IITR as a GBD collaborator were providing critical feedback on data sources, providing critical feedback on methods or results and drafting the work or revising it critically for important intellectual content to prepare the final draft of GBD documents.All the studies undertaken in the GBD were published in the above document of Lancet and other issues, New England Journal of Medicine etc. The GBD data outcomes will enable to achieve the Sustainable Development Goals (SDG), through world's decision-makers and development partners like WHO, UNICEF etc and national policy makers to make the best possible decisions when determining how to allocate money, talent, and attention to combat health issues including Sustainable Development Goals (SDG) -3: Ensure healthy lives and promote well being for all at all ages.

Anacardic acid was identified as an important candidate molecule for the improvement of yield and fibre quality in cotton.

It has been demonstrated that the over-expression of Pectin methylesterase (PME) isolated from Arabidopsis *thaliana* and *Aspergillus niger* provides resistance against broad spectrum of insects by producing methanol. It is being tried to introduce this gene in cotton for methanol production for insect resistance.

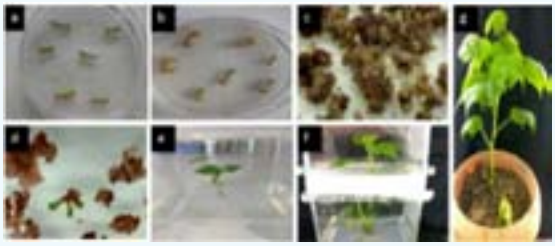


Fig.: 8.5 Different stages of transgenic cotton developed via somatic embryogenesis. (a) Hypocotyls as explants. (b) Callusformation fromexplants. (c) Embryogenic callus formation bearing globular embryos. (d) Bipolar embryo formation. (e-f) Plantlet formation. (g) Putative

Breeder seeds of high the baine lines of opium poppy

The Breeder seeds of high thebaine lines , developed by the institute are being multiplied in isolation plots at CSIR-NBRI campus for commercialization, and performance trials of these thebaine lines were conducted at various villages of Rajasthan and Madhya Pradesh.

The analysis of sterol glycosyltransferase (sgt) gene family of *Withania* artificial miRNA technology in the glycosylation of secondary metabolite revealed that sterol glycosyltransferase enzyme activity of *W. somnifera* provides tolerance against high temperature.

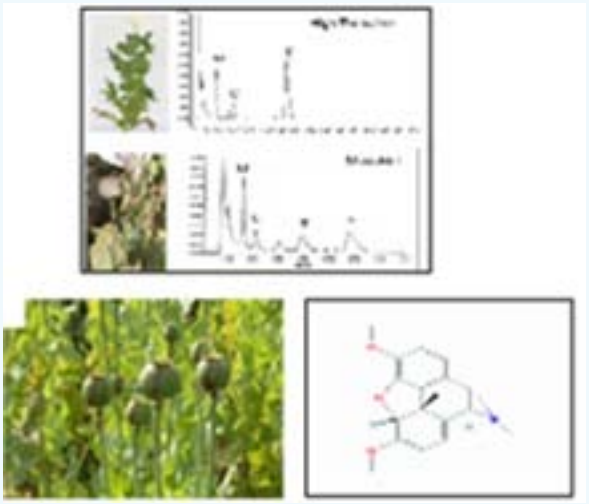


Fig. 8.6 Thebaine rich line of opium poppy developed by NBRI (a) Comparative HPLC profile of thebaine line and a variety (b) field view of thebaine line (c) chemical structure of Thebaine

Alpha-Cyclodextrin Interacts Close to Vinblastine Site of Tubulin and Delivers Curcumin Preferentially to the Tubulin Surface of Cancer Cell-

Tubulin is the key cytoskeleton component, which plays crucial role in eukaryotic cell division. Recently, it has been shown that few polyhydroxy carbohydrates perturb tubulin polymerization. Cyclodextrin (CD), a polyhydroxy carbohydrate has been extensively used as the delivery vehicle for delivery of hydrophobic drugs to the cancer cell. However, interaction of CD with intracellular components has not been addressed before. CSIR-IICB has shown for the first time that α-CD interacts with tubulin close to the vinblastine site using molecular docking and Förster Resonance Energy Transfer (FRET) experiment. In addition, they have shown that α-CD binds with intracellular tubulin/microtubule. It delivers high amount of curcumin onto the tubulin surface of cancer cell, which causes severe disruption of intracellular microtubules. Finally, they have shown that the inclusion complex of α-CD and curcumin (CCC) preferentially enters into the human lung cancer cell (A549) compared to the normal lung fibroblast cell (WI38), causes apoptotic death, activates tumor suppressor protein (p53) and cyclin-dependent kinase inhibitor 1 (p21) and inhibits 3D spheroid growth of cancer cell.

Lactucaxanthin – a potential anti-diabetic carotenoid- *Food & Function*

Intestinal and pancreatic α-amylase and α-glucosidase inhibitors offer an approach to lower the levels of post-prandial hyperglycemia through the control of dietary starch breakdown in digestion. This study by CSIR-CFTRI hypothesized that lactucaxanthin (Lxn) in lettuce (Lactuca sativa) inhibits the activity of α-amylase and α-glucosidase Lxn was isolated from lettuce with 96% purity confirmed by HPLC and LCMS. The *in vivo* results showed an increased activity for α-amylase and α-glucosidase in the intestine (4.7 and 1.30 fold, $p < 0.05$) and pancreas (1.3 and 1.48 fold, $p < 0.05$) of STZ induced

diabetic rats compared to normal rats. Lxn significantly inhibited ($p < 0.05$) the activity of α-amylase and α-glucosidase and could be of medicinal and nutritional relevance in the treatment of diabetes.

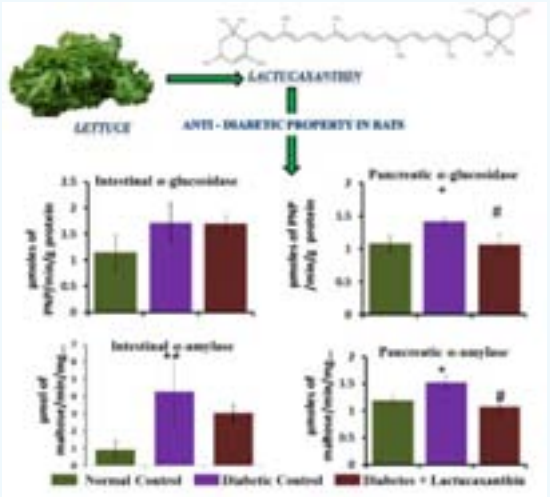


Fig: 8.7 Lactucaxanthin showing anti-diabetic activity

Removal of nutrients and organic pollution load from pulp and paper mill effluent by microalgae in outdoor open pond.

A mixed culture of microalgae, containing two *Scenedesmus* species, was analysed by CSIR-CFTRI to determine its potential in coupling of pulp and paper mill effluent treatment and microalgal cultivation. Laboratory studies suggested that 60% concentration of wastewater was optimum for microalgal cultivation. A maximum of 82% and 75% removal of BOD and COD respectively was achieved with microalgal cultivation in outdoor open pond. By the end of the cultivation period, 65% removal of NO_3-N and 71.29% removal of PO_4-P was observed. The fatty acid composition of mixed microalgal culture cultivated with effluent showed the palmitic acid, oleic acid, linoleic acid and α-linolenic acid as major fatty acids. The results obtained suggest that pulp and paper mill effluent could be used effectively for cultivation of microalgae to minimize the freshwater and nutrient requirements.

Influence of pre-treatments on post-harvest quality characteristics and shelf life extension of green tamarind fruits stored under different conditions.

An attempt was made by CSIR-CFTRI to prolong the shelf life and to preserve post-harvest quality of fresh tamarind fruits pretreated with fruit hardening chemical agents and aroma chemical compound stored under different storage (Room temperature and low temperature storage) conditions. Optimally matured (TSS 9-10°Brix) fresh and green tamarind fruits were first water washed, sorted to remove mechanically damaged and deformed ones and graded for uniform size, colour, texture and then hydro-cooled for 10 minutes, followed by the post-harvest dip treatments [T0–Control (Untreated), T1-0.25% Calcium chloride, T2-0.5% Calcium chloride and T3–500ppm Phenyl acetaldehyde] for 10 minutes. Both control and treated fruits were surface dried using mechanical driers, then packed into plastic trays with proper cushioning material and stored at RT (29±2°C, 65-70%) and low temperature (LT) conditions (4±10C,90-95% RH). These stored fruits were periodically analyzed for changes in various physiological and physico-chemical quality attributes. The results on LT and RT storage studies indicated that tamarind responded very well to fruit hardening salt, calcium chloride at 0.50% in terms of retention of fruit firmness, fruit color and total phenolic, apart from reduction in physiological loss in weight, effective shelf life of tamarind fruits in fresh form up to 28 days at LT and 16 days at RT storage conditions as against 16 days and 8 days respectively in untreated controls when stored under same conditions.

Selective Binding of Genomic *Escherichia coli* DNA with ZnO Leads to White Light Emission: A New Aspect of Nano−Bio Interaction and Interface

For the first time, a novel and intriguing application of deoxyribonucleic acid (DNA) in the area of optics by demonstrating white light emission by tuning the emission of a nanomaterial, ZnO rods, exhibiting surface defects, in the presence of genomic *Escherichia coli* DNA with comparatively high quantum efficiency. In order to understand the DNA specificity, CSIR-IICB also studied the interaction of ZnO with CT, and ML DNA, ss EC DNA, synthetic polynucleotides and different mononucleosides and bases. The studies unequivocally confirmed that the concentration and the nature of DNA and ZnO together plays a crucial role in obtaining CIE coordinates (0.33, 0.33) close to white light. The much enhanced melting temperature (Tm) of EC DNA and the energetics factors confirm enhanced hydrogen bonding of ZnO with EC DNA leading to a new emission band. Our experimental observations not only confirm the selective binding of ZnO to EC DNA but also open a new perspective for developing energy saving light emitting materials through nano-bio interactions

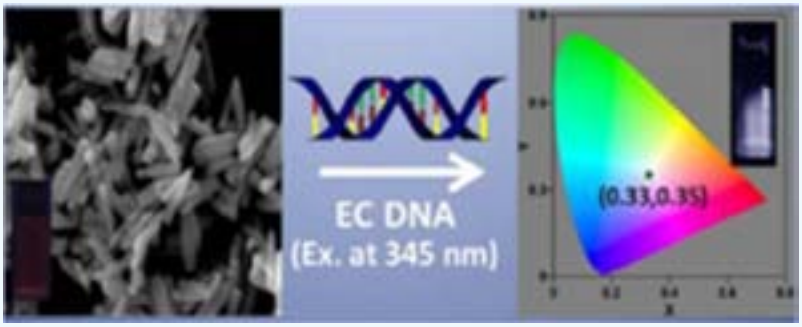


Fig. 8.8 A New Aspect of Nano−Bio Interaction and Interface

Chemical Sciences

Defect-Rich Metallic Titania (TiO1.23) - An Efficient Hydrogen Evolution Catalyst

A promising alternative to platinum for hydrogen evolution electro-catalyst, earth-abundant “titania” has investigated by CSIR-CECRI wherein electroinactive titania has been surmounted by exploiting defect engineering as a tool, which tailors the local atomic structure of nonconductive titania via electrochemical cathodization strategy. These findings suggest that by tuning oxygen vacancies in the lattice and its concomitant cumulative strained configuration, reduced titania can be an effective Hydrogen Evolution Reaction (HER) electro-catalyst for electrochemical water splitting.

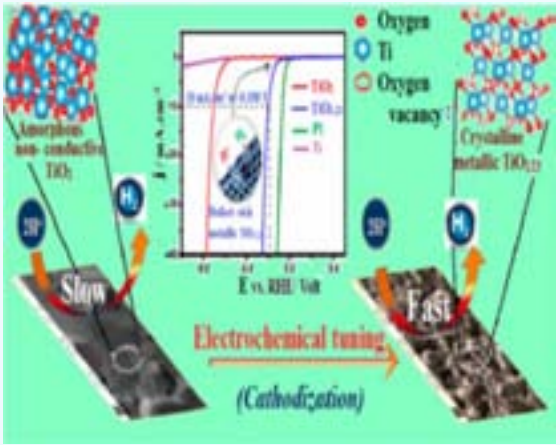


Fig: 8.9 Defect-Rich Metallic Titania as electro catalyst for electrochemical reaction

Pt Nanoparticle Anchored Molecular Self-Assemblies of DNA: An Extremely Stable and Efficient HER Electrocatalyst with Ultralow Pt Content

Platinum nanoparticles were successfully anchored on molecular self-assemblies of DNA and attempted as an efficient electrocatalytic hydrogen evolution reaction (HER) with ultralow loading of Pt to make economically affordable for water electrolyzers was carried donly CSIR-CECRI.

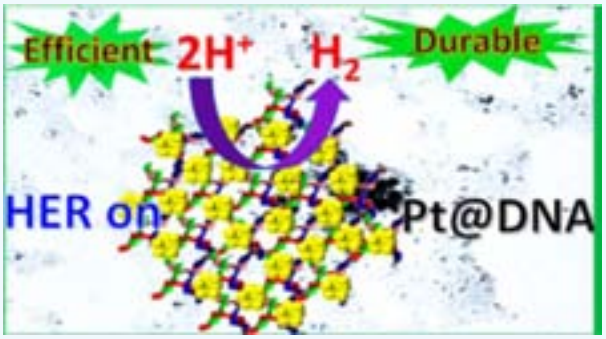


Fig: 8.10 Platinum nanoparticles

Developing abiotic stress (salt and/or drought) tolerant crops for sustainable agriculture

The majority of agricultural crops grown nowadays are glycophytes (salt sensitive), and their productivity becomes commercially non-viable with an increase in salinity in the 4–8 dS/m range. Salinity and drought both adversely affect photosynthesis, metabolic pathways and physiology. Consequently, this retards plant growth. In Gujarat, salinity is emerging as a major constraint for profitable production of crops like cumin, ground-nut etc. Halophytes are considered as a rich source of salt responsive genes that play an important role in engineering stress tolerance into glycophytes. *Salicornia brachiata* is an extreme halophyte that thrives in salt marshes and requires salt for growth. Adaptation to extreme salt conditions makes Salicornia a potential candidate for stress responsive genes. An expressed sequence tag (EST) database from *S. brachiata* subjected to salt stress has been developed by CSIR-CSMCRI. Some important genes like SbNHX-1, SbpAPX, SbASR etc. have been cloned and transformed to Tobacco (model plant), Cumin, Jatropha and Groundnut. These transgenic plants were first characterized under laboratory conditions and thereafter tested under containment facility (green house) as per bio-safety guidelines of DBT, Govt. of India. Transgenic plants have showed enhanced salt tolerance and also stable gene integration.

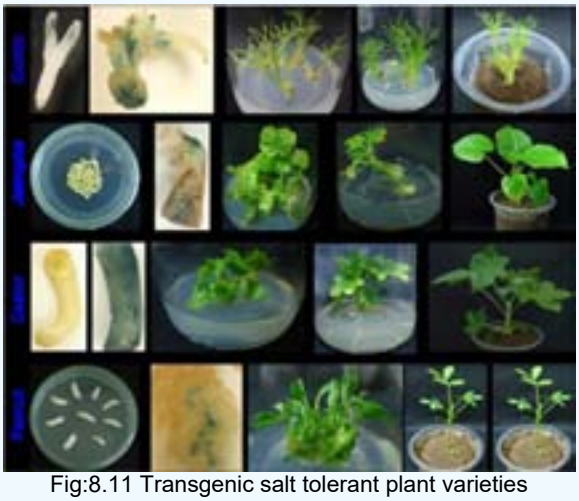


Fig:8.11 Transgenic salt tolerant plant varieties

Sustainable and efficient process for the preparation of polyethylene-polystyrene interpolymer based anion exchange membrane by in situ chloromethylation for electrodialytic applications

CSIR-CSMCRI has worked on the preparation of efficient and stable anion exchange membranes (AEMs) from the inter-polymer of polyethylene and polystyrene-co-polydivinylbenzene. The chloromethylated moiety in the interpolymer film was incorporated by in situ Friedly Craft reaction followed by quaternization with trimethylamine. This process dispensed the direct use of hazardous and carcinogenic chloromethyl ether which is required for functionalization of interpolymer films. The electrochemical properties such as membrane resistance, ionic conductivity and transport number have also been determined. The oxidative stability of the membrane has been verified by treatment with 3% Fentons reagent at room temperature. The performance of the membrane, in terms of water desalination by electrodialysis and ultrapure water production by electrodeionization process, has been evaluated and compared with polyethylene-poly4-methyl styrene interpolymer based membranes and two other commercial membranes (Lonsep and Fujifilm).

Block copolymer and injectable hydrogels for sustained delivery applications

Rapid gelation, low heat generation, biocompatibility, biodegradability, avoiding the use of small molecular weight gelator and high gel fraction are essential criteria for successful biomedical application of an injectable hydrogel. CSIR-CSMCRI has developed series of dually crosslinked injectable hydrogels of PEG and poly[2-(dimethylamino) ethyl methacrylate]-b-poly(N-isopropyl acrylamide) through extremely simple chemistry. Sequential reaction between PEG containing reactive termini and the copolymer provided chemically crosslinked hydrogels with gel fraction as high as 97-99% with gelation time 1-4 min in the physiological conditions. The gelation occurred with ca. 1oC rise in temperature/g of the injectable solution, avoids formation of by-products and can be performed at temperature range of 20-37oC. The hydrogels undergo hardening at physiological temperature as confirmed by the rheological experiments. The gelation time, water swelling, mechanical properties and the degradability of the hydrogels depend on the PEG to copolymer ratio in the injectable solution. Rheological behavior of the fully hydrated hydrogels showed desirable mechanical property for soft tissue regeneration. The hydrogels exhibited blood compatibility and retained the viability of HepG2 cells with time. Platelets adhesion and aggregation followed by fibrinogen adsorption ability makes these hydrogels suitable for wound healing application.

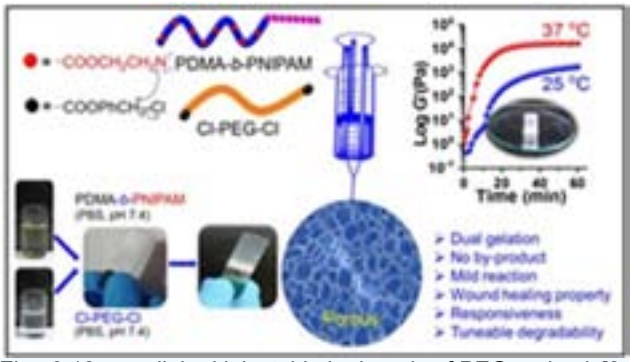


Fig: 8.12 crosslinked injectable hydrogels of PEG and poly[2-(dimethylamino) ethyl methacrylate]-b-poly(N-isopropyl acrylamide)

Development of material/metal complexes for diversified applications

The luminescent property of DNA like double helical molecules incorporating europium and terbium(III) ions have been employed for the detection and determination of AMP in the blood and urine. The nanocrystalline (001) faceted anatase TiO2 photocatalyst selectively oxidized non-activated aliphatic/cyclic alcohol to corresponding aldehyde/ketone. The first asymmetric synthesis of N-chiral amine oxides via dynamic kinetic resolution of unsymmetrical a-hydroxy tertiary amines (up to

91:9 er) has been achieved by CSIR-CSMCRI using a bimetallic titanium complex. The chiral macrocyclic CrIII salen complexes with various chiral collar catalyzed the asymmetric aminolysis of aromatic ester epoxides with various anilines to prepare the β-amino-α-hydroxyl esters in very good yield with high diastereo- and enantioselectivity. The detection of nitroaromatic explosives through fluorescence quenching in aqueous phase has been achieved using syntheses hydrolytic stable MOFs. The uniformly dispersed palladium nanoparticles supported on cucurbit [6]uril (CB[6]) has resulted in chemoselective hydrogenation of substituted nitrobenzene to aniline with excellent activity and selectivity (up to 100%) under mild reaction conditions.

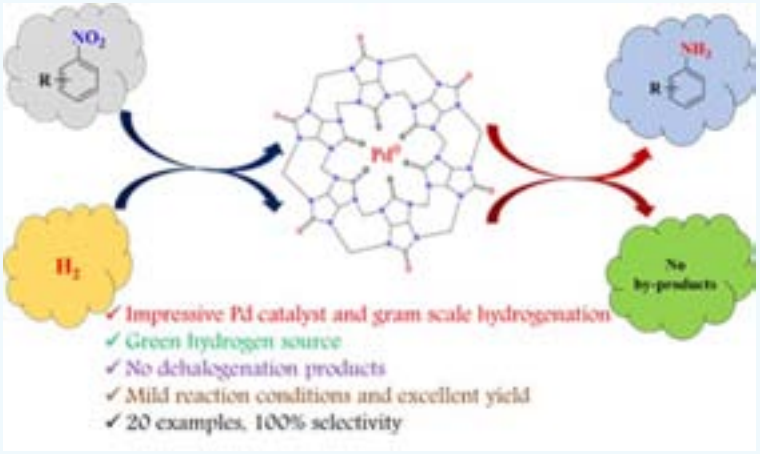


Fig: 8.13 Uniformly dispersed palladium nanoparticles

Porous polymer scaffold for on-site delivery of stem cells

Wound healing by cell transplantation techniques often suffer setbacks due to oxidative stress encountered at injury sites. A porous polyethyleneglycol–polyurethane (PEG–PU) scaffold that facilitates cell delivery and boosts tissue repair was developed by CSIR-IICT through semi-interpenetrating polymer network approach. The key physico-chemical properties assessed confirms these polymeric matrices are highly thermostable, barostable, degrade at an acidic pH (5.8), biodegradable, cytocompatible and possess excellent porosity. Mechanism of cellular penetration into porous polymer networks was evident by a ≥6 – fold increase in gene expression of MMP-13 and MMP-2 via activation of Akt and Erk. H2O2-induced apoptosis of mouse bone marrow stem cells (BMSCs) was abrogated in presence of polymer networks indicating a protective effect from oxidative stress. Transplantation of BMSC + PEG–PU at murine excisional splint wound site depicted significant increase in fibroblast proliferation, collagen deposition, anti-oxidant enzyme activities of catalase, SOD and GPx. Furthermore it significantly decreased expression of pro-inflammatory cytokines (IL-1β, TNF-α, IL-8, etc) with a concomitant increase in anti-inflammatory cytokines (IL-10, IL-13) at an early healing period of day 7. Finally, immunostaining revealed an enhanced engraftment and vascularity indicating an accelerated wound tissue closure. This pre-clinical study demonstrates the proof-of-concept and further necessitates their clinical evaluation as potential cell delivery vehicle scaffolds.

Engineered Asymmetric Composite Membranes with Rectifying Properties

Asymmetric composite membranes with rectifying properties were developed by CSIR-IICT grafting pH-stimulus-responsive materials onto the top layer of the composite structure, which is prepared by two novel block copolymers using a phase-separation technique. This engineered asymmetric composite membrane shows potential applications in sensors, filtration, and Nano fluidic devices. [Engineered Asymmetric Composite Membranes with Rectifying.

Polymer nanocomposites

Graphene is the 2D nanomaterial discovered during the past decade that has attracted outstanding research interest across several disciplines. The modification of graphene with hydrophilic/hydrophobic entities is pursued to broaden its application in several areas of nanoscience and technology. A process has been developed by CSIR-IICT for the preparation of graphene polymer nanocomposites with improved adhesion properties. Hybrid nanocomposites with conjugated polymers has been developed for improved optoelectronic properties.

Natural product derived new molecules were synthesized and evaluated as anticancer agents Mito-esculetin

CSIR-IICT has synthesized a novel mitochondria-targeted esculetin (Mito-Esc) and found that mito-Esc has a great potential to inhibit atherosclerotic features and age-delaying properties in ApoE-/- mice. Based on these results, a patent application has been filed on the 'synthesis and usefulness of Mito-Esc in the treatment of atherosclerosis', a major cardiovascular disorder. This patent entitled "An antioxidant compound having anti atherosclerotic effects and preparation thereof" has been recently approved by the USPTO (notice of allowance has been issued, 20160244470A1). Similarly patent applications on the above aspect have been filed in India (0478DEL2015), and UK (1602960.8).

Green chemistry by heterogeneous catalysis

The key research objective was to convert homogeneous catalytic reactions into heterogeneous versions (replacement of precious metal catalysts by first-row transition elements) through the attachment of catalytic sites on stable supports. CSIR-NCL carried out thermal decomposition of a molecular complex of a metal on a carbon support to obtain supported robust nanocatalyst and have designed several environmentally benign catalytic reactions, in particular acceptorless dehydrogenation and related reactions based on developed nanocatalysts. It has replaced an expensive noble metal catalysts with an inexpensive, benign, and sustainable nanoscale iron catalyst for the efficient acceptorless dehydrogenation of N-heterocycles and alcohols with liberation of hydrogen gas.

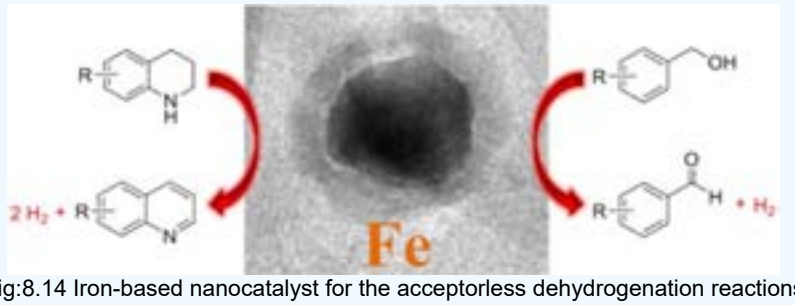


Fig:8.14 Iron-based nanocatalyst for the acceptorless dehydrogenation reactions

Field emission properties of highly ordered low aspect ratio carbon nanocup arrays

A high performance field emission of cup-stacked carbon nanotubes (CSCNTs) was designed and developed by CSIR-NCL. These 3D high-aspect ratio carbon nanocup structures were synthesized by a combination of anodization and chemical vapor deposition techniques. The morphological analysis revealed that CSCNTs have low-aspect ratio structures with a cup diameter of ~50 nm and length of ~100 nm. The enhanced field emission behavior observed for the CSCNTs is attributed to a high field enhancement factor of 1645, high field emission current density of 1 μA/cm2 and low turn-on field 2.30 V/μm with better emission current stability. The enhancements observed in CSCNTs arrays is attributed synergic effect of high aspect ratio, atomically sharp diameter of the cups, uniform distribution of the emitters over the whole area of specimen and lower screening effect of the

CSCNTs. These obtained results provide new information about the effect of the stacking carbon layers on their electronic properties and open up possibilities to integrate new morphologies of graphitic carbon in nanotechnology applications

Removal of arsenite and arsenate metal ions from wastewater using TFA and TAFA resins

In this study by CSIR-NCL, tanninformaldehyde (TFA) and tannin-anilineformaldehyde (TAFA) resins were synthesized and utilized successfully for an adsorptive removal of arsenite [As (III)] and arsenate [As (V)] metal ions from the contaminated water. A computational intelligence CI) based hybrid strategy was employed by CSIR-NCL to model and optimize the resin-basedadsorption of arsenite and arsenate metal ions for securing optimal reaction conditions. This strategy first uses an exclusively reaction data-driven modelling strategy, namely, genetic programming (GP), to predict the extent (%) ofarsenite/arsenate adsorbed on the TFA/TAFA resins. Finally, the sets of theoptimal reaction condition variables provided by the GP-GA hybrid method were verified experimentally. The verification results indicate that the optimized conditions have led to 0.3% and 1.3% increase in the adsorption of the arsenite and arsenate ions on the TFA resin. More significantly, the optimized conditions resulted in an improvement of 12.77% in the adsorption of arsenate on the TAFA resin. The GP-GA based strategy introduced here can be gainfully utilized for modeling and optimization of similar type of contaminant-removal processes

Developing Nanoengineered Charge Selective Intermediate Layers for Organic Photovoltaics

The performance and shelf-life of a solar cell strongly depends on the constituent materials and their transport (both bulk and interfacial) properties. From the engineering point of view, controlled processing of these materials that have better compatibility with cell fabrication techniques offers a significant value addition. A suitable screening tool that can be quickly optimized for an individual molecular system will have tremendous impact in developing practical OPVs. In CSIR-NIIST, has developed a solution processing method for fabricating inorganic intermediate materials that are compatible with the organic components in an OPV. Previously these materials were typically fabricated using inconvenient vacuum techniques. These specially designed layers offer huge advantage in terms of device stability and shelf-life. Also, the band positions can be chemically tuned to match operational requirements of the novel molecules. Owing to the higher thermal and chemical stabilities of these layers and due to fact that they offer a protection to the underlying organic components, even the air-processed solar cell offer much higher stability compared to the standard techniques.

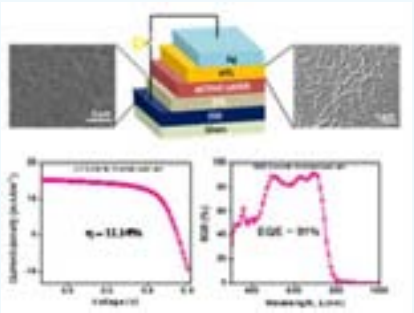


Fig: 8.15 Charge selective intermediate layers for organic photovoltaics

Organic Light Emitting Diodes (OLEDs)

Organic light emitting diodes (OLEDs) are the next generation lighting sources whose aesthetic appeal and the resemblance to the natural light make it more suitable for lighting application. In line

with the developments in OLEDs worldwide. White OLED with brightness more than 20000 cd/m^2 has been developed in CSIR-NIIST. These have maximum current efficiency of 40 cd/A and max power efficiency of 26 lm/w. At 10000 cd/m^2 the values are 38 cd/A and 16 lm/w. Further, CSIR-NIIST developed a light extraction technique which when applied improved the performance to 62 cd/A and 48 lm/w. At 10000 cd/m2 brightness the values are 52 cd/A and 24 lm/w.

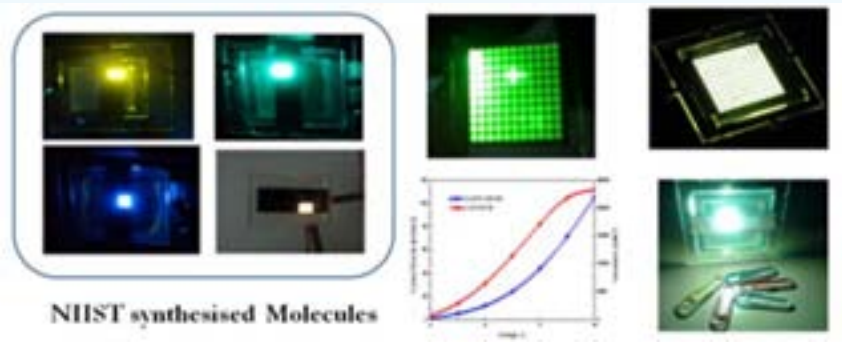


Fig: 8.16 Light emitting diodes

Enhanced Near Infrared Reflectance with Brilliant Yellow Hues inScheelite Type Solid Solutions, $(LiLaZn)_{1/3}MoO_4$−$BiVO_4$ for EnergySaving Products

CSIR-NIIST has synthesized enhanced near infrared (NIR) solar reflectance with interesting yellow hues in a new series of scheelite-type solid solutions, $[(LiLaZn)_{x/3}Bi_{1-x}][Mo_xV_{1-x}]O_4$ (x = 0, 0.1,0.2, 0.3, 0.4) via conventional solid state reaction (SSR) method and planetary ball milling assisted solid state reaction (PBM) method. The solid solutions undergo a phase transformation from a monoclinic to a tetragonal phase. The compounds exhibit strong absorption in the UV and blue regions of the visible spectrum displaying high NIR reflecting intense yellow shades ranging from reddish to greenish. The yellow hue and NIR reflectance is enhanced by the morphological modifications through PBM method. Typically, the pigment $[(LiLaZn)_{0.099}Bi_{0.7}][Mo_{0.3}V_{0.7}]O_4$ displayed intense yellow color (b* = 86.63) with NIR reflectance of 95% much better values than the commercial sicopal yellow. The applicability studies of these pigments on concrete cement block and metal sheet imparts good coloring performance with high NIR solar reflectance. Chemical and light resistance tests indicate their durability in the extreme weathering conditions. Thus, the prepared compositions consisting of less toxic elements demonstrate sustainable use of the present pigments in exterior surface coating applications as energy saving products

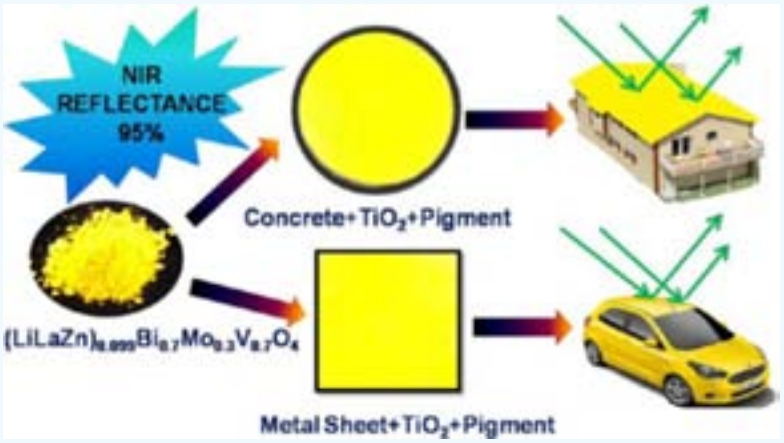


Fig: 8.17 Multifunctional inorganic pigments

Terbium doped Sr_2MO_4 [M = Sn and Zr] yellow pigments with high infrared reflectance for energy saving applications

A new class of environmentally benign and high infrared reflective inorganic yellow pigments, $Sr_2M_{1-x}Tb_xO_4$ (M = Sn and Zr; x = 0, 0.2 and 0.4) were synthesized at CSIR-NIIST by a solid-state route. The substitution of terbium in Sr_2MO_4 hosts produces visible light responsive compounds by shifting the absorption edge to higher wavelength side. The pigments exhibited good yellow hue (b^* = 53.4) with high NIR spectral reflectance of 95%. The coloring performance of the synthesized pigments was investigated in polymer matrix and on metal plates for potential applications. These results demonstrate the synthesized pigments as promising NIR reflective yellow colorants for cool roof and surface coating applications

Fig: 8.18 Pigment with high infrared reflectance

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Ceramic Colorants from Inorganic Industrial Solid Waste, 'Jarosite': A low cost Corrosion Resistant Pigment for Paints and Coatings

Processing of automobile grade Zn alloys from zinc ore through hydrometallurgy route discharge voluminous amount of inorganic waste named Jarosite. In India, a typical zinc alloy processing plant annually produced 0.25 million ton jarosite which is chemically a sodium and sulphate containing iron silicate. Jarosite solid residue is expressed as [M $(Fe_3(SO_4)(OH_6)]$ where M= Na^+,K^+,NH_4^+). Jarosite being a natural yellow pigment has >60% IR reflectivity. A chemical modification strategy is first employed by CSIR-NIIST for achieving hydrophobic surface that eventually prevent the leaching of hazardous impurities. A hydrophobic contact angle of 108° is seen over the chemical modification. Such surface engineered jarosite was found to offer exceptional adsorption to range of inorganic stains and hence it is examined to prepare series of 'adsorptive-pigments' to produce green, yellow, orange and brown colors. The newly developed colorants were systematically characterized for color index, particle size, morphology and NIR reflectance property. Subsequently, the hydrophobic, NIR reflective jarosite colorants were coated on traditional tile bodies to obtain cool-tiles. Further it is also investigated for the anticorrosion property over metallic iron sheet. This work describes an innovative process for obtaining high-value, mineral-pigment from the highly economical source, *jarosite,* for the first time.

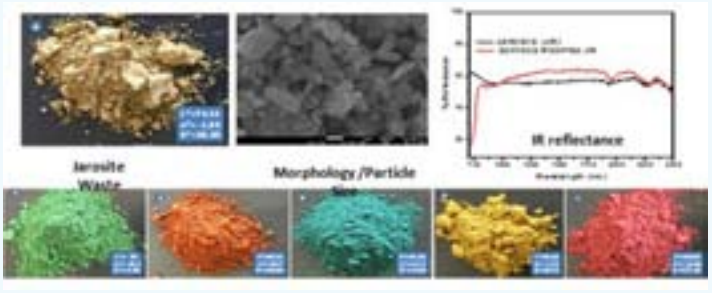


Fig: 8.19 Jarosite Colorants via adsorption

A lysosome targetable luminescent bioprobe based on a europium β-diketonate complex for cellular imaging applications

CSIR-NIIST has developed a novel lysosome targetable luminescent bioprobe derived from a europium coordination compound, namely $Eu(pfphOCH_3IN)_3(DDXPO)$ 4 [where $HpfphOCH_3IN$ = 4,4,5,5,5-pentafluoro-3-hydroxy-1-(1-(4-methoxyphenyl)-1H-indol-3-yl)pent-2-en-1-one and DDXPO = 4,5-bis(diphenylphosphino)-9,9-dimethylxanthene oxide]. Notably, the newly designed europium complex exhibits significant quantum yield ($\Phi_{overall}$ = 25 ± 3%) and $^5D_0$ excited state lifetime (τ = 398 ± 3 μs) values under physiological pH (7.2) conditions when excited at 405 nm. Hence the developed europium complex has been evaluated for live cell imaging applications using mouse pre-adipocyte cell lines (3T3L1). Colocalization studies of the designed bio-probe with commercial Lysosome-GFP in 3T3L1 cells demonstrated the specific localization of the probe in the lysosome with a high colocalization coefficient (A = 0.83). Most importantly, the developed bioprobe exhibits good cell permeability, photostability and non-cytotoxicity.

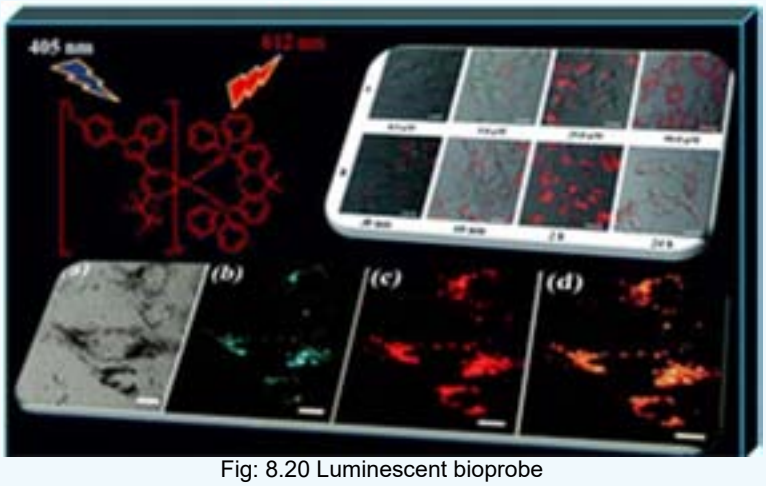


Fig: 8.20 Luminescent bioprobe

Scaling up of Beta Glucosidase (BGL) production from *Aspergillus niger*

BGL is a critical component in biomass hydrolyzing enzymes and addition of it can improve the efficiency of acid cellulases used in textile industry and can upgrade them to biomass hydrolyzing enzymes. CSIR-NIIST has a process for production of BGL using the fungus *Aspergillus niger* and developing this into a full-fledged technology for commercial deployment full performance data in blends with all leading cellulases for biomass hydrolysis, and with the techno-economic data.

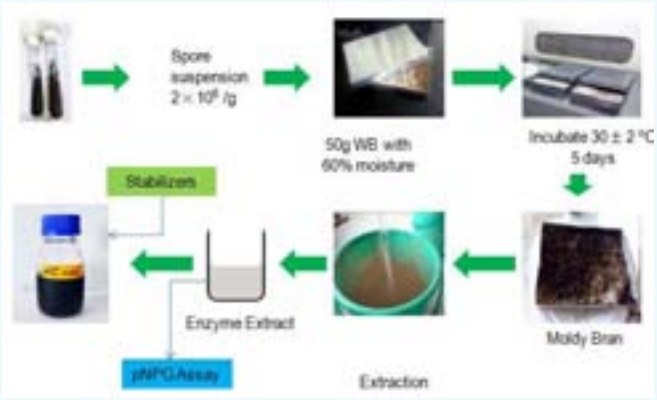


Fig: 8.21. Process flow for Scaling up of Beta glucosidase (BGL) production

Metal Oxide/Mxene Composite Electrodes for High Performance Supercapacitors

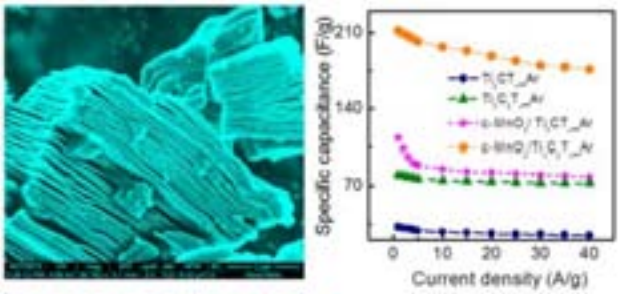


Fig: 8.22 nanocrystalline ε-MnO_2 whiskers formed on MXene nanosheet

Transition metal carbides (MXenes) are an emerging class of two dimensional (2D) materials with promising electrochemical energy storage performance. In CSIR-NIIST, nanocrystalline ε-MnO_2 whiskers were formed on MXene nanosheet surfaces (ε-MnO_2/Ti_2CTx and ε-MnO_2/Ti_3C_2Tx) to make nanocomposite electrodes for aqueous pseudocapacitorsn by direct chemical synthesis. The ε-MnO_2 nanowhiskers increase the surface area of the composite electrode and enhance the specific capacitance by nearly *three orders of magnitude* compared to pure MXene based symmetric supercapacitors. Combined with enhanced pseudocapacitance, the fabricated ε-MnO_2/MXene supercapacitors exhibited excellent cycling stability with ~88% of the initial specific capacitance retained after 10000 cycles which is much higher than pure ε-MnO_2 based supercapacitors (~74%). The proposed electrode structure capitalizes on the high specific capacitance of MnO_2 and the ability of MXenes to improve conductivity and cycling stability

Supercapacitors Based on Two Dimensional VO_2 Nanosheet Electrodes in Organic Gel Electrolyte

VO_2 is a low band-gap semiconductor with relatively high conductivity among transition metal oxides, which makes it an interesting material for supercapacitor electrode applications. In CSIR-NIIST, two-dimensional nanosheets of VO_2 are prepared by the simultaneous solution reduction and exfoliation from bulk V_2O_5 powder by hydrothermal method. The performance of VO_2 as supercapacitor electrode in organic electrolytes is being determined for the first time. A specific capacitance of 405 Fg^{-1} is achieved for VO_2 based supercapacitor in an organic electrolyte, in three electrode configuration. The symmetric capacitor based on VO_2 nanosheet electrodes and the liquid organic electrolyte exhibits an energy density of 46 Wh kg^{-1} at a power density of 1.4 kW kg^{-1} at a constant current density of 1 Ag^{-1}. Furthermore, flexible solid-state supercapacitors are fabricated using same electrode material and Alumina-silica based gel electrolyte. The solid-state device delivers a specific capacitance of 145 Fg^{-1} and a device capacitance of 36 Fg^{-1} at a discharge current density of 1 Ag^{-1}. Series combination of three solid state capacitors is capable of lighting up a red LED for more than 1 minute.

Three-Photon Active Organic Fluorophore for Deep Tissue Ratiometric Imaging of Intracellular Divalent Zinc

Deep tissue bioimaging with three-photon (3P) excitation using near-infrared (NIR) light in the second IR window (1.0–1.4 μm) could provide high-resolution images with an improved signal-to-noise ratio. In line with thisCSIR-NIIST have developed a photostable and nontoxic 3P excitable donor-π-acceptor system (GMP) having 3P cross-section (σ_3) of 1.78 x 10^{-80} cm^6 s^2 $photon^{-2}$ and action cross-section ($\sigma_3\eta_3$) of 2.31 x 10^{-81} cm^6 s^2 $photon^{-2}$, which provides ratiometric fluorescence response with divalent zinc ions in aqueous conditions has been. The probe signals the Zn^{2+} binding at 530 and 600 nm, respectively, upon 1150 nm excitation with enhanced σ_3 of 1.85 x 10^{-80} cm^6 s^2 $photon^{-2}$ and $\sigma_3\eta_3$ of 3.33 x 10^{-81} cm^6 s^2 $photon^{-2}$. The application of this probe is demonstrated for ratiometric 3P imaging of Zn2+ in vitro using HuH-7 cell lines. Furthermore, the Zn^{2+} concentration in rat hippocampal slices was imaged at 1150 nm excitation after incubation with GMP, illustrating its potential as a 3P ratiometric probe for deep tissue Zn^{2+} ion imaging.

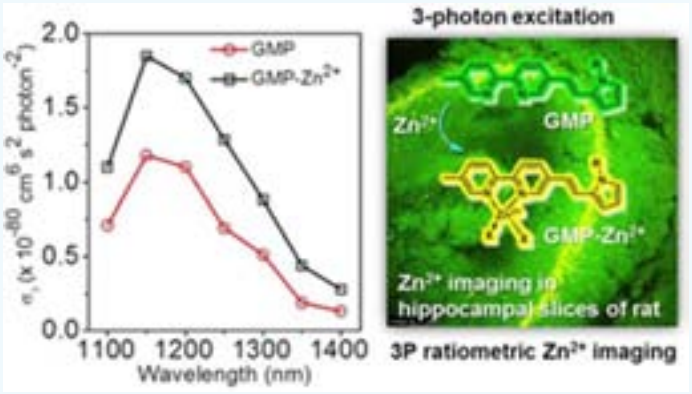


Fig: 8.23 Zn^{2+} imaging in hippocampal slices of rat
Fig:

Engineering Sciences

Development of a Novel Method for Evaluation of Seismic Earth Pressures on Retaining Wall

An analytical model is developed by CSIR-CBRI for the evaluation of seismic earth pressures on retaining wall. Developed theory is consistent with dynamic centrifuge experimental results. This can be used for safe and economic design of soil retaining structure considering wave propagation in the earthquake prone areas. Proposed method has immense potential for the inclusion in the standard codal provision, which is a step ahead of state of the art.

Surface-Engineered Multifunctional Eu:Gd2O3 Nanoplates for Targeted and pH-Responsive Drug Delivery and Imaging Applications

The synthesis of surface engineered multifunctional Eu:Gd2O3 triangular nanoplates with small size and uniform shape via a high-temperature solvothermal technique. Surface engineering has been performed by a one-step polyacrylate coating, followed by controlled conjugation chemistry. CSIR-CGCRI modified the drug molecules with terminal double bond and ester linkage for the easy conjugation of nanoparticles. The nanoparticle surface was further modified with free thiols to specifically attach the modified drug molecules with a pH-responsive feature. High drug loading has been encountered for both hydrophilic drug daunorubicin (~69% loading) and hydrophobic drug curcumin (~75% loading) with excellent pH-responsive drug release. These nanoparticles have also been used as imaging probes in fluorescence imaging. A detailed fluorescence imaging study has confirmed the efficient delivery of drugs to the nuclei of cancer cells with a high cytotoxic effect. Synthesized surface-engineered nanomaterials having small hydrodynamic size, excellent colloidal stability, and high drug-loading capacity, along with targeted and pH-responsive delivery of dual drugs to the cancer cells, will be potential nanobiomaterials for various biomedical applications.

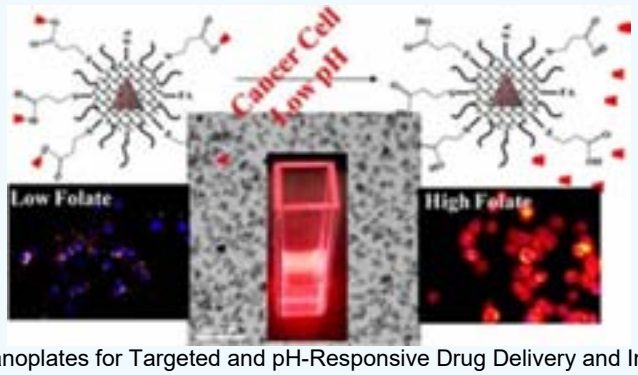


Fig: 8.24 Gd_2O_3 Nanoplates for Targeted and pH-Responsive Drug Delivery and Imaging Applications

Hierarchically Structured Macro with Nested Mesoporous Zinc Indium Oxide Conducting Film

Fabrication of homogeneously distributed (HD) macropores by breath figure process is an active research area. Adopting the process, for the first time, CSIR-CGCRI report the fabrication of HD macro with nested meso (hierarchical) porous nanocrystalline zinc indium oxide conducting sol−gel thin film on glass by dip-coating at 45−50% room relative humidity (RH) from a solution in ethanol-2-butanol (1:1, w/w) medium with a 1:1, Zn:In ratio. In this process, solution composition and RH are found to play key roles on HD macropore generation. The film is highly promising toward visible-light-driven photoelectrochemical water splitting

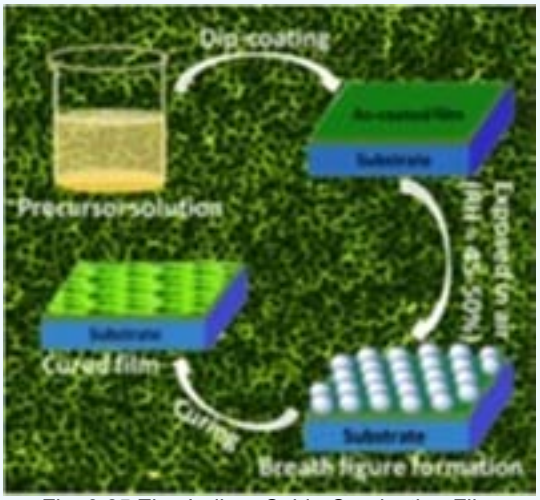


Fig: 8.25 Zinc Indium Oxide Conducting Film

Indian Highway capacity Manual - The main hypothesis behind conceiving the project was that Indian traffic

CSIR-CRRI study on Alignment Road from Sasoma to Saser Brangsa -The main objective of study is to carry out a detailed investigation to realign the existing alignment from KM 41.50 to KM 48.80 and propose suitable new alignment from KM 48.80 to KM 54.7.To achieve the stated objectives a study methodology was devised. The study team of CRRI carried out the required investigations to improve and realign the existing road from KM 41.5 to KM 48.8 (Figure) and propose the most appropriate alignment from KM 48.8 to KM 54.7.The major activities included topographical data collection, geometric design, geotechnical characterization and slope stability analysis and suggestion of remedial measures. Topographical data was collected from different sources namely Survey of India (SOI), Stereo Satellite data. Site investigation reports from various organizations and relevant literature were also collected. A detailed topographic survey was conducted using LiDAR technology on the study alignment.

The collected data was analyzed and geometric design and slope stability analysis were carried out. Finally Design Drawings (submitted in the month of November 2016) including horizontal, vertical alignment and cross section, remedial measure drawings were prepared and remedial measures were suggested. Final Report was submitted in December 2017.

Utilisation of Municipal solid waste in road construction/ emabankment –

A detailed study was carried out by CSIR- CRRI to investigate the possibility of utilizing the Municipal Solid Waste (MSW) collected from Ghazipur, East Delhi as an embankment fill material. The MSW is proposed to be utilized in the widening of NH-24 (Delhi-Meerut Expressway) from the existing 4 lane to 14 lane. The construction would be carried out by National Highway Authority of India (NHAI) under

the supervision of CSIR- Central Road Research Institute. About 200 tons of Municipal Solid Waste was collected from three different locations on the landfill site, based on its age. These materials were dried and then segregated into different sizes in the existing compost plant. The different fractions were studied for their suitability for use in embankment construction. A segregation methodology was proposed in the study to arrive at a final material to be used in the embankment This Municipal Solid Waste (MSW) was also studied for the presence of heavy metals by carrying out leachate studies. The segregated MSW is then characterised for its Geotechnical characteristics. Stability and Settlement analysis was also carried out to investigate its feasibility for embankment construction. It was concluded that ;

- About 65-75% of segregated Municipal Solid wastes can be used for embankment construction.
- Leachate studies indicate that MSW is a non hazardous material as concentration of heavy metals is within the permissible limit.
- Typical design cross sections with MSW embankment have been arrived for experimental test track construction along the Delhi-Meerut expressway. The MSW embankment would be instrumented and monitored over a period of 2 years before recommending the material for large scale field applications.

Environmental bacteria that could detect mercury and respond to presence of mercury by color change

CSIR-NEERI has Identified microbiome of foam and lake water from Bengaluru that produces high levels of biosurfactant. Efforts are towards developing bacterial consortia for bioremediation of mercury contaminated soil and control of foam formation in lake environment employing biological systems.

Anaerobic baffled reactor (ABR) for vegetable/kitchen

CSIR-NEERI has developed anaerobic baffled for biomethanation. The reactor demonstrated superior performance owing to longitudinal separation of acidogenic and methanogenic phases. This resulted in segregation of the microbial communities as per their respective roles in reactions of anaerobic digestion (viz., hydrolysis, acidogenesis, acetogenesis, methanogenesis) indicating efficient phase separation. The ABR also showedm high stability to organic and hydraulic shock loads with high sludge retention time leading to high efficiency and robustness. Further it was observed that the ABR supported hydrogenotrophic methanogenesis resulting in consistent 60% methane production

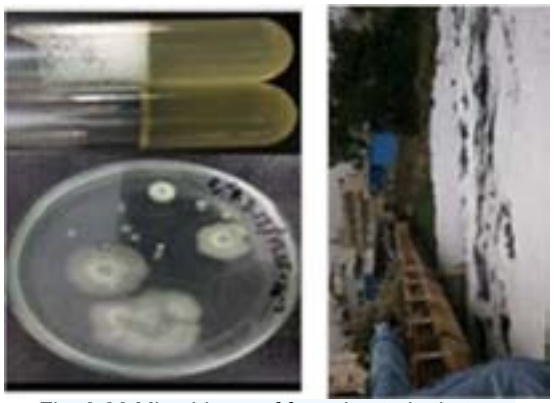


Fig: 8.26 Microbiome of foam bacteria that can detect mercury by color change

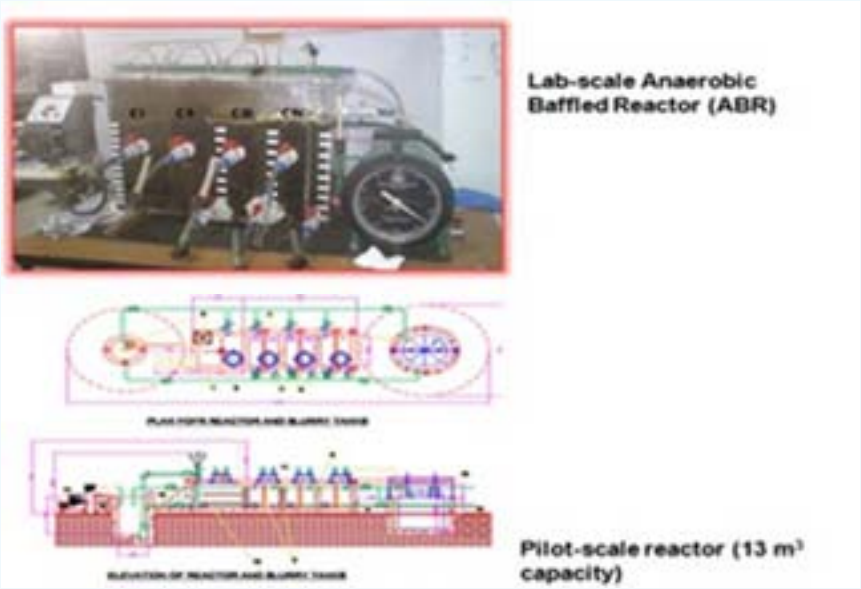


Fig: 8.27 Lab scale reactor & Pilot scale reactor

Water quality and Sediment analysis to understand the special properties of the Ganga River. To establish a substantial knowledge repository pertaining to the river Ganga, by covering myriad aspects of the River, and provide scientific foundation for the river management.

CSIR-NEERI Published a book naming "Chemistry of Volumetric Water Quality Analysis"

A GIS Based software tool is developed by CSIR-NML for assessment risk of contamination in water distribuition system by identifying most vulnerable pipe in supply lines. It also evalute water. Ultimately will utilised in Development of Water Safety Plan for urban local bodies/townships/villages

Development of Zero waste technology for processing and utilization of thermal coal

Technology developed by CSIR-NML for dry beneficiation of thermal coal. Validated the developed technology at pilot scale (5-10tph). Wet Processing Scheme developed for recovering the combustibles from rejects of dry circuit. Developed technology through geopolymerisation for making bricks at a pilot scale. Technology developed for making geopolymer cement from high iron containing fly ash (1 tpd). Developed a process for making geopolymer concrete using bottom ash (10 kg scale).

Hot Dip galvanizing simulation at CSIR-NML

- Development of Galvanizing and Galvannealing process for IFHS grade of steel. Optimization of thermal cycle for DP 590 grades of AHS steels using HDPS.
- Development of processes for Galvanizing of DP 590 and DP 780 grades of AHS steels

Reduction of silica in slimes of limestone washing plant (LSWP) by conventional & column flotation and utilization solurry waste for value added products

A process based on froth flotation technique using suitable reagents was developed for the recovery of calcium carbonate from limestone washing plant (LSWP) slimes. It mitigates the problems associated with handling of large quantities of slimes presently being lost as tailings; while recovering carbonate values by more than 50% by mass. A conceptual flow sheet was developed for implementation at plant scale of 140 tonnes per hour. Slurry waste with 40 to 50% solids generated from limestone washing plant has been utilized for the development of cost effective value added products such as tiles/pavers at laboratory scale. A conceptual flow chart for product making was also developed.

Informtion Sciences

The Climate Change Informatics programme at CSIR-NISCAIR has developed three facilities for Geospatial, Biospatial and Environmental studies as part of the VACCIN project. As a result India emerged as the pioneering leader to have studied for the first time the impact of climate variability and biogeography migration of marine living organisms on the top predator populations like tuna fishery in the Northern India Ocean.

As part of the CSIR Knowledge Gateway (KNOWGATE) project, CSIR-NISCAIR developed a web portal including federated searching for knowledge resources, a Virtual Union Catalogue using open source software, a CSIR Cloud Module to enhance computing power for data intensive research and applications hosting for KRCs and CSIR Trend Module for analysing research and technological data.

A scenario based approach to seismic hazard assessment:

Current computational resources and physical knowledge of the seismic waves generation and propagation processes allow for reliable numerical and analytical models of waveform generation and propagation. From the simulation of ground motion it is easy to extract the desired earthquake hazard parameters. Accordingly, a scenario-based approach to seismic hazard assessment has been developed by CSIR-4PI, namely the neo-deterministic seismic hazard assessment (NDSHA), which allows for a wide range of possible seismic sources to be used in the definition of reliable scenarios by means of realistic waveforms modeling. Such reliable and comprehensive characterization of expected earthquake ground motion is essential to improve building codes, particularly for the protection of critical infrastructures and for land use planning. The first ever neo-deterministic seismic hazard map of India was given by CSIR-4PI in 2003 by computing synthetic seismograms with input data set consisting of structural models, seismogenic zones, focal mechanisms and earthquake catalogues. The seismic hazard, expressed in terms of maximum displacement (Dmax), maximum velocity (Vmax), and design ground acceleration (DGA), has been extracted from the synthetic signals and mapped on a regular grid over the studied territory.

Velocity image along a transact in Dharwar Craton

CSIR-4PI generated velocity image along a transact in Dharwar Craton (from Talkaveri to Cudapah) using 22 broadband station data. This provides crustal structure beneath the transact which is helpful to understand the transition zone between Western and Eastern Dharwar, the geodynamics of the region and the velocity structure. It can also be used to precise the earthquake locations, simulation of ground motion for earthquake hazard assessment.

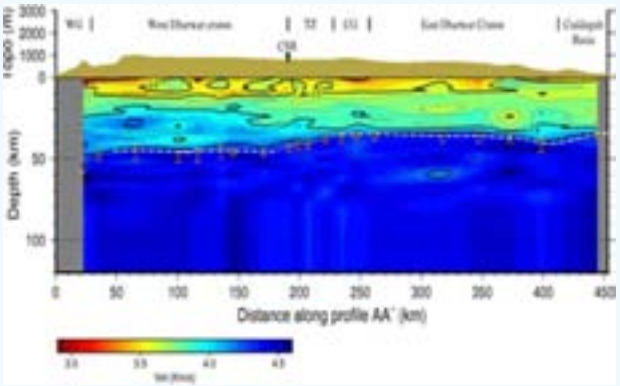


Fig: 8.28 transition zone between Western and Eastern Dharwar

High resolution long-range dynamical forecasting of Indian monsoon 2016

The first outlook of high resolution long-range forecast of the Monsoon 2016 was made available by CSIR-4PI in the middle of April, 2016. The date of onset of monsoon over Kerala, the seasonal (JJA) as well as monthly rainfall anomalies are forecasted using the variable resolution general circulation model (GCM). These forecasts are based on an ensemble (5 member) consisting of information on the atmospheric state (initial conditions) from 15th March 2016 to 15th April 2016. The forecasts are also presented in the pre-season meeting organized by IMD in mid-April; IMD acknowledged these forecasts. For 2016, the CSIR-4PI forecast of the date of Onset of Monsoon was June 02, while that of IMD was 8th June. The post season validation of the spatial distribution of monthly and seasonal rainfall anomalies show good agreement of the forecast with observation over many regions of the country.

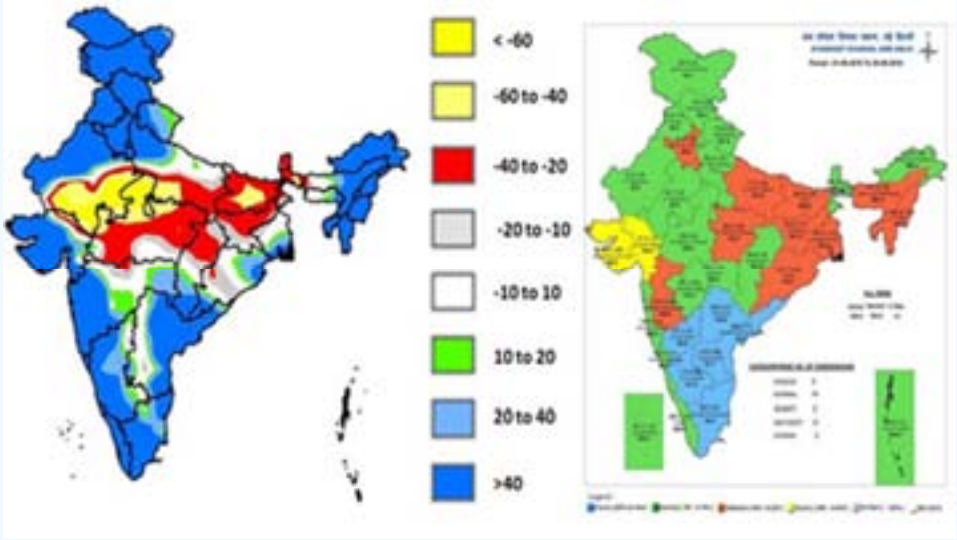


Fig: 8.29 The monthly scale validation of rainfall anomaly for June 2016

The relationship between antecedent soil moisture and monsoon rainfall over the Indian region through observational analysis.

Understanding the relationship between gradually varying soil moisture (SM) conditions and monsoon rainfall anomalies is crucial for seasonal prediction. Though, it is an important issue, very few studies in the past attempted to diagnose the linkages between the antecedent SM and Indian summer monsoon rainfall. CSIR-4PI examined the relationship between spring (April-May) SM and June rainfall using observed data during the period 1979-2010. The Empirical Orthogonal Function (EOF) analyses showed that the spring SM plays a significant role in June rainfall over the Central India (CI), South India (SI) and North East India (NEI) regions. The composite anomaly of the spring SM and June rainfall showed that excess (deficit) June rainfall over the CI was preceded by wet (dry) spring SM. The anomalies in surface specific humidity, air temperature, and surface radiation fluxes also supported the existence of a positive SM-precipitation feedback over the CI. On the contrary, excess (deficit) June rainfall over the SI and NEI region were preceded by dry (wet) spring SM. The abnormal wet (dry) SM over the SI and NEI decreased (increased) the 2m-air temperature and increased (decreased) the surface pressure compared to the surrounding oceans which resulted in less (more) moisture transport from oceans to land (negative SM-precipitation feedback over the Indian monsoon region).

Physical Sciences

Development of Electronic Devices

CSIR-CEERI has designed and developed ion controller based Fluid-FET concept for micro reactor; unique passive particle separator-cum-counter chip for WBC, RBC & plasma from blood; micro-viscometer based on dielectric property of fluids Designed Application specific instruction set processor (ASIP) and mixed signal sensor interface electronic circuits with patented auto-calibration technology. Voltametric methods for multisensor systems to authenticate various liquids, such as, milk, fruit juices, wine, soft drinks, teas and bottled water

Heliborne Geophysical Surveys

Under the Umbrella MoU signed between CSIR-NGRI and AMD to conduct Heliborne Geophysical Surveys in the parts of Kaladgi, Bhima, Satpura (MP) and Chhattisgarh blocks for Uranium Exploration, a total of 20939 LKM was covered over both Chhattisgarh and Satpura basins in the year 2016-17.

The Peak ground acceleration map of the central part of the Indo Gangetic plains shows the areas closer to the epicenter had relatively higher ground motion accelerations than the others. The violet region in the figure is the area where the maximum damage to built in environment occurred as well as the loss of life in comparison to the regions where the ground motion accelerations were less than 0.06 g.

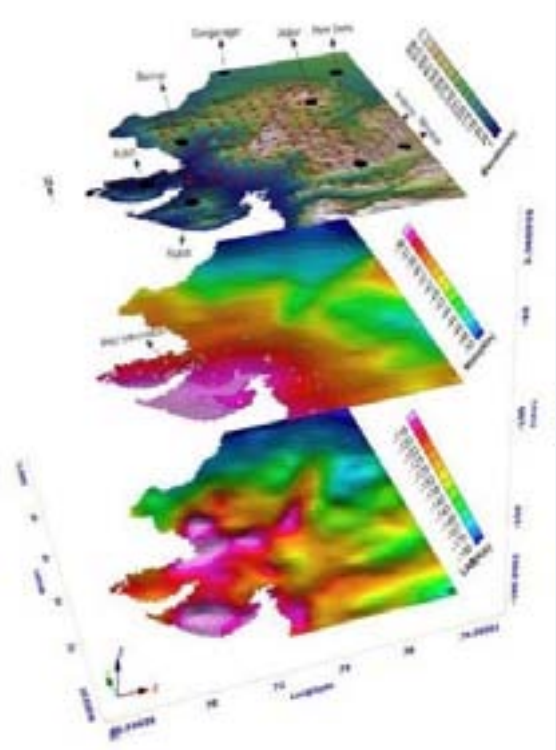


Fig: 8.30 Image of gas-hydrate (future potential energy resource) bearing marine sediments in Krishna Godavari offshore basin.

Full waveform inversion, the most advanced technique to image subsurface, has been able to resolve complex structures (circled) and BSR (a marker due to presence of gas-hydrate) and minute changes in velocity due to the presence of gas-hydrate.

9.0 CENTRAL MANAGEMENT ACTIVITY

9.1 CSIR Society

During the period, the CSIR Society met on 6th April, 2016 under the Chairmanship of Shri Narendra Modi the Hon'ble Prime Minister of India and President, CSIR.

The Hon'ble Prime Minister addressed the members and highlighted the need for deployment of scientific solutions to address the day to day problems of common man whether in the field of agriculture, productivity, malnutrition, health care, infectious diseases, genetic disorders, renewable energy, Defence, or detection of food adulteration etc.

The Hon'ble Prime Minister underlined the importance of vibrant scientists – students interaction. He stressed the need for every scientist to have the sensitivity and passion to improve the quality of life of people through technology solutions. He directed that parameters be laid down to assess the performance of CSIR laboratories and to create a healthy competition among various laboratories. He called upon CSIR to list at least one hundred problems being faced by people in India and solve them technologically within a specified time period.

The Hon'ble Prime Minister concluded by wishing CSIR fruitful research in areas that would bring societal goods.

The Society approved following items:

- Confirmation of the proceedings of the CSIR Society meeting held on 10th July, 2013.
- Annual Accounts of CSIR for the years 2012-13 and 2013-14, the Audit report and CSIR's comments thereon; and
- CSIR Annual Report for the year 2013-14.

9.2 Governing Body

During the year, the Governing Body (GB) of CSIR met twice i.e. on 01st June, 2016 and 22nd November, 2016. Some noteworthy decisions taken during these meeting are as follows:

9.2.1 187th meeting held on 01st June, 2016

The Chairman, GB, CSIR, Dr. Girish Sahni welcomed all the members and highlighted that the diversity of CSIR is its inherent strength. Given the diverse expertise of the laboratories, CSIR's focus is needed wide spread and in tune with the globalization, CSIR has reinvented itself and focus more on filing patents. However, the challenge before CSIR was to translate these patents to production. He informed that CSIR is also publishing good papers but the primary focus should be on providing technological solutions. He stressed that CSIR needed to change in accordance with changing times. He informed the GB about the last CSIR Society meeting wherein the Hon'ble Prime Minister of India and President, CSIR desired CSIR to look within and realign with its mandate i.e. to develop technologies that provide solutions to the problems of common man. He informed GB that CSIR would focus on simple and affordable solutions to the societal and industrial problems.

Following significant recommendations/ ratifications were made by GB:

- Payment of Honorarium to official and non-official member of CSIR Society; Governing Body; Advisory Board; Research Councils; Search/ Selection/ Assessment Committees (for Recruitment

and Assessment Board and CSIR Administration); Project Selection and Monitoring (NMITLI, OSDD, PPD & HRDG); Invited Guest Lecture (HRDC) and other activities of CSIR involving outside expert;

- Recruitment of Scientists. Amendment to Rule 6.1.2 (ii) of CSIR Scientist Recruitment and Promotion Rules, 2001;
- Enhancement of Fellowship amount in respect of Research Fellows working in EMR funded projects;
- Revision in terms and conditions in Bhatnagar Fellowship Scheme;
- CSIR-Industry Sponsored Research Fellowship Scheme;
- Hand over a portion of CSIR-NAL property situated at Kodihalli adjacent to Old Airport Road for construction of under pass at the junction of the Road;
- Transfer of CSIR-IIP land to Ministry of Road Transport & Highways, GOI;
- Transfer of land of CSIR-NEIST for NH-37 widening works;
- Transfer of physical possession of the Chhatar Manzil and Farhat Bux Palace bulding premises of CSIR-CDRI to the State Archaeological Directorate, Govt. of Uttar Pradesh; and
- Discontinuation of interviews for various junior level posts in GOI as well as in CSIR-recommendation of the Committee of Secretaries (CoS).

9.2.2 188th meeting held on 22nd November, 2016

The Chairman, GB, CSIR Dr. Girish Sahni made a brief presentation covering the key initiatives taken over the last one year that include Restructuring of CSIR Hqrs, Revisiting the CSIR Scientist Recruitment and Assessment Promotion Rules(CSRAP Rules), Cadre Review of administrative staff-related restructure and resizing, Revision of CSIR Guidelines of Transfer Technology and Utilization of Knowledgebase, Incentivization of performance etc. GB recommended/ ratified many items. Significant ones are:

- Launching of CSIR Aroma Mission;
- Creation of CSIR Innovation Fund;
- Revision of Prize money and terms of CSIR Technology and Innovation Awards;
- Revision of prize money and terms of CSIR Innovation Awards for School Children (CIASC);
- CSIR integrated Skill initiative;
- Enhancement of stipend in respect of Research Interns; Revisiting CSIR Guidelines for Technology Transfer and Utilisation of Knowledgebase;
- Transfer of land required by the Nagpur Metro Rail Corporation Ltd. (NMRCL) for entry and exit to the Metro Rail Station via Foot Over Bridge and for Parking of Vehicles;
- Amendments in Recruitment Rules for the post of Assistants (GEN/F&A/S&P);
- Amendments in Recruitment Rules, 2008 for the post of Director of CSIR Laboratories/ Institutes/ Centre;
- Restructuring and Review of the Administrative Cadres of CSIR;
- Review of CSRAP Rules-2001;

- Revision of Prize Money of (i) Shanti Swarup Bhatnagar Prize,(ii) CSIR Young Scientists Award and (iii) Introduction of prize money for GN Ramachandran Gold Medal; and
- Enhancement of CSIR Emeritus Scientist allowance and modification in selection/ eligibility criteria.

9.3 CSIR's Platinum Jubilee Foundation Day Celebration

The Hon'ble Prime Minister of India, Shri Narendra Modi ushered in CSIR's Platinum Jubilee Celebrations on 26 September 2016 with a lively interaction with farmers from five different locations across the country. The Prime Minister, who is also the President of the Council of Scientific and Industrial Research (CSIR), dedicated seven new varieties of medicinal plants developed by CSIR laboratories to the nation at a function held in Vigyan Bhawan in New Delhi.

An exclusive exhibition of major technological contributions of CSIR was organized for the benefit of the Hon'ble PM. The exhibits that showcased some of the most stellar achievements of CSIR including the ones that are in the pipeline and have great potential of delivery to remove the drudgery of the common masses, largely in the areas of healthcare, water conservation, solid waste management, waste-to-wealth, Communication & IT, housing, industrial competitiveness, and contributions to the strategic sector.

The Hon'ble Prime Minister then released new varieties of turmeric, khus, Rose-scented geranium, aromatic grass Citronella, Lemongrass, flowering plant lily and ornamental flower plant Gerbera developed by CSIR labs. These were simultaneously handed over to farmers at five different locations – Hyderabad, Cuddalore, Palampur, Jorhat and Jammu. The Honble Prime Minister Shri Narendra Modi also had a live interaction with the farmers via video-conferencing where he urged them to strive for taking a quantum jump in agriculture with the help of science & technology. He also encouraged them to use modern technology, increase participation of youth in agriculture, concentrate on value addition based agriculture and explore different markets for their produce.

- "CSIR has done a lot for the healthcare sector. But can we develop cost-effective diagnostic kits which could even be used by health workers in rural areas?"

"A major reason why the poor suffer from diseases is because of filth and dirt. We should develop affordable technologies for waste management, waste to wealth creation, and safe drinking water."

- "CSIR has done a lot of work on water security. But we should give more thrust on economically, effectively and efficiently using our water resources."
- "In agriculture, our aim is 'per drop more crop'. But keeping into account the scarcity of both water and land we should have another mission – 'an inch of land and a bunch of crop'.
- He appreciated the exhibition showcasing CSIR's achievements and suggested that the exhibition should be taken to other parts of the country, so that people can know and appreciate CSIR's contributions.

9.3.2 Address by Dr. Harsh Vardhan, the Hon'ble Union Minister of S&T and ES, and Vice President, CSIR

The Hon'ble Minister of Science & Technology and Earth Sciences, Dr. Harsh Vardhan while thanking the Hon'ble Prime Minister for his valuable support and guidance, assured him that CSIR would definitely deliver to the nation in a time-bound manner. He said that this journey of 75 years has been glorious and, after having seen all the scientists working in the various labs on his visits to most of the laboratories all over the country and having seen the diverse types of activities in CSIR, he had no doubt that CSIR was certainly the finest institution in the country. That is why today it is the only institution in the whole of India that is a part of the first 100 best institutions in the world.

The hon'ble Minister said that CSIR and our scientists, various other arms of our ministry whether Biotechnology or Earth Science and other departments – they have the potential, capability, knowledge, experience and the wisdom to solve any problem of the country. "You give them the problem and they will be able to solve it," he said. "The only request is, you have to help us to make it a big movement in the country and I can assure you that we will realize your vision of helping the farmers, helping the poor, helping the needy in this country and bring joy on the face of every Indian. What you have seen just now in the exhibition, it is only the tip of the iceberg."

9.3.3 Address by Dr. Girish Sahni, Director General, CSIR

Dr. Girish Sahni, Director-General, CSIR said that CSIR had touched the lives of all the citizens of the country. He said that CSIR is ranked very high among the world comity of R&D institutions, being recognized at the 12th position by SCIMAGO. This shows that CSIR does not only produce research papers but also produces technologies and patents. But these patents should not just remain as impressive statistics on paper, but should be realized for the greater good of the citizens of the country.

He said that inspired by the directions given by the Hon'ble Prime Minister four months ago our conviction that greater value should be released from S&T specifically for the benefit of the poor has become deeper and our resolution to follow this path stronger. This requires a readjustment of our collective mindset, because reaping technological benefits from fundamental science has its share of challenges. Many technological innovations of the early stage are not attractive to investors specially those that do not have the potential for large profits but have still significant relevance to society. Traditional ventures have found investments often woefully lacking.

Dr. Sahni informed that CSIR had also launched an ambitious Aroma and Phyto-Pharmaceutical Plants Mission for the first time to deliver value right from the beginning and also looks to pave the way for the Ayurvedic system and its propagation at a global level.

CSIR has already launched a Skill Development Initiative which will cater to the aspirations at the upper end of the value of skill development via our labs utilising their infrastructure and their human resources to train thousands of young people to be directly useful and attractive to industry. Similarly, through another plan called Jigyaasa, CSIR plans to incite curiosity and excitement in young students

through the scientific process. Students including those from Kendriya Vidyalayas, state govt. schools, etc. will be invited across India to spend quality time in CSIR's laboratories and gather first hand experience that how science is actually done.

9.3.4 Address by Hon'ble Minister of State for S&T and ES Shri Y.S. Chowdary

The Hon'ble Minister of State for Science & Technology and Earth Sciences, Shri Y.S. Chowdary said he envisioned a quantum jump in the field of Science & Technology research and gave a call to the scientific fraternity to work dedicatedly for the 'Target Nobel Prize'. The Ministry stands firmly behind all the efforts made in this direction, he added. He further said, "I would like to restate the CSIR's vision to pursue science, which strives for global impact, technology that enables innovation driven industry in nurturing trans-disciplinary leadership thereby catalysing inclusive economic development for the people of India." He said that the gap between the scientific fraternity and the common people and their increasing expectations needs to be filled up.

9.3.5 Shanti Swarup Bhatnagar Prize Presentation Ceremony for Science & Technology

Shanti Swarup Bhatnagar Prize for Science and Technology was instituted in the year 1957, in the memory of late Dr (Sir) Shanti Swarup Bhatnagar, FRS, the founder director of the Council of Scientific & Industrial Research (CSIR). The SSB Prize is awarded each year on the basis of conspicuously important and outstanding contributions to human knowledge and progress, made through work done primarily in India during the five years, preceding the year of the prize.

The SSB Prize, comprising a citation, a cash award of Rupees five lakh and a plaque, is given to each person selected for the award in the following disciplines:

- Biological Sciences
- Chemical Sciences
- Earth, Atmosphere, Ocean and Planetary Sciences
- Mathematical sciences
- Medical Sciences
- Physical Sciences

Shanti Swarup Bhatnagar Prize 2012

Biological Sciences

- Dr Shantanu Chowdhury of CSIR-Institute of Genomics and Integrative Biology, Delhi; and.
- Dr Suman Kumar Dhar of Jawaharlal Nehru University, New Delhi

Chemical Sciences

- Dr Govindasamy Mugesh of Indian Institute of Science, Bangalore; and
- Dr Gangadhar J. Sanjayan of CSIR-National Chemical Laboratory, Pune

Engineering Sciences

- Dr. Ravishankar Narayanan of Indian Institute of Science, Bangalore; and
- Dr. Y Shanthi Pavan of Indian Institute Technology Madras, Chennai

Mathematical Sciences

- Dr. Siva Ramachandran Athreya of Indian Statistical Institute, Bangalore; and
- Dr. Debashish Goswami of Indian Statistical Institute, Kolkata

Medical Sciences

- Dr. Sandip Basu of Bhabha Atomic Research Centre, Mumbai.

Physical Sciences

- Dr. Arindam Ghosh of Indian Institute of Science, Bangalore; and
- Dr. Krishnendu Sengupta of Indian Association for the Cultivation of Science, Kolkata

Shanti Swarup Bhatnagar Prize 2013

Biological Sciences

- Dr. Sathees Chukkurumbal Raghavan of Indian Institute of Science, Bangalore.

Chemical Sciences

- Dr. Yamuna Krishnan of Tata Institute of Fundamental Research, Bangalore.

Engineering Sciences

- Dr. Bikramjit Basu of Indian Institute of Science, Bangalore; and
- Dr. Suman Chakraborty of Indian Institute of Technology, Kharagpur

Mathematical Sciences

- Dr. Eknath Prabhakar Ghate of Tata Institute of Fundamental Research, Mumbai

Medical Sciences

- Dr. Pushkar Sharma of National Institute of Immunology, New Delhi.

Physical Sciences

- Dr. Amol Dighe of Tata Institute of Fundamental Research, Mumbai; and
- Dr. Vijay Balakrishna Shenoy of the Indian Institute of Science, Bangalore

Shanti Swarup Bhatnagar Prize 2014

Biological Sciences

- Dr. Roop Mallik of the Tata Institute of Fundamental Research, Mumbai.

Chemical Sciences

- Dr. Kavirayani Ramakrishna Prasad of Indian Institute of Science, Bangalore; and
- Dr. Souvik Maiti of CSIR-Institute of Genomics and Integrative Biology, Delhi

Earth, Atmosphere, Ocean and Planetary Sciences

- Dr. Sachchida Nand Tripathi of Indian Institute of Technology, Kanpur.

Engineering Sciences

- Dr. S Venkata Mohan of CSIR-Indian Institute of Chemical Technology, Hyderabad; and

- Dr. Soumen Chakrabarti of Indian Institute of Technology, Mumbai.

Mathematical Sciences

- Dr. Kaushal Kumar Verma of Indian Institute of Science, Bangalore.

Medical Sciences

- Dr. Anurag Agrawal of CSIR-Institute of Genomics and Integrative Biology, Delhi.

Physical Sciences

- Dr. Pratap Raychaudhuri of Tata Institute of Fundamental Research, Mumbai; and
- Dr. Sadiqali Abbas Rangwala of Raman Research Institute, Bengaluru.

Shanti Swarup Bhatnagar Prize 2015

Biological Sciences

- Dr. Balasubramanian Gopal of Indian Institute of Science, Bangalore; and
- Dr. Rajeev Kumar Varshney of the International Crops Research Institute for the Semi-Arid Tropics, Hyderabad.

Chemical Sciences

- Dr. D. Srinivasa Reddy of CSIR- National Chemical Laboratory, Pune; and
- Dr. Pradyut Ghosh of Indian Association for the Cultivation of Science, Kolkata.

Earth, Atmosphere, Ocean and Planetary Sciences

- Dr. Jyotiranjan Srichandan Ray of Physical Research Laboratory, Ahmedabad.

Engineering Sciences

- Dr. Yogesh Moreshwar Joshi of Indian Institute of Technology, Kanpur.

Mathematical Sciences

- Dr. K Sandeep of TIFR Centre for Applicable Mathematics, Bangalore; and
- Dr. Ritabrata Munshi of Tata Institute of Fundamental Research, Mumbai.

Medical Sciences

- Dr Vidita Ashok Vaidya of Tata Institute of Fundamental Research, Mumbai.

Physical Sciences

- Dr. Bedangadas Mohanty of National Institute of Science Education and Research, Bhubaneswar; and
- Dr. Mandar Madhukar Deshmukh of Tata Institute of Fundamental Research, Mumbai.

Shanti Swarup Bhatnagar Prize (SSB) for Science and Technology 2016

For the year 2016, following scientists were recognized for their excellent work in their respective domains through winning this coveted award, however no award was given in the area of Medical Sciences.

Biological Sciences

- Dr Rishikesh Narayanan, Indian Institute of Science, Bangalore and
- Dr. Suvendra Nath Bhattacharyya, CSIR-Indian Institute of Chemical Biology, Kolkata

Chemical Sciences

- Dr. Partha Sarthi Mukherjee, Indian Institute of Science, Bangalore.

Earth, Atmosphere, Ocean and Planetary Sciences

- Dr. Sunil Kumar Singh, Physical Research Laboratory, Ahmedabad.

Engineering Sciences

- Dr. Avinash Kumar Agarwal, Indian Institute of Technology Kanpur
- Dr. Venkata Narayana Padmanabhan, Microsoft Research India, Bangalore

Mathematical Sciences

- Dr. Amlendu Krishna, Tata Institute of Fundamental Research, Mumbai; and
- Dr. Naveen Garg, Indian Institute of Technology Delhi, New Delhi.

Medical Sciences

- Dr. Niyaz Ahmed A S, University of Hyderabad, Hyderabad.

Physical Sciences

- Dr. Subramaniam Anantha Ramakrishna, Indian Institute of Technology Kanpur; and
- Dr. Sudhir Kumar Vempati, Indian Institute of Science, Bengaluru.

9.3.6 CSIR Young Scientist Awards 2016

The Council of Scientific & Industrial Research introduced, in 1987, a scheme of awards for Young Scientists in the CSIR system in order to promote excellence in various fields of science and technology. These awards are known as 'CSIR Young Scientist Awards'. CSIR scientists below 35 years of age, as reckoned on 26 September (CSIR Foundation Day) of the preceding year, are eligible for the award. These awards are given annually in the following disciplines:

- Biological Sciences
- Chemical Sciences
- Earth, Atmosphere, Ocean and Planetary Sciences
- Engineering Sciences
- Physical Sciences (including instrumentation)

Each award consists of a citation, a cash prize of rupees fifty thousand and a plaque. CSIR Young Scientist Awardees are also entitled to a research grant of rupees five lakh per annum for a period of five years and an honorarium of rupees seven thousand and five hundred per month till the age of 45 years. The following awards were given this year:

Biological Sciences

- Dr. Umakanta Subudhi of CSIR-Institute of Minerals and Materials Technology, Bhubaneswar

Chemical Sciences

- Ms R.V. Lakshmi of CSIR-National Aerospace Laboratories, Bengaluru; and
- Dr. Sandip B. Bharate of CSIR-Indian Institute of Integrative Medicine, Jammu.

Earth, Atmosphere, Ocean and Planetary Sciences

- Dr. V. Rakesh of CSIR-Fourth Paradigm Institute, Bengaluru.

Engineering Sciences

- Dr. Bala Subrahmanyam Pesala of CSIR-Central Electronics Engineering Research Institute, CSIR Madras Complex, Chennai

Physical Sciences (including instrumentation)

- Dr. Pankaj Kumar of CSIR-National Physical Laboratory, New Delhi.

9.3.7 CSIR Technology Awards-2016

Instituted in 1990, CSIR Technology Awards seek to foster and encourage multidisciplinary in-house team efforts and external interaction for technology development, transfer and commercialization. These awards include awards for:

(i) Life Sciences;

(ii) Physical Sciences including Engineering;

(iii) Innovation;

(iv) Business Development and Technology Marketing; and

(v) Most Significant CSIR Technology of the Five-Year Plan Period (awarded once in five years, coinciding with the plan period, to such technology which has proven in the marketplace at least for five years).

Each Technology Award comprises of a cash prize of Rs 2 lakh, except the award for the Most Significant CSIR Technology of the Five-Year Plan Period, which has a cash prize of Rs 5 lakh. Besides, a plaque and a citation are also given to the awardees. The winners of the CSIR Technology Awards-2016 are:

Technology Award for Life Sciences

CSIR-NBRI, Lucknow and CSIR-CIMAP, received the CSIR Technology Award for “Development of Herbal Composition (NBRMAP-DB) for the Management of Diabetes Type II”.

This award inspires researchers engaged in finding innovative solutions, for affordable healthcare through the amalgamation of modern scientific methods, and India’s rich traditional knowledge.

Technology Award for Physical Sciences including Engineering

CSIR-IIP was awarded the CSIR Technology Awards for “Development of Wax De-oiling Technology and its Commercialization at Numaligarh Refinery”.

The successful commercialization of the technology at NRL resulted in several benefits such as enhanced refinery profitability, encouraged small scale entrepreneurs for start-ups with setting-up of medium and small sized ancillaries to generate direct and indirect employment in ‘North-East’ region. Besides satisfying local demand, NRL has also started export of wax to numerous countries abroad.

The commercialization of indigenous Wax De-oiling Technology is in the direction with 'Make in India' initiative.

Technology Award for Innovation

CSIR-NAL has won the CSIR Technology Award for "LED Based DRISHTI Visibility Measuring System". Drishti is a visibility measuring system installed at Indian airports to give information to pilots on the visibility at the runway for safe landing and take-off operations of aircrafts.

Drishti stands on par with or better than the imported transmissometers. It has provision to get multi systems visibility data in a single computer with remote health monitoring, multiple display modules, web enabling of data, secured encrypted communication of data from Runway to ATC and many more. Further, Drishti is 1/3rd the total cost of imported system.

Certificate of Merit under CSIR Technology Awards-2016

CSIR-IICT, Hyderabad was recognized with Certificate of Merit for "Technology Transfer for Commercial Plants of 4000 MT per year of para-tert-butyl toluene, 3000 MT per year of para-tert-butyl benzoic acid and 2000 MT per year of para-tert-butyl methyl benzoate" to M/s Vinati Organics Ltd., Mumbai.

9.3.8 CSIR Award for S&T Innovations for Rural Development (CAIRD)

CSIR instituted the CSIR Awards for S&T Innovations for Rural Development (CAIRD) in the year 2006 to recognize and honour outstanding S&T innovations that have helped transform the lives of rural people or alleviated the drudgery of the rural people. CAIRD for the years 2012-14 was presented by the Hon'ble Minister for Science & Technology and Earth Sciences, Dr. Harsh Vardhan, Minister of State for Science & Technology and Earth Sciences, Shri Y.S. Chowdary and Dr. Girish Sahni, Director General, CSIR.

CAIRD-2012

CSIR-CSMCRI, Bhavnagar along with AquaAgri processing Pvt. Ltd. (AquaAgri), New Delhi for "Cultivation of red seaweed *Kappaphycus alvarezii* and co-production of bionutrients & Carrageenan from fresh seaweed".

End-to-end innovation recognized for the award pertains to cultivation technology developed for the red seaweed *Kappaphycus alvarezii* and development of a patented process for liquefying the fresh seaweed and simultaneous recovery of two products, k-Carrageenan and the plant sap (bionutrients), by CSIR-CSMCRI.

CAIRD-2013

CSIR-CCMB, Hyderabad and ICAR-Indian Institute of Rice Research (ICAR-IIRR), Hyderabad for "Development and deployment of a novel rice variety, *Improved Samba Mahsuri* which is bacterial blight resistant, high yielding and possesses fine-grains."

CAIRD-2014

CSIR-CIMAP, Lucknow for "Enhancing income of the farmers.

CSIR-CIMAP developed varieties having reduced maturation period first to 12 months and then to 6 months, with desired oil quality. The varieties have potential to grow over a vast varying agro climatic conditions of U.P., Bihar, Chhattisgarh, Jharkhand, Karnataka, Odisha. Already these Vetiver varieties developed by CSIR-CIMAP are being grown by more than 50,000 farmers in more than 10,000 ha of waste, salt-affected and irrigated lands. As essential oil yield of 25-30 kg/ha can be easily achieved, which on an average provide a net profit of over Rs. 1,50,000 in a span of 10-12 months.

9.3.9 CSIR Diamond Jubilee Technology Award (CDJTA)

CSIR instituted the CSIR Diamond Jubilee Technology Award in commemoration of its Diamond Jubilee from the year 2003. The award acknowledges the most outstanding technological innovation that has brought prestige to the nation.

The award is given to a technology that is developed in the country by Indian innovators and meets the highest global standards. Technologies leading to commercially successful products, processes and services, which give India a sustainable competitive advantage are considered for the award. The award consists of a cash prize of Rs. 10 lakh, a citation and a shield.

CDJTA for the years 2012-14 was presented by the Hon'ble Minister for Science & Technology and Earth Sciences, Dr. Harsh Vardhan, Minister of State for Science & Technology and Earth Sciences, Shri Y.S. Chowdary and Dr. Girish Sahni, Director General, CSIR.

CDJTA-2012

Serum Institute of India Pvt. Ltd., Pune for development of "MenAfrivac" vaccine for prevention of Meningococcal A disease. MenAfrivac (Meningococcal A Conjugate vaccine) is a novel and effective vaccine indicated for active immunization against invasive meningococcal disease caused by group A bacteria. This vaccine has been developed through an innovative product development plan that uses the purified polysaccharide for conjugation with Tetanus toxoid, which acts as a carrier protein.

CDJTA-2013

Mahindra Reva Electric Vehicles Private Ltd., Bengaluru for designing, developing and launching of an innovative electric car, maned e2o, which is one of the lightest, low cost, highway safe, four seater hatchback green car. Mahindra Reva's success in designing, developing and launching the e2o has reiterated the prowess of the country and its commitment for building and sustaining clean and green environment.

CDJTA-2014

Avra Laboratories Private Ltd., Hyderabad for Development and Commercialization of "Irinotecan – a unique drug for colorectal cancer." Avra Laboratories have developed a process for the synthesis of 7-Ethyl-10-hydroxycamptothecin (SN-38), an intermediate for synthesis of Irinotecan-HCL, thereby totally replacing the natural product extracted from a Chinese plant, *Camptotheca acuminata*.

9.3.10 G N Ramachandran Gold Medal For Excellence in Biological Sciences & Technology 2016

CSIR instituted a Gold medal in 2004 in the fond memory of Prof. G N Ramachandran, a pioneer of protein chemistry & the founding father of structural biology in India, for recognizing excellence in the interdisciplinary subject/field of Biological Sciences & Technology.

Prof. Valakunja Nagaraja of the Indian Institute of Science, Bangalore, has been awarded for his very important contributions to the understanding of topoisomerase function and inhibition, protein-DNA interactions and bacterial gene regulation.

9.3.11 CSIR Innovation Award for School Children 2016

From the year 2011, the award was renamed as the 'CSIR Innovation Award CSIR announced the Diamond Jubilee Invention Award for School Children on 26 April 2002 in order to enhance creativity amongst school children. The day is also celebrated as 'World Intellectual Property Day' throughout the world. The objectives of this competition are to capture creativity and innovativeness amongst school children and create awareness about for School Children'.

The award comprises a cash prize, trophy and a certificate. No first prize has been awarded as no innovation was found suitable as per the required criterion in 2016. The following 21 children were awarded for 14 innovations – two Second Prizes, three Third Prizes, four Fourth Prizes and five Fifth Prizes.

Second Prize (Rs Fifty thousand only)

- Shantanu D. Asode of class IX for the invention `Modern Technologies in Indian Railway' and Rishabh Garg also of class IX for the invention `One Million Years at a Glance'.

Third Prize: (Rs. Thirty thousand only)

- Thongam Avinash Singh: Onthokpa Loo of class Xth standard of Ananda Purna School, Thombal, Manipur has developed an innovative `Fish Trapping Device';
- Vaishanv Sukhadeo Baravakar; Prathmesh Dilip Kolhale; Rohit Anil Dixit; Shreyas Gajanan Yadav: Raksha Jyoti –a group of 8th of M.E.S Waghire High School, Pune for developing an innovative device ` A Safeguard Against Wild Animals'; and
- Mritunjai Pandey: of class IXth of Heritage School, Rohini, New Delhi for the invention `S-TUBE Tyre'.

Fourth Prize(Rs. Twenty thousand only)

- Tushar Bhaskar, Shivam Shankar & Saket Kumar- a group of XIIth class for the invention `Improved Biomass Pellet Burning Chulha with a new exhaust';
- R. Elakiya and R. Pavithra of class XIth and XIIth of S.R.C. Memorial Matriculation Higher Secondary School, Punjai Puliampatti, Erode, Tamilnadu has developed ` Innovative Power Loom for Physically Challenged Person';
- Harjinder Kaur and Manpreet Kaur of class Xth of Government Model Senior Secondary School, P. A. P. Campus, Jalandhar Cant for the innovation `Herbal Bandages, Gauges and Sanitary Pads'; and
- Mahamaya Mishra of class IX of Kendriya Vidyalaya No. 1, Bhoi Nagar, Bhubaneswar, Odisha for the invention `Polythene waste management and rural cell'.

Fifth Prize: (Rs Ten thousand only)

- Utkarsh Jain for the invention `New design of headlight of an automobile';
- Yash Nigam for the development of an innovative gadgetsTORA-K;
- Prashant Singh has developed `Manual Exhaust Fan'.
- Disha Tarafdar for the invention `Eco Friendly Board Duster'; and
- Isha Vipul Dave has developed an innovative vegetarian formula ` NUTRAMEAL-Nutrition from Weeds'.

9.4 CSIR Platinum Jubilee Techno Fest

The CSIR Platinum Jubilee Techno Fest pavilion has been adjudged First (Gold Medal) for excellence in display in the category "Ministries & Departments" at the 36th India International Trade Fair-2016. The Gold medal was presented by the India Trade Promotion Organisation (ITPO) Chairman, Mr. L.C. Goyal.

Dr. Girish Sahni, Director General, CSIR said: “Getting recognized for what CSIR is doing is indeed exciting. Everything happened because of the hard work put in by the entire CSIR family. The outcome of the last 75-year journey of the organization was on display and people liked it. We tried to portray our technologies in an aesthetically appealing way and we succeeded, as we stood first. This will motivate us to continue the good work in the future.”

9.5 Skill Development

To connect skill development and High-Tech training with job opportunities and entrepreneurship, CSIR has launched its ambitious program “CSIR Integrated Skill Initiative” with a target of 100,000 skilled personnel in next 5 years. CSIR has already initiated 10 skill programs in the areas of Leather Processing Technology, Industrial Maintenance Engineering, Mechatronics, Instrumentation, Battery maintenance, Internet of Things, Advance Manufacturing Technology, etc. with its target to have 75 programmes by the end of 2017. All these programmes are industry relevant with great entrepreneurial prospects. The target groups are from 10th standard to bachelors level.

10.0 HEADQUARTER ACTIVITIES

With a view to improve the efficiency and dynamism in the Scientific Divisions at CSIR Hqrs and to involve senior and experienced Directors in the functioning of the CSIR Hqrs., DG, CSIR has reorganized the Scientific Divisions. The Planning and Performance Division (PPD) has been reorganized into two Divisions i.e. Research, Project Planning and Business Development Directorate (RPPBDD) and Mission Directorate (MD).

10.1 Research Project Planning and Business Development Directorate (RPPBDD)

The Directorate is the nerve centre of CSIR Headquarters, which is mandated to assist the overall R&D Planning for CSIR with inputs from other divisions/ directorates. Its main activities are: preparation of background papers for allocation of Finances in consultation with Heads of other Directorates and FA, CSIR and release of funds with the approval of DG,CSIR; approval and approval of R&D projects/ schemes; preparation of required background papers including detailed Demands for Grants and notes for Parliament Consultative Committee; interaction with Finance Ministry, NITI Aayog, and other Central and State ministries as well as Govt. Departments; CSIR Annual Report; All activities relating to business development including marketing guidelines; MoUs / Agreements with foreign entities with their security and sensitivity clearances; Management of Innovation Fund; Parliament matters relating to the above activities; Policy matters pertaining to the above activities; Awards- CSIR Technology Awards, CSIR Diamond Jubilee Technology Award and CSIR Award for S&T Innovation for Rural Development.

10.1.1 Department related Parliamentary Standing Committee on Science & Technology and Environment & Forests

The Department related Parliamentary Standing Committee on Science & Technology, Environment and Forests considers and recommends for grants of DSIR including CSIR to the Govt. of India.

Demands for Grants 2017-18

The Directorate prepared Background Note on Demands for Grants 2017-18 and submitted to Rajya Sabha Secretariat for the consideration of Demands for Grants for DSIR including CSIR. The document consists of the significant achievements of CSIR during 2016-17. Scheme wise details, Cluster wise achievements of 2016-17, Project wise details-objectives, achievements of 2016-17 and financial budgetary support from the government under Plan and Non-Plan for the last three years and the Budget Estimates 2017-18. The power point presentation of DG, CSIR, made before the Committee, was prepared by the Directorate. It also prepared responses to questionnaire on Demand for Grants received in three parts.

Two Hundred Ninety Seven Report

The Committee made certain recommendations in its 297th Report which was presented to both the Houses of the Parliament on 31st March, 2017. Excerpts of some of the significant recommendations are as follows:

- Request and Justification for Additional Allocation for Plan & Non-Plan Budget (2017-18): The Committee feels that request for the enhancement in the budgetary allocation is fully justified and the matter should be taken up by with the concerned Ministry/ Department vigorously. The Committee also observes that scientific institutions like CSIR should not suffer due to

lack of money especially in the cutting edge national labs which are involved in various researches in the field of science.

- The Committee notes and appreciates the efforts of CSIR in publishing large number of research papers in International SCI journals every year. However, the Committee observes that good work done by the CSIR in the form of research papers do not translate into sustainable technologies for use of the masses. Hence, the Committee recommends that Department should make all out efforts so that research and inventions may be translated into sustainable technologies. The Committee further recommends that the scientific journals/papers/ publications etc. should come out on time and with high standards.
- The Committee observes that the National Laboratories Scheme of the Department is very significant in improving lives of citizens of the country through scientific advancement. The Committee recommends that Department should have a proper monitoring and planning mechanism in place so that allocated amount must be utilized fully during 2017-18.
- The Committee commends the role of CSIR-NPL for its glorious achievements in the past in the field of scientific research activities and emerging as a leading national institution for research in a whole gamut of areas in the physical science. The Committee hopes that CSIR-NPL would be able to excel in its field and also strive hard for its contribution towards nation building.
- The Committee is also constrained to note that CSIR-NAL's proposal for funding of 70-seater Regional Transport Aircraft has been awaiting the Government's approval since the last three years. The Committee recommends that DSIR should immediately take the required action in the matter and ensure that approval for the project is granted at the earliest so that further action in respect of the project can be taken up by the CSIR-NAL.
- The Committee felt that Department should take proactive measures so that technologies developed by the CSIR Scientific Institutions like CSIR-CGCRI reaches the masses faster through industries/ companies. The Committee also recommends that proper mechanism must be in place for disseminating the activities and achievements of scientific labs at national level by involving universities and initiating discussion & interactions with State Governments and also through media.
- The Committee appreciated the good work done by CSIR-IICB in the field of chemical and biological sciences, and extensive research work done in containing diseases such as cholera, developing leishmaniasis detection kit and achievements made in translating medicine for asthma namely Asmon, Prostalyn, compounds from Paan leaf, mentoring National Institute of Pharmaceutical Education and Research (NIPER), Kolkata and futuristic research focused on Dengue and Alzheimer's etc. The Committee feels that these research outcomes/ findings should be disseminated all over the country involving various stakeholders and universities so that general public at large may benefit. The Committee further recommended that NRDC of the Department should be engaged by doing MoU in order to promote, develop and commercialize the technology emanating from CSIR-IICB at the earliest.
- The Committee recommended that there should be much more interactions between CSIR laboratories and the industries as well as Universities.
- The Committee recommended that the Department must come out some concrete proposals to trap, harness and retain human resources in the field of science.

Statement by the Hon'ble Minister of State for S&T and Earth Sciences

Hon'ble Minister of State for Science & Technology and Earth Sciences has to make a statement on the floor of the House regarding status of implementation on the recommendations of the Department related Parliamentary Standing Committee. The Diectorate prepared the statement as contained in 297th report comprising of some of the significant recommendations of the Committee and `Action Taken' thereof and facilitated its laying in both the Houses of the Parliament.

10.1.2 Monitoring of the 12th FYP Projects

Monitoring forms an important component of strategy for implementing planned initiatives. In this context, the Cluster concept evolved during the mid-term appraisal of 11th Five Year Plan was continued into the 12th Five Year Plan as well, albeit with greater rigor and focus. The projects were monitored following the mechanism evolved through CSIR's R&D Management strategy for planning and participative performance monitoring of R&D projects, of which monitoring at various levels such as Task Force level, Research Council level, Cluster level, Sectoral Monitoring Committee level were integral components.

The projects were routinely reviewed at the laboratory level, Task Force level and Research Council level. The recommendations were given due consideration and action taken. For the sake of convenience of monitoring the 12th FYP projects at the CSIR level, thirteen Sectoral Monitoring Groups were constituted under thematic areas as given below:

Thematic Areas	**Labs in Domain**
Adequate and Clean Energy	CSIR- IIP, CIMFR, NCL, CECRI
Advanced materials	CSIR- CGCRI, IMMT, NML, AMPRI, CECRI, NCL, NIIST, IICT, IIP, NEIST
Aerospace Engineering	CSIR- NAL, CSIO, CEERI
Agri, Food & Nutrition	CSIR- NBRI, CIMAP, IHBT, CFTRI, CCMB, NIIST, IICT, NCL, NEIST
Biotechnology and Biology	CSIR- CCMB, IGIB, IICB, IMTECH, IITR
Drugs Discovery & Development / Healthcare	CSIR- CDRI, IIM, IICT, IMTECH, NEIST, IICB, IGIB, NCL, IITR
Earth System Sciences	CSIR- NIO, NGRI, 4PI
Ecology and Environment	CSIR- NEERI, CLRI, IIP, IICT, NCL, NPL
Electronics and Instrumentation	CSIR- CSIO, CMERI, CRRI, NPL
Housing, Road, Construction, Structures and Safety	CSIR- CBRI, CRRI, SERC, NGRI, CGCRI, NML, IMMT
Information Sciences – Data intensive and Informatics	CSIR- 4PI, URDIP, TKDL, NISTADS, NISCAIR

Mining, Metals and Minerals	CSIR- CIMFR, NML, IMMT
Sustainable Chemical Industry	CSIR- IICT, NCL, CLRI, CSMCRI, NEIST, NIIST

The Sectoral Monitoring Committees reviewed the projects between end of December 2016 and end of March 2017. Besides reviewing the overall physical and financial progress of the projects, the Committees critically appraised the projects from the outcomes point of view. The technologies/products and leads developed were assessed for their further improvements necessary for taking them to their logical conclusion.

10.1.3 CSIR Awards for S&T Innovation for Rural Development (CAIRD) and CSIR Diamond Jubilee Technology Award (CDJTA)

CSIR instituted the CSIR Award for S&T Innovations for Rural Development (CAIRD) in 2006 to recognize and honour those outstanding S&T innovations that have helped transform the lives of rural people or alleviated the drudgery of the rural people. The award consists of a cash prize of Rs. 10 lakh (Rupees Ten lakhs only), a citation and a shield. CSIR instituted the CSIR Diamond Jubilee Technology Award (CDJTA) in commemoration of its Diamond Jubilee from the year 2003. The award acknowledges the most outstanding technological innovation that has brought prestige to the nation. The award consists of a cash prize of Rs. 10 lakh, a citation and shield. The nominations for the year 2015 and 2016 has been invited and the best innovation would be selected after following due process. CAIRD and CDJTA for the years 2012-14 were presented to the winners by the Hon'ble Minister for Science & Technology and Earth Sciences, Dr. Harsh Vardhan, Minister of State for Science & Technology and Earth Sciences, CSIR at the CSIR Platinum Jubilee Foundation Day Function held on 26 September 2016 at Vigyan Bhawan, New Delhi.

10.1.5 CSIR Technology Awards

The CSIR Technology Awards were instituted in 1990 with a view to foster and encourage in-house multidisciplinary team efforts and external interaction for technology development, transfer, marketing and commercialization. These awards include: (i) Life Sciences; (ii) Physical Sciences including Engineering; (iii) Innovation; (iv) Business Development and Technology Marketing; and (v) Most significant CSIR Technology of the Five Year Plan Period. Each award carries a cash prize of Rs. 2 lakh (Rupees Two lakhs only), except the "Most Significant CSIR Technology of the Five Year Plan Period" which carries a cash prize of Rs.5 lakh (Rupees Five lakhs only). Besides, a plaque and a citation are also given to the awardees.

The Hon'ble Union Minister of Science & Technology and Earth Sciences and Vice President, CSIR, Dr. Harsh Vardhan gave away the CSIR Technology Awards 2016 to the winners on the occasion of CSIR Platinum Jubilee Foundation Day i.e. on 26th September, 2016.

10.1.6 Audit Inspection of CSIR

CSIR-CCMB was entrusted with research work on three major diseases prevalent in India i.e. HIV, Tuberculosis and Hepatitis. Research on these infectious diseases required a Bio Safety Level-313 (BSL-3) facility. The ATN has been submitted to Principal Director of Audit on the queries raised by the audit.

10.1.7 Parliament Questions

Directorate has prepared the suitable responses to Parliament Questions on varied issues such as performance of CSIR, financial details of CSIR laboratories, Development of S&T etc. During the year, around 213 questions were replied including inputs to DST and other ministries.

10.1.8 CSIR Annual Report 2015-16

Based on the inputs received from all the constituent labs of CSIR and Divisions of Headquarters, Division prepared draft CSIR Annual Report for the year 2015-16. The report contains Executive summary, Scientific Excellence, Technologies developed, Central Management Activities, Headquarters Activities, list of top 50 cluster wise publications etc.

10.1.9 Security & Sensitivity clearance

The R&D proposals involving foreign scientists/ agencies were examined and assessed in the Division from security and sensitivity angle. The proposals covered collaboration, Agreements, MoUs. During the year twenty eight proposals were processed by the Division. Some of the clientele covering these proposals were: Ferro Corporation, USA, PTB, Germany, UK Consortium, UK, MIDI, Ethopia, Safran Ceramics, Le Haillan France etc.

10.1.10 CSIR 800

During 2016-17, CSIR successfully implemented 35 projects costing Rs 24.60 crores (approximately) of 1 year duration under CSIR-800 program for benefit of the rural sector. The success of the implementation is corroborated by the fact that CSIR benefitted more than 4.5 lakh people against envisaged 3 lakh people and generated revenue in cash/kind form of more than Rs. 50 crores.

10.2 Human Resource Development Group (HRDG)

The Human Resource Development (HRD) Group of CSIR has a mandate to develop and nurture S&T manpower at the national level. It also promotes, guides and co-ordinates scientific & industrial research through research grants to scientists/professors working in universities / R & D institutes. The activities of the HRD Group include: Selection of Junior Research Fellows (JRF) through National Eligibility Test (NET); Selection of Senior Research Fellows (SRF), Research Associates (RA), Senior Research Associates (SRA) and Shyama Prasad Mukherjee Fellows (SPMF); Award of Shanti Swarup Bhatnagar Prizes (SSB), CSIR Young Scientist Awards (YSA) and GN Ramachandran Gold Medal; Funding of Extra Mural Research (EMR) Schemes at universities/ R&D organizations; Travel / Conference / Symposium grants.

Significant achievements of HRD Group during the year are as follows:

10.2.1 National S & T Manpower Development

10.2.1.1 CSIR-UGC National Eligibility Test (NET) for JRF and LS

CSIR-UGC National Eligibility Test (NET) June 2016 for Junior Research Fellowship and Eligibility for Lectureship was conducted on 19th June 2016 at 27 centres throughout the country. 1,97,129 candidates registered & 1,36,039 appeared for the examination. The result of CSIR-UGC NET June 2016 was declared on 7th October 2016. A total number of 3540 candidates qualified for CSIR/ UGC Junior Research Fellowship & lectureship and 3479 qualified for lectureship only.

Subject	Chemical Sciences	Earth Sciences	Life Sciences	Mathematical Sciences	Physical Sciences	Total
Qualified-JRF	931	161	1338	537	573	3540
Qualified-LS	765	177	1573	552	412	3479

Out of 3540 candidates qualified for JRF, 2040 are to be supported by CSIR and rest by UGC.

The CSIR-UGC NET December examination was held on 18th December 2016. 1,95,681 candidates registered and 1,36,384 appeared for the examination. The result was declared on 23rd March 2017. A total number of 3498 candidates qualified for CSIR/UGC Junior Research Fellowship & lectureship and 3337 qualified for lectureship only.

Subject	Chemical Sciences	Earth Sciences	Life Sciences	Mathematical Sciences	Physical Sciences	Total
Qualified-JRF	880	147	1322	600	549	3498
Qualified-LS	779	132	1371	629	426	3337

Out of 3498 candidates qualified for JRF, 1998 are to be supported by CSIR and rest by UGC.

10.2.1.2 Shyama Prasad Mukherji Fellowship (SPMF)

The objective of the SPM Fellowship Scheme is to identify and nurture budding scientific talent towards pursuit of scientific research. Under this scheme, the fellowship is given to top JRF-NET scholars in five disciplines of basic sciences. During April 2016- March 17, SPM Fellowship was awarded to 27 students from six disciplines two from Maths, one from Engineering, five each from Life and Earth and seven each from Chemical and Physical Sciences.

10.2.1.3 Senior Research Fellowship (SRF), SRF Extended and Research Associateship (RA)

The expert committee meetings for the selections of SRFs and RAs in 18 disciplines were held during 2016-17. Out of total 3,273 candidates called for interview, the candidates selected for SRF and RA were 518 and 170 respectively.

10.2.1.4 Senior Research Associate-ship (SRA) / Scientist's Pool Scheme

The Senior Research Associate-ship (SRA-ship) is primarily meant to provide temporary placement to highly qualified Indian scientists, engineers, technologists, and medical personnel who are not in regular employment in the country and including those returning from foreign countries. During the year 2016-17, seventy (70) Senior Research Associates were selected and their total number as on 31st March 2017 was 142.

10.2.1.5 Junior Research Fellowship for GATE qualified engineering and pharmacy graduates (JRF-GATE)

CSIR introduced a research fellowship known as the Junior Research Fellowship (JRF)-GATE in 2002 for the GATE qualified candidates with BE/ BTech/ BArch/ BPharm degree to pursue research leading to PhD in engineering and pharmaceutical sciences. JRFs selected under this scheme get an excellent opportunity to work with CSIR scientists with state-of-art R&D facility. During 2016-17,

nineteen (19) JRF-GATE fellowships were awarded and around 93 JRF-GATE Fellows are working at present in different CSIR laboratories.

10.2.1.6 CSIR Nehru Science Postdoctoral Research Fellowship Scheme

CSIR Nehru Science Postdoctoral Research Fellowship scheme was instituted in the year 2008 to identify & nurture promising young researchers in niche areas of basic science, engineering, medicine and agriculture. The scheme aims at facilitating their transition from mentored to independent research career. 15 candidates were selected out of 73 called for interview during 2016-17 following a very stringent criterion.

10.2.2 Promotion and Recognition of Excellence

10.2.2.1 CSIR Young Scientist Awards

The CSIR Young Scientist Awards (YSA) are given to scientists below the age of 35 years in 5 disciplines of Science & Technology (S&T) with the objective to recognize in-house excellence. In the year 2016, six scientists were selected for Young Scientist Awards, one each from Biological, Earth, Atmosphere, Ocean & Planetary Sciences, Engineering sciences and Physical Sciences(including Instrumentation) and two from Chemical Sciences. These Awards were presented by Dr. Harsh Vardhan, Hon'ble Minister for Science & Technology and Earth Sciences and Vice President, CSIR at the CSIR Platinum Jubilee Foundation Day Function held on 26 September 2016 at Vigyan Bhawan, New Delhi.

10.2..2..2 Shanti Swarup Bhatnagar Prize for Science & Technology

The Shanti Swarup Bhatnagar Prize (SSB) for Science & Technology is given every year to Indian scientists below 45 years of age for their notable & outstanding contributions, applied or fundamental, in seven disciplines of Science & Technology. The Shanti Swarup Bhatnagar Prizes for the year 2012, 2013, 2014 and 2015 were presented by Dr. Harsh Vardhan, Hon'ble Minister for Science & Technology and Earth Sciences and Vice President, CSIR at the CSIR Platinum Jubilee Foundation Day Function held on 26 September 2016 at Vigyan Bhawan, New Delhi.

10.2..2..3 GN Ramachandran Gold Medal for Excellence in Biological Sciences & Technology

GN Ramachandran Gold Medal for Excellence in Biological Sciences & Technology is given every year for notable and outstanding research, applied or fundamental, in the interdisciplinary subject/field of Biological Sciences and Technology. For the year 2016, GN Ramachandran Gold Medal was presented to Prof. Valakunja Nagaraja of Indian Institute of Science, Bengaluru by Dr. Harsh Vardhan, Hon'ble Minister for Science & Technology and Earth Sciences and Vice President, CSIR at the CSIR Platinum Jubilee Foundation Day Function held on 26 September 2016.

10.2.2.4 Funding of Extra Mural Research Schemes to promote R & D

CSIR provides financial assistance to promote research in the field of Science and Technology including Agriculture, Engineering and Medicine. It is given in the form of research grants to Professors/ Scientists working in Universities/ Academic Institutes/ IIT's etc. The number of research schemes recommended and renewed during 2016-2017 are as given below:

Schemes	No. of Proposals Considered	Proposals Recommended	Proposals Renewed
General	499	182	644

Emeritus Scientist	135	46	84
Sponsored	13	3	12
One Time Grant	2	1	-

10.2.2.5 Travel / Conference Grants

Travel grant is provided by CSIR to young researchers for presenting research papers at International Conferences abroad. Total of 667 travel grant applications from students were considered and 281 cases were recommended for support. Travel grant committee also considered 190 applications for travel support from regular employees and recommended 86 cases for support. For organizing national/international conferences/ symposia/ workshops etc., a total of 882 proposals from universities/institutes/scientific societies etc. were considered and 367 cases were recommended for support.

Schemes	Total Considered	Total Recommended
Travel Grant to students	667	281
Travel Grant to regular employees	190	86
Symposia Grant	882	367

10.2.2.6 Faculty Training & Motivation and Adoption of Schools & Colleges by CSIR Labs

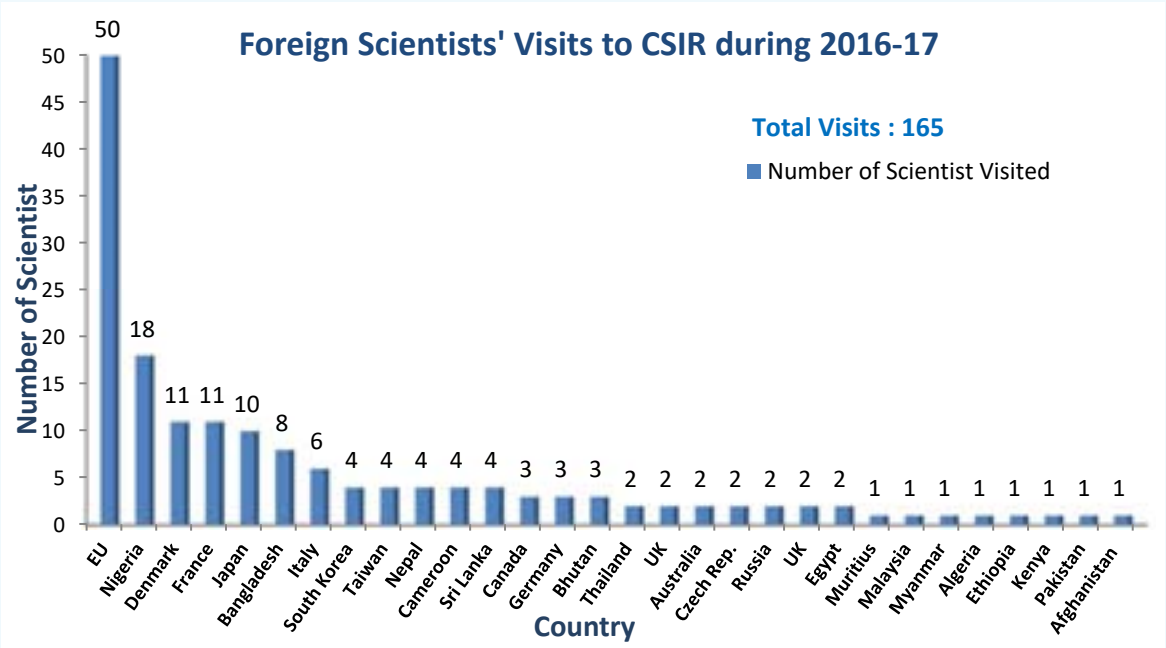
The main objective of this scheme is to promote interest, excitement and excellence in science education at the school and under graduate level by taking up training and motivational programmes for students and science teachers. The scheme is implemented through CSIR laboratories.

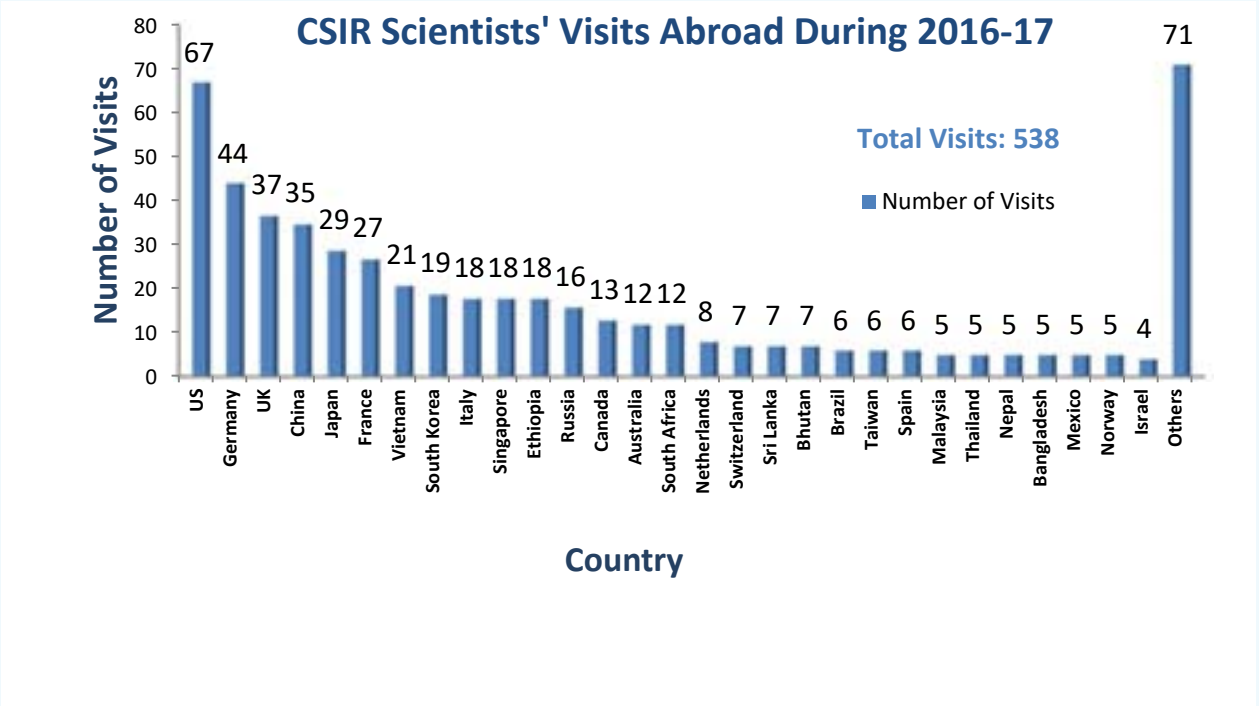
10.3 International S&T Affairs Directorate (ISTAD)

ISTAD continued playing a key role in furthering and expanding CSIR's international partnerships by initiating new cooperation tools with frontline international agencies across the globe, managing / supporting collaborative projects, joint / international seminars and workshops and coordinating scientific visits of CSIR delegations / scientists abroad and of foreign delegations / distinguished researchers to CSIR and its research institutes.

10.3.1. Scientific interactions through exchange visits

During 2016-17 over 538 CSIR scientists were deputed abroad as part of internalization strategy and for international benchmarking. These visits facilitated projecting CSIR globally. Schimago Institutions Ranking also positioned CSIR India as the 12th institution amongst the publically funded R&D institutions of the world. More than 165 scientists / research scholars from abroad visited CSIR institutes for collaborative projects, conference participation, business meetings and research fellowship programmes that further provided S&T networking opportunities.





10.3.2. S&T Cooperation

CSIR-BMBF Cooperation

Under CSIR-BMBF, five ongoing projects were implemented by CSIR-IIP, CSIR-CFTRI, CSIR-NBRI, CSIR-NAL and CSIR-CGCRI under the CSIR-BMBF (German Ministry for Education and Research) programme. A joint call for research proposal was made with an aim to further enhance the cooperation with Germany, which resulted in induction of following three new joint projects under CSIR-BMBF Cooperation arrangement:

(i) Design of new and efficient nanostructured half-Heusler derivatives as potential thermoelectric materials via varying valence electron count (VEC): Development of a model system for solar powered thermoelectric generators (STEGs) for power generation between CSIR-NPL, New Delhi and Deutsches Zentrum fur Luft- und Raumfahrt e.V;

(ii) AlGaN/GaN High electron mobility material based sensors for polar liquids with CSIR-CEERI, Pilani and Leibniz Institut für Höchstfrequenztechnik; and

(iii) Synthesis and tailoring the surface architecture of new fiber-based materials and their carbon composites for applications towards sensing: analysis of pathogens, protein markers, neurotransmitters with CSIR-CECRI and University of Regensburg

Other Programmes supporting Indo-German Cooperation

Cooperation linkages of CSIR with German institutions were further boosted through cooperation programmes of DST, GoI with DAAD and the Indo-German S&T Centre who awarded research project funding to CSIR-NCL and CSIR-CLRI respectively to implement research projects on a) Oxo-/IIyd roxy-/Azidoacyloxylation Deoxygenation-Cyclisation Cascade of Alkenes by Iodine & Photoredox Relay Catalysis in collaboration with University of Regensburg; and b) Resource and energy reliability by Co-digestion of veg-market and slaughterhouse waste in collaboration with LEHMANN Maschinenbau GmbH. The total funding granted was Rs. 41.25 lakhs.

CSIR-National Research Council (CSIR-CNR) Italy

CSIR has five ongoing exchange programme with National Research Council (CNR), Italy viz. (i) Development of catalytic renewable process by converting Indian origin non-edible oil to valuable chemicals (CSIR-NCL); (ii) A rapid high performance biosensor based on gold nano particle anchored graphene sheets for the electrochemical detection of biomarkers and DNA mutations for clinical and environmental applications(CSIR-CECRI); (iii) Sono chemical synthesis of bio based composite materials for energy applications(CSIR-CECRI); (iv) Improved safe management of arsenic rich waste generated from arsenic removal plant (CSIR-CMERI); and (v) Design, Materials Development and Fabrication of Capacitive Micro-machined Ultrasonic Transducer (CMUT) (CSIR-CEERI).

EU funded projects INNO INDIGO ERANET & INDIGO Policy

Two new projects that have been funded by EC. These are:

(i) Innovation driven Initiative for the Development and Integration of Indian and European Research (INNO INDIGO); and

(ii) Support for policy cooperation in Indian and European Research and Innovation (INDIGO POLICY).

Meetings for the EC projects organised

Under INNDO INDIGO Project two Valorization Webinars were organized that hosted ~ 100 India-EU research project participants to educate them in their endeavor to commercialize outcome of their joint projects.

Under INDIGO POLICY Project a Report on Factsheet: Europe and India Innovation landscapes: Policies, framework and programmes was published jointly by CSIR and APRE, Italy. Successful implementation of the planned activities under these projects led to release of the second grant installment by European Commission of Rs. 27.26 lakhs under INNO INDIGO Project and Rs. 12.76 lakhs under INDIGO POLICY Project.

CSIR through CSIR-NIO together with APRE, Austria organized the seventh edition of the EU-India Science Technology and Innovation (STI) Cooperation Days event at CSIR-NIO, Goa on September 21-22, 2016 with support of all project partners. This edition focused on bio-economy, including marine and maritime research, in order to maximize future scientific and business collaboration in these fields.

More than 200 participants from India and Europe comprising government officials, funding agencies, policymakers, researchers, innovators, students and representatives from Industry and NGO's attended the two day event that showcased results and shared best practices in particular on sustainable food security, rural renaissance, bio-based innovation and blue growth economy. New funding opportunities in Horizon 2020 were also presented. Indian and European researchers were effectively networked for joint research and education collaborations through various innovative interactive and networking sessions. The event demonstrated strong EU-India partnership and political commitment to foster cooperation on research and innovation.

India-EU Inter-governmental Programmes

CSIR-NEERI was granted a research project entitled "Wastewater Reuse: Improving the odds by understanding Natural Attenuation (WRANA)" for implementation by CSIR-NEERI, University of Minho, Portugal and University of Tartu, Estonia under DBT-INNO INDIGO project scheme with funding of Rs. 63.56 lakhs.

India-EU Bilateral Workshop on 'Microbial Electrochemical Technologies for sustainability: Fuels, Chemicals, Remediation" under the DST-EU project of CSIR-IICT in Hyderabad on February 27-28, 2017 with participation of 9 EU experts (Finland-5, Turkey-4).

South Asian Association for Regional Cooperation (SAARC)

Regional collaboration under SAARC Framework was strengthened through organization of a training course on Metrology by CSIR-NPL at New Delhi during September 5-9, 2016 for sixteen (16) researchers from Sri Lanka, Afghanistan, Bangladesh, Nepal, Bhutan and Pakistan.

Ad hoc visits by foreign dignitaries/ scientists/ researchers to CSIR Institutions

(i) Her Excellency Professor Ameenah Gurib-Fakim, President of Mauritius and a renowned Organic Chemist visited CSIR-NBRI and had an interactive meeting with the scientists of CSIR-NBRI, CSIR-CDRI and CSIR-CIMAP.

(ii) Hon'ble Prime Minister of Portugal, Mr. Antonio Costa along with his delegation visited CSIR-NIO for S&T Cooperation in the area of Marine Research.

(iii) Cooperation between CSIR institutes and their Russian partners received considerable boost by the CSIR as well as through cooperation programmes of DST. Several new research linkages between scientists of CSIR and those from Russia were developed. Nine (9) projects were bagged by CSIR institutes with a total funding of Rs. 305.31 lakhs in 2016-17.

(iv) A meeting of CSIR team led by DG, CSIR with Taiwanese Deputy Minister for Education and his delegation was held on 11th November. The meeting recommended establishing research and technology partnership between CSIR and ITRI. It was proposed to initially focus partnership in areas, viz Engineering, Automation, Bio-medical & Health Research. Organization of thematic interactions was proposed to discuss specific projects in identified areas and the partnership model.

10.3.3 Security and sensitivity clearance of various projects

Eight (8) collaborative research projects were awarded to CSIR institutes under inter-governmental bilateral / multilateral S&T cooperation programme and by the joint / national / international organizations with a total grant of Rs. 166.07 lakhs. These projects were scrutinized from security & sensitivity angles and approved for implementation by CSIR institutes in collaboration with their foreign partners.

10.3.4 MoU with International Organisations

During the year, five MoU between CSIR and International Organisations for scientific and technical cooperation were processed by the Division. These are: CSIR-NIO and Institute for Development Research (IRD), France, CSIR-IICT with International Associated Laboratory (LIA) , France, CSIR-CDRI and National Cancer Institute, USA, CSIR-CDRI and Stichting Katholieke Universiteit, The Netherlands, and CSIR-IICT and Drugs for Neglected Diseases Initiative (DNDi), Switzerland.

10.3.5 Multilateral Co-operation

CSIR-Raman Research Fellowship

The Raman Research Fellowship are granted to the CSIR researchers for carrying out research in the emerging/ high priority areas. Fourteen promising CSIR scientists were selected for grant of Raman Research Fellowship for 2016-17.

CSIR-TWAS Fellowship

CSIR in association with TWAS offers fellowship to provide training and advanced exposure / award higher educational degrees to researchers from developing countries, thereby enhancing CSIR brand, CSIR continued the CSIR-TWAS Fellowship Programme Seventeen (17) researchers from Nigeria (11), Cameroon (4), Kenya (1) and Ethiopia (1) were awarded the Doctoral Fellowship, whereas nine (9) researchers from Nigeria (7), Egypt (2), Algeria (1) were awarded Postdoctoral Fellowships to pursue research in CSIR-CECRI, CSIR-CFTRI , CSIR-CGCRI, CSIR-CLRI, CSIR-CMERI, CSIR-CSMCRI, CSIR-IHBT, CSIR-IICT, CSIR-IMMT, CSIR-NCL, CSIR-NGRI, CSIR-NIIST, CSIR-NIO, CSIR- NISTADS, CSIR-NML, CSIR-SERC.

International Conferences / Workshops

During the year Seven (7) international conferences / workshops enhancing international recognition of CSIR were organized by CSIR laboratories/ institutes which include: CSIR-NGRI (2 workshops),

CSIR-CGCRI, CSIR-CIMFR, CSIR-CLRI (2 conferences), CSIR-IIP with due approvals of the competent authorities.

10.4 Human Resource Development Centre (HRDC)

CSIR - Human Resource Development Centre has been contributing significantly for meeting the training & development needs of CSIR personnel by conducting customized and structured training & development programmes. The Centre has organized 37 training & development programmes during the year on diverse subjects to meet multiple skill needs of CSIR personnel. The highlights of the significant training & development activities undertaken by the Centre are given below:

Leadership Development Programme

Leadership development is a continuous process for competitive advantage and performance. The Centre, in its leadership development endeavour, has organized two programmes during the year: A 3-day "Programme on Excellence in Leadership" was organized for the newly recruited Directors of various CSIR labs. The principal objective of the programme was to create an interactive forum for the newly inducted Directors and to expose them to the nuances of administrative and managerial functions of CSIR Laboratories. Another leadership development programme was conducted for middle-level scientists to nurture them and create a futuristic leadership pipeline.

New Training & Development Initiatives

The Centre organized a one-day HR meet of all the heads of Human Resource Groups of the CSIR labs. During the meet, various HR activities related issues were deliberated upon and a roadmap was drawn to strengthen the HR activities.

A "Workshop on Socio-Economic Impact Assessment of R&D Outcomes" was conducted for scientists. The Workshop was designed to cover an overview of socio-economic assessment of R&D outcomes and conducting impact assessment of commercialized technologies. A customised two-day Orientation Programme for newly recruited S&T and other officers of CSIR-IMMT organized at their campus. The Centre also organized a Workshop on "Design and Analysis of Experiments" to meet the contemporary training needs of the scientists & technical personnel in their R&D activities.

Other Major Training & Development Programmes

In all, 15 programmes were conducted for S&T cadre during the year. A series of three Managerial Effectiveness Programmes was also organized for Common Cadre Officers during the year. The objective of these programmes was to upgrade the managerial skills of the officers in order to enhance their effectiveness specifically while working in cross functional teams.

Training Assistance to other institutes

The Centre has organized two programmes for the officers of Central Electronics Ltd (CEL) Sahibabad. The broad objective of the programme was to bring an organizational effectiveness and efficiency at workplace. The first one was designed and conducted on Managing for Excellence through Effective Leadership for the senior officers and the second programme on Managerial Effectiveness for Junior Executives.

Miscellaneous Programmes & Activities

Three Workshops on "Gender Sensitisation and Sexual Harassment of Women at Workplace: Prevention, Prohibition and Redressal" were also conducted. Two programmes on Work-Life balance were exclusively organized for women scientists and officers during the year.

The Centre also conducted one day Training Workshop on RTI Online Portal for Nodal Officers of all CSIR laboratories and the departments under DSIR viz. AcSIR, CEL, CDC and NRDC. A programme on *"Saamaany sanvarg ke adhikaariyon ke liye raajabhaasha neeti ke prabhaavee kaaryaanvayan evam vyavahaarikata vishay par prashikshan kaaryakram*" was also organized for Common Cadre Officers.

10.5 Recruitment &Assessment Board (RAB)

Recruitment & Assessment Board (CSIR-RAB) has been formed in 2002 with the primary mandate of providing an effective, fair and transparent system of recruitment and assessment of scientific staff in CSIR laboratories/units.

SCOPE OF CSIR – RAB

The scope of the Board is limited to recruitment and assessment of regular scientific staff of CSIR for both entry level positions and as well as lateral entry positions. The Board also has the responsibility of recruitment of "Distinguished Scientists" in CSIR system as and when such instructions are issued by the Director General, CSIR.

ACTIVITIES UNDERTAKEN IN 2016-17

- Recruitment of Scientists
  - RAB facilitated recruitment of 190 scientists in 18 CSIR Laboratories.
- Assessment of Scientists
  - Assessment of Junior Scientists to Principal Scientists due for promotion during 2013 - 14 covering all the areas of CSIR was concluded. A total of 479 candidates were considered for assessment. The assessments were conducted at 10 locations.
- The centralized assessment of 193 Senior Principal Scientists through 'Peer Review' process for the period 2013-14 was successfully executed. A total of 86 (44.56%) Scientists were promoted to the level of Chief Scientist.
- Successfully concluded the consultancy project worth Rs. 3 Lakhs. The project was executed for Central Silk Board, Ministry of Textiles, Bangalore involved a key part of the rectruitment process for 2 scientist positions.

10.6 Information Technology Division (ITD)

The major achievements of the Division during the year are as follows:

(i) It has provided the state-of-art High Level Video conferencing facility to all Dignitaries, Senior Officials and Scientists. They are able to communicate across the globe from their desk, hence saving Travelling Cost and Time.

(ii) Division arranges approximately 60 VC sessions per month (Point to Point and Multiparty). Due to this Facility DG, CSIR Addresses the whole CSIR family from the convenience of his chamber at different occasions like Technology day, New year etc.. This facility has been extended to all the CSIR Labs/ Institutes and its units including CSIR Science Centre.

(iii) Live Webcast of CSIR Foundation day function from Vigyan Bhawan every year to facilitate all Scientific Community and Staff of CSIR of CSIR to participate live from their own organizations was organised by the Division.

(iv) It also facilitated the PRAGATI VC chaired by Hon'ble Prime Minister of India and conducted by NIC every month.

(v) The CSIR website has been designed as per Guidelines for Government Websites (GIGW) guidelines which is now dynamic, bilingual and disabled friendly.

10.7 Mission Directorate (MD)

In July 2016, the Competent Authority created Mission Directorate which has been given the responsibilities of activities pertaining to New Millennium Indian Technology Leadership Initiative, Fast Track Translation (FTT Projects) and Mission Projects.

10.7.1 New Millennium Indian Technology Leadership Initiative (NMITLI)

CSIR's New Millennium Indian Technology Leadership Initiative (CSIR-NMITLI) envisages symbiotic promotion and fostering of Public-Private-Partnership (PPP) in a Team-India spirit to enable Indian industries attain global leadership position in select areas. The programme is backed by national determination. It turns sound technological ideas into a realty through systematic development and operationalization of innovative projects for realizing desired objectives. Brief details of some significant achievements in the year are presented below:

MicroPCR being accepted by ICMR:

''Truelab' platform and 'Truenat' test have been developed under New Millennium Indian Technology Leadership Initiative (NMITLI) Progamme. Both the platform and test have now been extensively validated through multi centric studies for TB diagnosis. ICMR is considering to rollout it into the RNTCP algorithm as a replacement of smear microscopy at District Microscopy Centers in the country. This would be the first time in the world that patients will be tested for TB using a molecular test instead of smear, that too using an Indian technology.

Technology transfer negotiation of 3 kWe Polymer Electrolyte Membrane Fuel Cell (PEMFC) System

In a joint effort CSIR laboratories, CSIR-NCL, CSIR-CECRI and CSIR-NPL and M/s Reliance Industries Limited successfully scaled up the stacks to 1.0kW system then to 2.00 kW and finally to 3.0 kW. The system was tested for more than 100 hours at specially fabricated test-bed in the premises of RIL's Patalganga location. Fuel Cell Test bed Facility was inaugurated by Prof. M.M. Sharma, FRS, Former Director, ICT, Mumbai at RIL's Patalganga site.

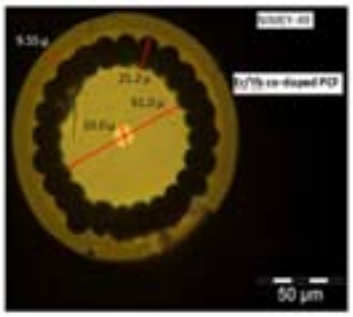
Fuel Test Facility at PG Site

Design and development of photonic crystal cladded and double cladded Er and Er/Yb fibers and application demonstration of high-power optical amplifier

Over the past decade, the demand for high-speed data transmission has increased tremendously and High power optical amplifiers are in great demand for applications like, Fiber-To-The-Home (FTTH), CATV as well as Free Space Optical communication. Conventional Erbium Doped Fiber Amplifier

(EDFA) is used in good volume in all these applications, but the present high power requirements cannot be met by these. EDF is generally not a cost-effective solution for high output (>27dBm) applications due to the prohibitive cost of high power single mode pump lasers. To relax this limitation, a double-clad Erbium co-doped with Ytterbium Fiber (EYDF) Amplifier is required in which the signal light propagates in the core and pump light propagates in the first cladding around the core. Such a double-clad EYDF amplifier can use watt-class multimode laser diodes, with promise of realizing multiple watt-class amplifier of high output power. Compared with EDF, the co-doping with Yb ions considerably improves the pump absorption.

In a joint effort CSIR-CGCRI along with M/s Vinvish Technologies Pvt. Ltd., Thiruvananthapuram designed, developed and demonstrated a prototype of High Power Optical Amplifier Module with an output of 2W.



Microscopic cross sectional view of Er/Yb co-doped photonic crystal fiber

20W High Power Erbium Doped Fibre Amplifier (HP-EDFA) Unit

10.7.2 Fast Track Translation Projects

World over, the R, D & I organizations have changed their R&D trajectories, using innovation as a major tool. Thus, the R&D activities, be in public domain or in private domain are being pursued as a business strategy. Core strengths for the purpose are being expanded and are being built in niche areas by the nations through identified constituents of “National Innovation System (NIS)”. In doing so, they are not only building up a state-of-art infrastructure but are also redeploying and retraining their HR through strategic R&D management intervention.

CSIR has strengthened its resource base and is undertaking challenge driven R&D in the identified domains so as to create technological niches. In line with the recent Government directions, policy measures are under consideration so as to boost translational research in CSIR. The desired mechanisms to enable tangible outcomes for such research efforts are being put in place. The initiative on CSIR Fast-Track Translation (FTT) Projects is a strong step forward in that direction.

CSIR laboratories have developed and deliberated upon CSIR Fast-Track Translation (FTT) Projects through specially organized brainstorming sessions. The FTT projects were scrutinized by the respective Directors, Cluster Directors and DG, CSIR. After due scrutiny 138 FTT projects of a duration of 18 to 24 months have been approved and are at various stages of execution. These projects target to attempt to solve some of the social issues being faced by the Country.

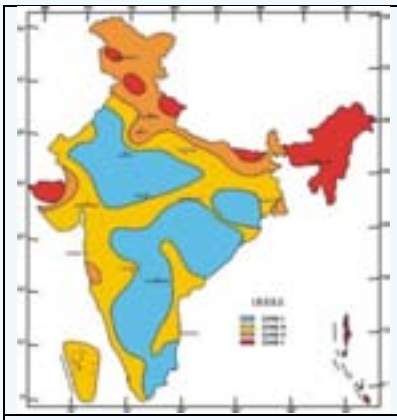
Unique features of these projects are that each of these projects have distinct business plan, stakeholder connect, deployment-focussed, and addressing some of the social issues being faced by the society. `Some of the significant achievements from these FTT Projects are highlighted below:

Technology for double fortified salt (DFS) composition containing iron and iodine to control both deficiencies

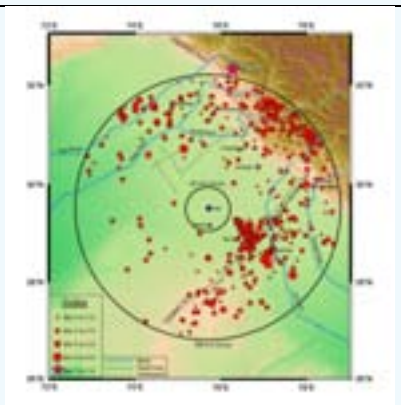
The Institutional Human Ethics Committee, Gujarat Medical Education & Research Society (GMERS) Medical College Gotri Medical College Vadodara has approved the proposed efficacy study for DFS in collaboration with the Pharmacology Department, Govt. Medical College, Bhavnagar and GMERS Medical College, Vadodara. CSIR-CSMCRI organized medical camps for screening of anemic population during SEWA SETU Programme of the Gujarat State Government.

Earthquake hazard assessment of the Himalaya and the Central part of Indo-Gangetic plains

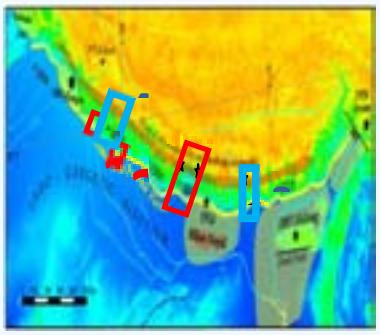
- A map depicting at what frequency the ground shall shake due to an earthquake has been prepared on the basis of seismological and ambient noise data for Lucknow city; and
- Outreach programs are being conducted in seismic zone IV (UP) and seismic zone V (Himachal Pradesh)



Seismic Hazard Map of India



Seismicity Map Around The Proposed NPP Site At Gorakhpur, Haryana



Earthquake Hazard Assessment In Central Indo Gangetic Plains

JNV school in Haridwar are preparing the Hazard map of their school in the event of an earthquake happening

Gas Sensor for Environmental Monitoring

Ammonia sensor system has been developed and put under field trials.

Development of a High Yielding Variety of *Artemisia annua*

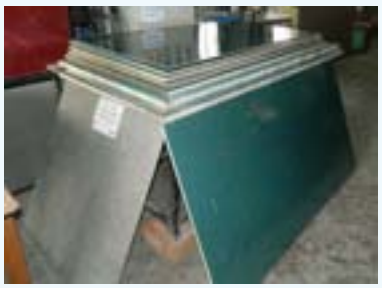
A new variety 'CIM Sanjeevani' has been developed with direct benefit to Farmers: Dry leaves yield (old variety) = 25 q/ha; Dry leaves yield (new variety) = 30 q/ha; Value of leaves from old variety (@Rs. 34 /Kg), Rs. 85000; Value of leaves from new variety (@Rs. 36 /Kg), Rs. 108000; with Net profit from new variety = Rs 23000/ha.

Development of a Linalool Rich Cold Tolerant Ocimum Chemotype

The farmers may be benefited with 30-35% additional profit. The socio-economic condition of the farmers will be improved due to their income enhancement. The variety has been developed and now it has to be popularized at farmers' field for cultivation.

Fibre and particulate reinforced hybrid polymeric composites as an architectural interior for use in building construction sector

Technical support was provided to M/s. Eco-Bright Sheet Pvt. Co.Ltd., Bhilai, CG. in setting up of industry for commercial manufacturing of Advanced Composites Wood (AC-Wood). The technology was licensed on 7 March 2017. Assistance provided to this industry for establishment of required major equipment / machineries, raw materials and infrastructure for setting-up industry. Also training was provided to 10 staffs of M/s. Eco-Bright Sheet Pvt. Co.Ltd., Bhilai, CG. at AMPRI Bhopal for five days, till their satisfaction, and reaching confidence level for manufacturing AC Wood by themselves.



Hybrid green composites for possible use in architectural partition panels

Hybrid green composite panel with new texture

Development of Reaction Bonded Silicon Nitride Ceramic Radome

Two nos. green radomes of smaller size fabricated as proof of concept. This has been followed by fabrication of two nos. green radomes of Pralay size for Defence R&D Organization.

Development of Medium Wind-Solar Hybrid (WiSH) Systems of 7 – 10 kW class for Agricultural and other rural applications

MoU signed with M/s ENZEN Global Pvt. Ltd for the development. Pilot Technology Demonstrator Prototype commissioned at site offered by Karnataka Renewable Energy Development Limited KREDL.

4 kW NALWIN Wind turbine
~ 3.65 m (12 feet) CFRP Blade

10.7.3 Mission Projects

Directorate has been entrusted with the development, management and monitoring of identified Mission Mode Projects (MMPs) with CSIR in order to put concerted and sustained efforts in an identified area by synergizing the best competencies available in various CSIR labs and outside institutions. The combined and time targeted efforts will enable CSIR to cross threshold of intellectual barrier in order to deliver scientific, industrial and social goods. Within MMPs, each project will have clearly defined objectives, scopes, and implementation timelines and milestones, as well as measurable outcomes and service levels.

Following Mission projects have been conceptualized in a top down approach which are under preparation: Aroma; Phytopharmaceuticals; Sickle Cell Anemia; Chemical Intermediates and API; and Catalysis for Sustainable Development. Unique features of these projects are that each of these projects have distinct business plan, stakeholder connect, deployment-focussed, and addressing some of the social issues being faced by the society.

10.8 Traditional Knowledge Digital Library (TKDL)

Misappropriation of Traditional Knowledge and bio-piracy of Genetic Resources are the issues of great concern for all the developing countries and these issues are being pursued at several multilateral forums.

CSIR has successfully foiled attempts by two multinationals to patent medicinal compositions that have been used since long in the Indian systems of medicines like Ayurveda and Unani and which have been documented in the Traditional Knowledge Digital Library (TKDL), a unit of CSIR.

CSIR's Innovation Protection Unit located the patent application for a medicinal composition containing turmeric, pine bark and green tea for treating hair loss. The patent was filed by Pangaea Laboratories at the European Patent Office in February 2011, and in January 2014 a pre-grant opposition along with evidence material of use of the products in traditional Indian medicine was registered. Finally, on 29th June, the UK-based company withdrew the application.

CSIR's also recently thwarted Colgate-Palmolive Co.'s bid to patent a mouthwash formula containing herb extract used in Indian traditional systems of medicine to cure oral diseases, at the European Patent office. The Traditional Knowledge Digital Library gave references from ancient books stating the herb and its extracts of *Myristica fragrans* were historically used for oral diseases in Indian

systems of medicine. It informed the EPO about references of the extracts in 'Charaka Samhita' – the ancient text of the traditional medicinal practices. It also cited how the extracts are used in different traditional medicines like 'Raughan', 'Dantaprabha Churna Manjan' and 'Sahakaravati'.

TKDL integrates diverse disciplines like ayurveda, unani, siddha and yoga. It is based on 359 books of Indian systems of medicine. It acts as a bridge between these books and international patent examiners. Till date, the CSIR has achieved success in about 200 such cases where the patent applications have either been withdrawn/cancelled/declared dead/terminated or have the claims amended by applicants or rejected by the examiners on the basis of the TKDL submissions.

10.9 Intellectual Protection Unit (IPU)

The Unit manages `CSIR Innovation Award for School Children'. CSIR Innovation Award for School Children was announced on April, 2002, the day celebrated as World Inttellectual Property Day throughout the world with an objectives to capture creativity and innovativeness amongst school children and create awareness about for School Children'.

For the year 2016, the competition has been renewed with an intervening training-cum-awareness programme. CSIR received 377 innovation proposals, which were screened for training purpose. Of these, 35 proposals were selected and 78 students and teachers were given two days training on 26th and 27th April 2016. Based on the training, the students resubmitted the innovation applications for award. Fourteen innovations were selected for awards from these revised applications. The winner gets a cash prize, trophy and certificate.

The unit was able to file 225 patents in India and 101 patents abroad on behalf of all the laboratories of CSIR. Besides, 317 patents were granted to CSIR in India and 298 in abroad.

10.10 Unit for Science Dissemination (USD)

The Unit for Science Dissemination is fully responsible for furthering favorable public image of CSIR as a whole. Several image-building activities were executed to achieve the overall objective through `Team USD'.

Execution of Diverse Image Building Activities

Image Building through Print Media

Publicity Efforts

- Effective media relations helped in furthering result-oriented relationship with the key press persons covering science in their respective dailies. Appropriate logistics support was ensured to all of them to earn their confidence in this Unit; several features/ stories were published with the support of inputs provided by this Unit.
- Press coverage was successfully organized during important CSIR events.
- Press releases were prepared and disseminated on several occasions and their coverage monitored for effectiveness.

Advertising Efforts

- Advt. in Newsletter of CSIR Pensioners Welfare Association, Lucknow News Letter No.-23 for 2016.
- Advt. for CSIR on the occasion of National Technology Day
- Advt on the occasion of CSIR Foundation day, 2016.

- Advt. on the occasion of Technofest 2016

Image Building through Interactive Media (Exhibitions,etc.)

CSIR participates in various National/International exhibitions and other related events with two main objectives: (i) Creating awareness about CSIR and its achievements, and (ii) Supporting its business development efforts.

This important activity was consolidated and efforts were made to project, as far as possible, an integrated picture of CSIR overall contribution to the theme areas of each event through extensive coordination with the participating CSIR labs on one side and the organizer of the event on the other.

Other events organized by the unit during this year include

CSIR participated in Asian Aroma Ingredient Congress(AAIC-2016), Ambience Hotel Delhi during 21-25 April 2016, India Technology Pavillion, Hannover during 25-29 April 2016, Infra Educa, 2016,Jhansi and Pragati Maidan during 28-29 May 2016 and 18-19 June, 2016, Science Expo, 2016, Solan (HP) during 18-20 July, 2016, Govt. Achievements & Scheme Expo, 2016, New Delhi during 22-24 July, 2016, 20th National Science Expo, Kolkata during 10-14 August 2016, Agri Tech. India, 2016,Bangaluru during 26-28 August,2016, India International Innovation Fair-2016, Bangalore during 9-11Sept 2016, Material Engineering Technology + Heat Treatment - MET+HTS, 2016, Navi Mumbai during 12-14 Oct, 2016, Vibrant India, 2016 & Meri Dilli Utsav, 2016, Delhi during 14-16 Oct., 2016, Distination Uttrakhand-2016, Dehradun during 24-26 Oct 2016, Agrovision, 2016, Nagpur during 11-14 Nov., 2016, Technofest-2016, New Delhi during 14-27 Nov 2016, Workshop cum Expo on Rural Technology, Shajahanpur during 1-3 Dec 2016, IISF Expo 2016, CSIR-NPL, New Delhi during 7-11 Dec 2016, Indian Science Congress, 2017,Tirupati during 3-7 Jan, 2017, Krishi Samridhi Rashtrya Kirshi Mela-2017, Chattisgarh,Raipur during 27-31 Jan 2017, Rajasthan Sarjan-2017, Rajasthan during 20-22 Jan 2017, IETF 2017 (CII), New Delhi during 2-4 Feb 2017, India Pharma & India Medical Device- 2017, Bangalore during 11-13 Feb 2017, Chemtech World Expo-2017, Mumbai during 14-17 Feb 2017, India Rwanda Technology &Innovation Expo-2017, Rwanda during 19-21Feb 2017, Vision Jammu & Kashmir-2017,Jammu during 23-25 Feb 2017, Gramoday Mela, Chitrakoot,MP during 24-27 Feb 2017, Destination North East-2017, Chandigarh during 6-8 March 2017, Showcase on R&D activities and outcome, New Delhi during 28 March 2017.

CSIR Platinum Jubilee Celebration:

CSIR mega exposition were organized at three places and Capsule version expo were also organized at different places. On this occasion about 16 theme publications were brought for wider dissemination.

Other Information Dissemination Services

The Unit provides press-clipping service to the office of the Minister of Science & Technology, DGSIR and other top management of CSIR after scanning about 28 Newspapers and 14 magazines on a regular basis. This activity was consolidated to make it more professional and timely.

CSIR in Media: A Daily News Bulletin

Soft copy of the news clippings on CSIR matter published in national media has been forwarded to all CSIR employees.

Technical Services

A large number of information queries pertaining to CSIR activities were attended either in person or by way of post/e-mail to the best satisfaction of the users.

Annexure-I

Awards/ Recognition 2016-17

During the year numerous awards and recognitions have come to CSIR staff, as enclosed under:

Awards/Recognition	Awardee(s)	Lab Name
Elected fellow of The World Academy of Science (TWAS)	Dr. Nahid Ali	CSIR-IICB
Shanti Swarup Bhatnagar Prize-2016	Dr. S.N. Bhattacharya	CSIR-IICB
Fellows of Indian Academy Sciences -2016	Dr. S.N. Bhattacharya Prof. Santosh Kapuria	CSIR-IICB CSIR-SERC
Fellows of Indian National Science Academy-2017	Dr. Amitava Das Dr. Neelam s. Sangwan	CSIR-CSMCRI CSIR-CIMAP
Fellows of National Academy of Sciences, Allahabad-2016	Dr. A.R. Bansal Dr. Sanjay Batra Dr. R.K. Bhadra Dr. Ramaiah Danaboyina Dr. .Sabyasachi Sanyal Dr. V.K. Khanna Dr. Renu Tripathi	CSIR-NGRI CSIR-CDRI CSIR-IICB CSIR-NEIST CSIR-CDRI CSIR-IITR CSIR-CDRI
CSIR Technology Award – 2016 Life Sciences Physical Sciences including Engineering Innovative Certificate of Merit	 Team-CSIR-CIMAP Team-CSIR-NBRI Team-CSIR-IIP Team-CSIR-NAL Team-CSIR-IICT	 CSIR-CIMAP CSIR-NBRI CSIR-IIP CSIR-NAL CSIR-IICT
CSIR Young Scientist Award, 2016 • Biological Sciences • Chemical Sciences	 Dr. Umakanta Subudhi Ms. R V Lakshmi Dr. Sandip B. Bharate	 CSIR-IMMT CSIR-NAL CSIR-IIIM
• Earth, Atmosphere, Ocean & Planetary Sciences • Engineering Sciences • Physical Sciences (Including instrumentation)	Dr. V. Rakesh Dr. B. S. Pelasa Dr. Pankaj Kumar	CSIR-4PI CSIR-CEERI CSIR-NPL
TWAS Prize-2016	Dr. Amitabha Chattopadhyay	CSIR-CCMB
JC Bose National Fellowship	Dr. Imran Siddiqui Dr. Rakesh Mishra	CSIR-CCMB CSIR-CCMB

National Geoscience Award-2016	Dr. S.K. Ray Dr. E.R. Masto Dr. N.P. Rao Dr. A. K. Krishna Dr. P.M. Kessarkar Dr. Abhishek Saha	CSIR-CIMFR CSIR-CIMFR CSIR-NGRI CSIR-NGRI CSIR-NIO CSIR-NIO
National Bioscience Award-2015	Dr. S.N. Bhattacharya Dr. H.V. Thulasiram Dr. Pawan Gupta Dr. Souvik Maiti Dr. Anurag Agrawal	CSIR-IICB CSIR-NCL CSIR-IMTECH CSIR-IGIB CSIR-IGIB
INSA Medal for Young Scientist -2016	Dr. Nazia Abbas	CSIR-IIIM
NASI-Scopus Young Scientist Awards	Dr. S. N. Battacharyya Dr. R. K. Chaturvedi Dr. Rajnish Kumar	CSIR-IICB CSIR-IITR CSIR-NCL
NASI-Reliance Industries Platinum Jubilee Awards	Dr. D. K. Mohapatra Dr. Inshad Ali Khan	CSIR-IICT CSIR-IIIM
NASI-Young Scientist Platinum Jubilee Awards	Dr. Ram Awatar Maurya Dr. Bhahwal Ali Shah Dr. Vasvi Chaudhry Mr. Mainak Bose	CSIR-NEIST CSIR-IIIM CSIR-IMTECH CSIR-IICB
NASI Senior Scientist Platinum Jubilee Fellowship	Dr. H. K. Majumder	CSIR-IICB
CRSI Gold Medal – 2016	Dr. S. Chandrashekar Dr. Atul Goel Dr. K.V. Radhakrishnan Dr. Srinivasa Reddy Dr. B. Mahipal Reddy	CSIR-IICT CSIR-CDRI CSIR-NIIST CSIR-NCL CSIR-IICT
CRSI Gold Medal - 2017	Dr. Amitava Das Dr. Rahul Banerjee Dr. Suman Lata Jain Dr. Sailaja Krishnamurthy Dr. Arvind Kumar Dr. Maya Shankar Singh	CSIR-CSMCRI CSIR-NCL CSIR-IIP CSIR-CECRI CSIR-CSMCRI CSIR-IICT
C.N.R. Rao National Prize for Chemical Research –2017	Dr. C.V. Ramana	CSIR-NCL
Innovative Young Biotechnologist Award (IYBA)-2015	Dr. Rajender Singh Dr. Niti Kumar	CSIR-CDRI CSIR-CDRI

Young Scientist Award 2016 by International Union of Biochemistry and Molecular Biology, Vancouver, Canada	Dr. Wahazuddin	CSIR-CDRI
TWAS/BVL.NXT 2016 Fellow by Academy of Sciences in Developing World (TWAS) and the Foundation Pour l'Université de Lyon	Dr. Wahazuddin	CSIR-CDRI
Awards at Platinum Jubilee Technofest 2016 at Indian International Trade Fair (IIFT), New Delhi		
• Gold for theme Genetics & Healthcare	Team CSIR-CDRI & CSIR-IICT Team	CSIR-CDRI & CSIR-IICT
• Bronze for theme Energy	Team CSIR-CECRI	CSIR-CECRI
• Gold for theme Agriculture and Floriculture	Team CSIR-NBRI	CSIR-NBRI
• Gold for theme Engineering and Infrastructure	CSIR-SERC	CSIR-SERC
Fellow of the Royal Society of Chemistry (FRSC), UK	Dr. S. Vasudevan Dr. G. Suresh Kumar Prof. Alok Dhawan Dr. B.L.V. Prasad	CSIR-CECRI CSIR-IICB CSIR-IITR CSIR-NCL
Elected as Vice-President of Indian Ceramic Society	Dr. K. Muraleedharan	CSIR-CGCRI
NRDC Meritorious Innovation Awards-2014	Team CSIR-CSIO & Team CSIR-CMERI-CoEFM	CSIR-CRRI & CSIR-CMERI
NRDC Meritorious Innovation Awards-2015	Team CSIR-CSIO	CSIR-CSIO
FICCI R&D Award 2017 for Waterless Chrome Tanning Technology	Dr. J. Raghava Rao, Shri P. Saravanan, Dr. R. Aravindhan, Dr. B. Madhan and Dr. Thanigaivelan	CSIR-CLRI
Dr. APJ Abdul Kalam Memorial Award 2016 by Government of Tamil Nadu	Dr. P. Shanmugam	CSIR-CLRI
VASVIK Award in Chemical Sciences & Technology	Dr. R.S. Somani Dr. Amol Kulkarni	CSIR-CSMCRI CSIR-NCL

FICCI R&D Award -2017 for 'Hydrazine Hydrate'	CSIR-IICT	CSIR-IICT
The ISEES Young Scientist Award- 2017	Mr. M.K. Shukla	CSIR-IIP
TDB National Award-2017	Team CSIR-IIP	CSIR-IIP
D.Sc. Degree (Honorary) by the University of	Prof. Alok Dhawan	CSIR-IITR

Bradford, Bradfor, UK – 2017		
OPPI Young Scientist Award-2016	Dr. R. K. Chaturvedi	CSIR-IITR
JEC Asia-2016 Innovation Award in the 'Aeronautics'	Team CSIR-NAL	CSIR-NAL
Eminent scientist - 2016 by the National Environmental Science Academy (NESA), New Delhi	Dr. R. Guruprasad	CSIR-NAL
VASVIK Research Award 2016	Dr. Amol Kulkarni	CSIR-NCL
American Physical Society Foreign Fellow 2016	Dr. G. Kumaraswamy	CSIR-NCL
Fellow Award of the Biotech Research Society, India	Dr. Madhavan Nampoothiri	CSIR-NIIST
Elected as Member of American Society of Civil Engineers	Dr. (Mrs.) N. Anandavalli	CSIR-SERC

Annexure-II

CSIR Patent Filed and Granted in India and Abroad during 2016-17

	India		Abroad	
	Filed	**Granted**	**Filed**	**Granted**
CSIR-AMPRI	7	0	4	0
CSIR-CBRI	3	2	0	0
CSIR-CCMB	0	0	10	1
CSIR-CDRI	1	7	9	19
CSIR-CECRI	10	2	1	7
CSIR-CEERI	3	0	0	1
CSIR-CFTRI	5	7	0	1
CSIR-CGCRI	7	4	0	2
CSIR-CIMAP	4	1	0	0
CSIR-CIMFR	4	6	0	1
CSIR-CLRI	10	1	13	0
CSIR-CMERI	4	1	1	0
CSIR-CRRI	1	0	0	2
CSIR-CSIO	3	1	1	0
CSIR-Schemes	2	5	1	6
CSIR-CSMCRI	13	8	26	44
CSIR-FPI	0	0	1	0
CSIR-IGIB	1	1	0	5
CSIR-IHBT	0	1	6	7
CSIR-IICB	2	0	6	14
CSIR-IICT	11	10	14	33
CSIR-IIIM	1	2	17	2
CSIR-IIP	11	8	12	7
CSIR-IITR	0	0	0	0
CSIR-IMMT	2	2	0	0
CSIR-IMT	4	1	20	18
CSIR-NAL	3	0	0	7
CSIR-NBRI	0	0	6	2
CSIR-NCL	82	11	143	95
CSIR-NEERI	3	1	1	2
CSIR-NEIST	6	4	3	0
CSIR-NGRI	0	0	0	0
CSIR-NIIST	1	5	15	14
CSIR-NIO	0	1	0	0
CSIR-NMITLI	0	0	1	2
CSIR-NML	15	6	0	0
CSIR-NPL	6	3	3	5
CSIR-SERC	0	0	3	1
	225	**101**	**317**	**298**

Annexure –IIA

Foreign Patents Granted to CSIR during 2016-17

CSIR-CCMB				
SNo	**Country**	**Patent No**	**Title of Invention**	**Inventors**
1	China	ZL201280034542.X	WDR13 AS A NOVEL BIOMARKER USEFUL FOR TREATING DIABETES AND CANCER.	SATISH KUMAR, VIJAY PRATAP SINGH
CSIR-CDRI				
SNo	**Country**	**Patent No**	**Title of Invention**	**Inventors**
2	China	ZL2009801523259	SUBSTITUTED BENZFUROCHROMENES AND RELATED COMPOUNDS FOR THE PREVENTION AND TREATMENT OF BONE RELATED DISORDERS	ATUL GOEL, AMIT KUMAR, SUMIT CHAURASIA, DIVYA SINGH, ABNISH KUMAR GAUTAM, RASHMI PANDEY, RITU TRIVEDI, MAN MOHAN SINGH, NAIBEDYA CHATTOPADHYAY, LAKSHMI MANICKAVASAGAM, GIRISH KUMAR JAIN, ANIL KUMAR DWIVEDI
3	Germany	1807408	OXY SUBSTITUTED FALVONES/CHALCONES AS ANTIHYPERGLYCEMIC AND ANTIDYSLIPIDEMIC AGENTS	RAM PRATAP, MAVURAPU SATYANARAYANA, CHANDESHWAR NATH, RAM RAGHUBIR, ANJU PURI, RAMESH CHANDER, PRITI TIWARI, BRAJENDRA K
4	Germany	2686337	NOVEL DOLASTATIN MIMICS AS ANTICANCER AGENTS	TUSHAR KANTI CHAKRABORTY, GAJULA PRAVEEN KUMAR, DULAL PANDA, JAYANT ASTHANA
5	Germany	2670722	CHIRAL 3-AMINOMETHYLPIPERIDINE DERIVATIVE AS INHIBITORS OF COLLAGEN INDUCED PLATELET ACTIVATION AND ADHESION	DINESH KUMAR DIKSHIT, MADHU DIKSHIT, TANVEER IRSHAD SIDDIQUI, ANIL KUMAR, RABI SANKAR BHATTA, GIRISH KUMAR JAIN, MANOJ KUMAR BARTHWAL, ANKITA MISRA, VIVEK KHANNA, PREM PRAKASH, MANISH JAIN, VISHAL SINGH, VARSHA GUPTA, ANIL KUMAR DWIVEDY
6	European Patent Office	2670722	CHIRAL 3-AMINOMETHYLPIPERIDINE DERIVATIVE AS INHIBITORS OF COLLAGEN INDUCED PLATELET ACTIVATION AND ADHESION	DINESH KUMAR DIKSHIT, MADHU DIKSHIT, TANVEER IRSHAD SIDDIQUI, ANIL KUMAR, RABI SANKAR BHATTA, GIRISH KUMAR JAIN, MANOJ KUMAR BARTHWAL, ANKITA MISRA, VIVEK KHANNA, PREM PRAKASH, MANISH JAIN, VISHAL SINGH, VARSHA GUPTA, ANIL KUMAR DWIVEDY
7	European Patent Office	2686337	NOVEL DOLASTATIN MIMICS AS ANTICANCER AGENTS	TUSHAR KANTI CHAKRABORTY, GAJULA PRAVEEN KUMAR, DULAL PANDA, JAYANT ASTHANA
8	European Patent Office	1807408	OXY SUBSTITUTED FALVONES/CHALCONES AS ANTIHYPERGLYCEMIC AND ANTIDYSLIPIDEMIC AGENTS	RAM PRATAP, MAVURAPU SATYANARAYANA, CHANDESHWAR NATH, RAM RAGHUBIR, ANJU PURI, RAMESH CHANDER, PRITI TIWARI, BRAJENDRA K

9	Spain	2670722	CHIRAL 3-AMINOMETHYLPIPERIDINE DERIVATIVE AS INHIBITORS OF COLLAGEN INDUCED PLATELET ACTIVATION AND ADHESION	DINESH KUMAR DIKSHIT, MADHU DIKSHIT, TANVEER IRSHAD SIDDIQUI, ANIL KUMAR, RABI SANKAR BHATTA, GIRISH KUMAR JAIN, MANOJ KUMAR BARTHWAL, ANKITA MISRA, VIVEK KHANNA, PREM PRAKASH, MANISH JAIN, VISHAL SINGH, VARSHA GUPTA, ANIL KUMAR DWIVEDY
10	France	2686337	NOVEL DOLASTATIN MIMICS AS ANTICANCER AGENTS	TUSHAR KANTI CHAKRABORTY, GAJULA PRAVEEN KUMAR, DULAL PANDA, JAYANT ASTHANA
11	France	2670722	CHIRAL 3-AMINOMETHYLPIPERIDINE DERIVATIVE AS INHIBITORS OF COLLAGEN INDUCED PLATELET ACTIVATION AND ADHESION	DINESH KUMAR DIKSHIT, MADHU DIKSHIT, TANVEER IRSHAD SIDDIQUI, ANIL KUMAR, RABI SANKAR BHATTA, GIRISH KUMAR JAIN, MANOJ KUMAR BARTHWAL, ANKITA MISRA, VIVEK KHANNA, PREM PRAKASH, MANISH JAIN, VISHAL SINGH, VARSHA GUPTA, ANIL KUMAR DWIVEDY
12	France	1807408	OXY SUBSTITUTED FALVONES/CHALCONES AS ANTIHYPERGLYCEMIC AND ANTIDYSLIPIDEMIC AGENTS	RAM PRATAP, MAVURAPU SATYANARAYANA, CHANDESHWAR NATH, RAM RAGHUBIR, ANJU PURI, RAMESH CHANDER, PRITI TIWARI, BRAJENDRA K
13	United Kingdom	1807408	OXY SUBSTITUTED FALVONES/CHALCONES AS ANTIHYPERGLYCEMIC AND ANTIDYSLIPIDEMIC AGENTS	RAM PRATAP, MAVURAPU SATYANARAYANA, CHANDESHWAR NATH, RAM RAGHUBIR, ANJU PURI, RAMESH CHANDER, PRITI TIWARI, BRAJENDRA K
14	United Kingdom	2686337	NOVEL DOLASTATIN MIMICS AS ANTICANCER AGENTS	TUSHAR KANTI CHAKRABORTY, GAJULA PRAVEEN KUMAR, DULAL PANDA, JAYANT ASTHANA
15	United Kingdom	2670722	CHIRAL 3-AMINOMETHYLPIPERIDINE DERIVATIVE AS INHIBITORS OF COLLAGEN INDUCED PLATELET ACTIVATION AND ADHESION	DINESH KUMAR DIKSHIT, MADHU DIKSHIT, TANVEER IRSHAD SIDDIQUI, ANIL KUMAR, RABI SANKAR BHATTA, GIRISH KUMAR JAIN, MANOJ KUMAR BARTHWAL, ANKITA MISRA, VIVEK KHANNA, PREM PRAKASH, MANISH JAIN, VISHAL SINGH, VARSHA GUPTA, ANIL KUMAR DWIVEDY
16	Japan	5957058	ULMUS WALLICHIANA PLANCHON DERIVED EXTRACT,DESIGNATED AS "OSTEOANABOL" AND ITS COMPOUNDS EMPLOYED IN PREVENTION OR TREATMENT OF OSTEO-HEALTH RELATED DISORDERS	RAKESH MAURYA, PREETI RAWAT, KUNAL SHARAN, JAWED AKHTAR SIDDIQUI, GAURAV SWARNKAR, GEETANJALI MISHRA, LAKSHMI MANICKAVASAGAM, GIRISH KUMAR JAIN, KAMAL RAM ARYA, NAIBEDYA CHATTOPADHYAY
17	South Korea	10-1686607	SUBSTITUTED BENZFUROCHROMENES AND RELATED COMPOUNDS FOR THE PREVENTION AND TREATMENT OF BONE RELATED DISORDERS	ATUL GOEL, AMIT KUMAR, SUMIT CHAURASIA, DIVYA SINGH, ABNISH KUMAR GAUTAM, RASHMI PANDEY, RITU TRIVEDI, MAN MOHAN SINGH, NAIBEDYA CHATTOPADHYAY, LAKSHMI

				MANICKAVASAGAM, GIRISH KUMAR JAIN, ANIL KUMAR DWIVEDI
18	South Korea	10-1646770	NOVEL DONOR-ACCEPTOR FLURENE SCAFFOLDS:A PROCESS AND USES THEREOF	ATUL GOEL, SUMIT CHAURASIA, VIJAY KUMAR, SUNDAR MANOHARAN, RS ANAND
19	Sweden	1807408	OXY SUBSTITUTED FALVONES/CHALCONES AS ANTIHYPERGLYCEMIC AND ANTIDYSLIPIDEMIC AGENTS	RAM PRATAP, MAVURAPU SATYANARAYANA, CHANDESHWAR NATH, RAM RAGHUBIR, ANJU PURI, RAMESH CHANDER, PRITI TIWARI, BRAJENDRA K
20	United States Of America	9,327,009	NEF-ASK1 INTERACTION INHIBITOR AS NOVEL ANTI-HIV THERAPEUTICS	TRIPATHI RAJ KAMAL, KUMAR BALAWANT, RAMACHANDRAN RAVISHANKAR, TRIPATHI JITENDRA KUMAR, BHADURIA SMRITI, GHOSH JIMUT KANTI

CSIR-CECRI

SNo	Country	Patent No	Title of Invention	Inventors
21	China	ZL201180058343.8	A HIGH VOLTAGE, HIGH PERFORMANCE LAYERED CATHODE MATERIAL FOR LITHIUM ION BATTERIES	SUKUMARAN GOPUKUMAR, CHANDRASEKARAN NITHYA, RAMASAMY THIRUNAKARAN, ARUMUGAM SIVASHANMUGAM
22	China	ZL201180056327.5	PROCESS FOR THE PREPARATION OF HIGH VOLTAGE NANO COMPOSITE CATHODE (4.9V) FOR LITHIUM ION BATTERIES	SUKUMARAN GOPUKUMAR, CHANDRASEKARAN NITHYA, RAMASAMY THIRUNAKARAN, ARUMUGAM SIVASHANMUGAM
23	China	ZL201280026906.X	A PROCESS FOR THE PREPARATION OF KISH GRAPHITIC LITHIUM-INSERTION ANODE MATERIALS FOR LITHIUM-ION BATTERIES	THRIVIKRAMAN PREM KUMAR, ASHOK KUMAR SHUKLA, THANUDASS SRI DEVI KUMARI, ARUL MANUEL STEPHAN
24	Japan	6046127	A PROCESS FOR THE PREPARATION OF KISH GRAPHITIC LITHIUM-INSERTION ANODE MATERIALS FOR LITHIUM-ION BATTERIES	THRIVIKRAMAN PREM KUMAR, ASHOK KUMAR SHUKLA, THANUDASS SRI DEVI KUMARI, ARUL MANUEL STEPHAN
25	South Korea	10-1670527	A HIGH VOLTAGE, HIGH PERFORMANCE LAYERED CATHODE MATERIAL FOR LITHIUM ION BATTERIES	SUKUMARAN GOPUKUMAR, CHANDRASEKARAN NITHYA, RAMASAMY THIRUNAKARAN, ARUMUGAM SIVASHANMUGAM
26	Russia	2584676	A PROCESS FOR THE PREPARATION OF KISH GRAPHITIC LITHIUM-INSERTION ANODE MATERIALS FOR LITHIUM-ION BATTERIES	THRIVIKRAMAN PREM KUMAR, ASHOK KUMAR SHUKLA, THANUDASS SRI DEVI KUMARI, ARUL MANUEL STEPHAN
27	Taiwan	I557973	A PROCESS FOR THE PREPARATION OF KISH GRAPHITIC LITHIUM-INSERTION ANODE MATERIALS FOR LITHIUM-ION BATTERIES	THRIVIKRAMAN PREM KUMAR, ASHOK KUMAR SHUKLA, THANUDASS SRI DEVI KUMARI, ARUL MANUEL STEPHAN

CSIR-CEERI

SNo	Country	Patent No	Title of Invention	Inventors
28	United States Of	9442227	PLANAR SOLAR CONCENTRATORS	BALA PESALA

	America		USING SUBWAVELENGTH GRATINGS	

CSIR-CFTRI

SNo	Country	Patent No	Title of Invention	Inventors
29	Vietnam	16288	A PROCESS FOR PREPARATION OF CASHEW APPLE BEVERAGE DRY MIX	MADINENI MADHAVA NAIDU, BASHYAM RAGHAVAN, MAYA PRAKASH

CSIR-CGCRI

SNo	Country	Patent No	Title of Invention	Inventors
30	China	ZL201380004960.9	AN IMPROVED SENSOR COMPOSITION FOR ACETONE DETECTION IN BREATH FOR DIABETIC DIAGNOSTICS	SEN AMARNATH, RANA SUBHASIS
31	United States Of America	9470675	AN IMPROVED SENSOR COMPOSITION FOR ACETONE DETECTION IN BREATH FOR DIABETIC DIAGNOSTICS	SEN AMARNATH, RANA SUBHASIS

CSIR-CIMFR

SNo	Country	Patent No	Title of Invention	Inventors
32	Australia	2011216967	A DEVICE FOR ROOF SUPPORT OF UNDERGROUND MINE /TUNNEL	SUDHIR KUMAR KASHYAP, AMALENDU SINHA

CSIR-CRRI

SNo	Country	Patent No	Title of Invention	Inventors
33	Singapore	11201500373T	NEW DESIGN FOR BOX INSERTION THROUGH HIGHLY UNSTABLE COHESIONLESS SOIL BY STABILISATION OF VERTICAL CUT SLOPES	SINGH KANWAR, PRASAD PULIKANTI SUBRAMANYA, MATHUR SUDHIR, AZAD FARHAT, GANGOPADHYAY SUBHAMAY
34	United States Of America	9359725	NEW DESIGN FOR BOX INSERTION THROUGH HIGHLY UNSTABLE COHESIONLESS SOIL BY STABILISATION OF VERTICAL CUT SLOPES	SINGH KANWAR, PRASAD PULIKANTI SUBRAMANYA, MATHUR SUDHIR, AZAD FARHAT, GANGOPADHYAY SUBHAMAY

CSIR-Schemes

SNo	Country	Patent No	Title of Invention	Inventors
35	Germany	2175871	A METHOD OF TREATING RHEUMATIC AND MUSCULO-SKELETAL DISORDERS (RMSDS), INCLUDING RHEUMATOID ARTHRITIS AND OSTEOARTHRITIS IN AN ANUMAL, HERBAL PREPARATIONS FOR DEGENERATIVE DISORDERS:OSTEOARTHRITIS AND RHEUMATOID ARTHRITIS	BHUSHAN PATWARDHAN, ARVIND CHOPRA, GUMDAL NARSIMULU, ROHINI HANDA, LATA S BICHILE, GHULAM NABI QAZI, ARVIND MANOHAR MUJUMDAR, VENIL N SUMANTRAN, PALPU PUSHPANGADAN, SHANTA MEHROTRA, AJAY KUMAR SINGH RAWAT, SAYYADA KHATOON, SUBHA RASTOGI, GOVINDARAJAN RAGHAVAN, ASHWINIKUMAR RAUT
36	European Patent Office	1494969	SOLID STATE PREPARATION OF LITHIUM COBALTATE (LICOO2) BY A NOVAL PROCEDURE FROM HIGHER OXIDE OF COBALT	CHANDRASEKARAN R, MANI A, VASUDEVAN T, GANGADHARAN R
37	European Patent	2175871	A METHOD OF TREATING	BHUSHAN PATWARDHAN, ARVIND

	Office		RHEUMATIC AND MUSCULO-SKELETAL DISORDERS (RMSDS), INCLUDING RHEUMATOID ARTHRITIS AND OSTEOARTHRITIS IN AN ANUMAL, HERBAL PREPARATIONS FOR DEGENERATIVE DISORDERS:OSTEOARTHRITIS AND RHEUMATOID ARTHRITIS	CHOPRA, GUMDAL NARSIMULU, ROHINI HANDA, LATA S BICHILE, GHULAM NABI QAZI, ARVIND MANOHAR MUJUMDAR, VENIL N SUMANTRAN, PALPU PUSHPANGADAN, SHANTA MEHROTRA, AJAY KUMAR SINGH RAWAT, SAYYADA KHATOON, SUBHA RASTOGI, GOVINDARAJAN RAGHAVAN, ASHWINIKUMAR RAUT
38	United Kingdom	2175871	A METHOD OF TREATING RHEUMATIC AND MUSCULO-SKELETAL DISORDERS (RMSDS), INCLUDING RHEUMATOID ARTHRITIS AND OSTEOARTHRITIS IN AN ANUMAL, HERBAL PREPARATIONS FOR DEGENERATIVE DISORDERS:OSTEOARTHRITIS AND RHEUMATOID ARTHRITIS	BHUSHAN PATWARDHAN, ARVIND CHOPRA, GUMDAL NARSIMULU, ROHINI HANDA, LATA S BICHILE, GHULAM NABI QAZI, ARVIND MANOHAR MUJUMDAR, VENIL N SUMANTRAN, PALPU PUSHPANGADAN, SHANTA MEHROTRA, AJAY KUMAR SINGH RAWAT, SAYYADA KHATOON, SUBHA RASTOGI, GOVINDARAJAN RAGHAVAN, ASHWINIKUMAR RAUT
39	United States Of America	9335332	NOVEL NICOTINAMIDE PHOSPHORIBOSYLTRANSFERASE (NMPRTASE) INHIBITOR FOR GLIOMA THERAPY	KUMARAVEL SOMASUNDARAM, NAGASUMA CHANDRA
40	United States Of America	9518033	(4E)-4-(4-SUBSTITUTED BENZYLIDENEAMINO)-2,3-DIHYDRO-3-SUBSTITUTED-2-THIOXOTHIAZOLE-5-CARBONITRILES AS A2AR ANTAGONIST AND PROCESS FOR PREPARATION THEREOF	PRATIBHA MEHTA LUTHRA, CHANDRABHUSHAN MISHRA

CSIR-CSMCRI

SNo	Country	Patent No	Title of Invention	Inventors
41	Australia	2011244076	PRODUCTION OF POTABLE WATER FROM HIGHLY SALINE SUB-SOIL BRINE IN SALT WORKS USING EXHAUST WASTE HEAT FORM DIESEL ENGINE EMPLOYED ROUND THE CLOCK DURING THE SALT MANUFACTURING SEASON TO CHARGE THE SALT PANS WITH SUSOIL BRINE	GHOSH PUSHPITO KUMAR, DESALE GIRISH RAJANIKANT, KHATRI BHAVIN HASMUKHLAL, PATEL RAJESHKUMAR NARANBHAI, SANATKUMAR NATAVARLAL PATEL, GAJJAR MAHESH RAMJIBHAI, BORLE NIITIN GANESH
42	Australia	2013303760	PROCESS FOR IMPROVED SEAWEED BIOMASS CONVERSION FOR FUEL INTERMEDIATES AND FERTILIZER	PUSHPITO KUMAR GHOSH, DIBYENDU MONDAL, PRATYUSH MAITI, KAMALESH PRASAD, SUBARNA MAITI, BHARTI GUNVANTRAY SHAH, ARUP KUMAR SIDDHANTA
43	Canada	2713315	IMPROVED PROCESS FOR THE PREPARATION OF IODATE-EXCHANGED SYNTHETIC HYDROTALCITE AS IODIZING AGENT WITH ZERO EFFLUENT DISCHARGE	PUSHPITO KUMAR GHOSH, MAHESH RAMANIKLAL GANDHI, SATISH HARIRAY MEHTA, GADDE RAMACHANDRAIAH, JATIN RAMESHCHANDRA CHUNAWALA, MRINAL VINODBHAI SHETH, GIRIRAJSINH SABALSINH GOHIL

44	Canada	2756763	INTEGRATED PROCESS OF PRODUCTION OF POTASSIUM SULPHATE, MAGNESIUM HYDROXIDE AND AMMONIUM SULFATE FROM KAINITE MIXED SALT AND AMMONIA	PUSHPITO KUMAR GHOSH, HARESH MAHIPATLAL MODY, JATIN RAMESHCHANDRA CHUNAWALA, MAHESHKUMAR RAMNIKLAL GANDHI, HARI CHAND BAJAJ, PRATYUSH MAITI, HIMANSHU LABHSHANKER JOSHI, HASINA HAJIBHAI DERAIYA, UPENDRA PADMAKANT SARAIYA
45	China	ZL201280025675.0	PROCESS FOR ENGINE WORTHY FATTY ACID METHYL ESTER (BIODIESEL) FROM NATURALLY OCCURRING AND CULTURED MICROALGAL MAT	MISHRA SANDHYA CHANDRIKA PRASAD, GHOSH PUSHPITO KUMAR, GANDHI MAHESH RAMNIKLAL, BHATTACHARYA SOURISH, MAITI SUBARNA, UPADHYAY SUMESH CHANDRA, MISHRA SANJIV KUMAR, SHRIVASTAV ANUPAMA VIJAYAKUMAR, PANCHA IMRAN, PALIWAL CHETAN, GHOSH TONMOY, MAURYA RAHUL, JAIN DEEPTI, GUPTA PRABUDDHA, PATIDAR SHAILESH KUMAR, SHAH ADITI, SAHU ABHISHEK, VEKARIYA VIJAY, DAVE KIRTAN, BOSAMIYA HETAL, ZALA KRUSHNADEVSINH
46	China	ZL201180071899.0	AN IMPROVED SOLAR DRYER WITH ENHANCED EFFICIENCY OF DRYING	PUSHPITO KUMAR GHOSH, SUBARNA MAITI, PANKAJ ARVINDBHAI PATEL, JITENDRA NARSINHBHAI BHARADIA, SHOBHIT SINGH CHAUHAN, MAHESH LAXMANBHAI SANGHANI, PRADIP VINUBHAI PARMAR, KRUTHIKA ESWARAN, PARASKUMAR VIVEKBABU AGRAVAT
47	China	ZL201280008824.2	Improved process for the preparation of fatty acid alkyl esters (Biodiesel) from triglyceride oils using eco-friendly solid base catalysts	KANNAN SRINIVASAN, SIVASHUNMUGAM SANKARANARAYANAN, CHURCHIL ANGEL ANTONYRAJ
48	China	ZL201380018356.1	PRODUCTION OF HIGH PURITY SALT WITH REDUCED LEVELS OF IMPURITIES	PUSHPITO KUMAR GHOSH, SUMESH CHANDRA UPADHYAY, VADAKKE PUTHOOR MOHANDAS, RAHUL JASVANTRAI SANGHAVI, BABULAL REBARY
49	Germany	1689521	PROCESS FOR THE PREPARATION OF A MOLECULAR SIEVE ADSORBENT FOR THE ADSORPTIVE DEHYDRATION OF ALCOHOLS	RAKSH VIR JASRA, JINCE SEBASTIAN, CHINTANSINH D CHUDASAMA
50	Germany	2819527	DOUBLE FORTIFIED SALT COMPOSITION CONTAINING IRON AND IODINE AND PROCESS OF PREPARATION THEREOF	JATIN RAMESHCHANDRA CHUNAWALA, PUSHPITO KUMAR GHOSH, MAHESHKUMAR RAMNIKLAL GANDHI, SATISH HARIRAY MEHTA, MRUNALBEN VINODRAY SHETH
51	Germany	2619303	A PROCESS FOR THE PRODUCTION OF OIL BEARING CHLORELLA SP. UTILIZING BY-PRODUCTS OF JATROPHA METHYL ESTER PRODUCTION	GHOSH PUSHPITO KUMAR, MISHRA SANDHYA CHANDRIKA PRASAD, GANDHI MAHESH RAMNIKLAL, UPADHYAY SUMESH CHANDRA, MISHRA SANJIV KUMAR, PANCHA IMRAN, SHRIVASTAV

			FROM WHOLE SEEDS	ANUPAMA VIJAYKUMAR, JAIN DEEPTI, SHETHIA BHUMI, MAITI SUBARNA, ZALA KRUSHNADEVSINH SUKHDEVSINGH
52	European Patent Office	2819527	DOUBLE FORTIFIED SALT COMPOSITION CONTAINING IRON AND IODINE AND PROCESS OF PREPARATION THEREOF	JATIN RAMESHCHANDRA CHUNAWALA, PUSHPITO KUMAR GHOSH, MAHESHKUMAR RAMNIKLAL GANDHI, SATISH HARIRAY MEHTA, MRUNALBEN VINODRAY SHETH
53	European Patent Office	1689521	PROCESS FOR THE PREPARATION OF A MOLECULAR SIEVE ADSORBENT FOR THE ADSORPTIVE DEHYDRATION OF ALCOHOLS	RAKSH VIR JASRA, JINCE SEBASTIAN, CHINTANSINH D CHUDASAMA
54	European Patent Office	1986957	AN IMPROVED PROCESS FOR PREPARATION OF MAGNESIUM OXIDE	GHOSH PUSHPITO KUMAR, JOSHI HIMANSHI LABHSHANKER, DERAIYA HASINA HAJIBHAI, GANDHI MAHESHKUMAR RAMNIKLAL, DAVE ROHIT HARSHDRAI, LANGALIA KAUSHIK JETHALAL, MOHANDAS VADAKKE PUTHOOR
55	European Patent Office	2619303	A PROCESS FOR THE PRODUCTION OF OIL BEARING CHLORELLA SP. UTILIZING BY-PRODUCTS OF JATROPHA METHYL ESTER PRODUCTION FROM WHOLE SEEDS	GHOSH PUSHPITO KUMAR, MISHRA SANDHYA CHANDRIKA PRASAD, GANDHI MAHESH RAMNIKLAL, UPADHYAY SUMESH CHANDRA, MISHRA SANJIV KUMAR, PANCHA IMRAN, SHRIVASTAV ANUPAMA VIJAYKUMAR, JAIN DEEPTI, SHETHIA BHUMI, MAITI SUBARNA, ZALA KRUSHNADEVSINH SUKHDEVSINGH
56	France	1689521	PROCESS FOR THE PREPARATION OF A MOLECULAR SIEVE ADSORBENT FOR THE ADSORPTIVE DEHYDRATION OF ALCOHOLS	RAKSH VIR JASRA, JINCE SEBASTIAN, CHINTANSINH D CHUDASAMA
57	France	2819527	DOUBLE FORTIFIED SALT COMPOSITION CONTAINING IRON AND IODINE AND PROCESS OF PREPARATION THEREOF	JATIN RAMESHCHANDRA CHUNAWALA, PUSHPITO KUMAR GHOSH, MAHESHKUMAR RAMNIKLAL GANDHI, SATISH HARIRAY MEHTA, MRUNALBEN VINODRAY SHETH
58	United Kingdom	2819527	DOUBLE FORTIFIED SALT COMPOSITION CONTAINING IRON AND IODINE AND PROCESS OF PREPARATION THEREOF	JATIN RAMESHCHANDRA CHUNAWALA, PUSHPITO KUMAR GHOSH, MAHESHKUMAR RAMNIKLAL GANDHI, SATISH HARIRAY MEHTA, MRUNALBEN VINODRAY SHETH
59	United Kingdom	2619303	A PROCESS FOR THE PRODUCTION OF OIL BEARING CHLORELLA SP. UTILIZING BY-PRODUCTS OF JATROPHA METHYL ESTER PRODUCTION FROM WHOLE SEEDS	GHOSH PUSHPITO KUMAR, MISHRA SANDHYA CHANDRIKA PRASAD, GANDHI MAHESH RAMNIKLAL, UPADHYAY SUMESH CHANDRA, MISHRA SANJIV KUMAR, PANCHA IMRAN, SHRIVASTAV ANUPAMA VIJAYKUMAR, JAIN DEEPTI, SHETHIA BHUMI, MAITI SUBARNA, ZALA KRUSHNADEVSINH SUKHDEVSINGH
60	United Kingdom	1689521	PROCESS FOR THE PREPARATION OF A MOLECULAR SIEVE	RAKSH VIR JASRA, JINCE SEBASTIAN, CHINTANSINH D CHUDASAMA

			ADSORBENT FOR THE ADSORPTIVE DEHYDRATION OF ALCOHOLS	
61	Indonesia	IDP000044011	A PROCESS FOR THE PRODUCTION OF OIL BEARING CHLORELLA SP. UTILIZING BY-PRODUCTS OF JATROPHA METHYL ESTER PRODUCTION FROM WHOLE SEEDS	GHOSH PUSHPITO KUMAR, MISHRA SANDHYA CHANDRIKA PRASAD, GANDHI MAHESH RAMNIKLAL, UPADHYAY SUMESH CHANDRA, MISHRA SANJIV KUMAR, PANCHA IMRAN, SHRIVASTAV ANUPAMA VIJAYKUMAR, JAIN DEEPTI, SHETHIA BHUMI, MAITI SUBARNA, ZALA KRUSHNADEVSINH SUKHDEVSINGH
62	Japan	5940540	A PROCESS FOR THE PRODUCTION OF OIL BEARING CHLORELLA SP. UTILIZING BY-PRODUCTS OF JATROPHA METHYL ESTER PRODUCTION FROM WHOLE SEEDS	GHOSH PUSHPITO KUMAR, MISHRA SANDHYA CHANDRIKA PRASAD, GANDHI MAHESH RAMNIKLAL, UPADHYAY SUMESH CHANDRA, MISHRA SANJIV KUMAR, PANCHA IMRAN, SHRIVASTAV ANUPAMA VIJAYKUMAR, JAIN DEEPTI, SHETHIA BHUMI, MAITI SUBARNA, ZALA KRUSHNADEVSINH SUKHDEVSINGH
63	Japan	5964327	Improved process for the preparation of fatty acid alkyl esters (Biodiesel) from triglyceride oils using eco-friendly solid base catalysts	KANNAN SRINIVASAN, SIVASHUNMUGAM SANKARANARAYANAN, CHURCHIL ANGEL ANTONYRAJ
64	Japan	6002756	PROCESS FOR ENGINE WORTHY FATTY ACID METHYL ESTER (BIODIESEL) FROM NATURALLY OCCURRING AND CULTURED MICROALGAL MAT	MISHRA SANDHYA CHANDRIKA PRASAD, GHOSH PUSHPITO KUMAR, GANDHI MAHESH RAMNIKLAL, BHATTACHARYA SOURISH, MAITI SUBARNA, UPADHYAY SUMESH CHANDRA, MISHRA SANJIV KUMAR, SHRIVASTAV ANUPAMA VIJAYAKUMAR, PANCHA IMRAN, PALIWAL CHETAN, GHOSH TONMOY, MAURYA RAHUL, JAIN DEEPTI, GUPTA PRABUDDHA, PATIDAR SHAILESH KUMAR, SHAH ADITI, SAHU ABHISHEK, VEKARIYA VIJAY, DAVE KIRTAN, BOSAMIYA HETAL, ZALA KRUSHNADEVSINH
65	Japan	5933557	HIGH FLUX HOLLOW FIBER ULTRAFILTRATION MEMBRANES AND PROCESS FOR THE PREPARATION THEREOF	ALAMURU VENKTARAMI REDDY, PARAMITA RAY, PUYAM SOBHINDRO SINGH, KALLEM PARASHURAM, SANDIPKUMAR MAURYA, JITENDRA JAYDEVPRASAD TRIVEDI
66	Japan	6067948	A DEVICE FOR EFFICIENT AND COST-EFFECTIVE SEAWEED HARVESTING FOR LARGE-SCALE COMMERCIAL APPLICATION	PUSHPITO KUMAR GHOSH, VAIBHAV AJIT MANTRI, JAYANTA KUMAR POTHAL, VEERAPRAKASAM VEERAGURUNATHAN, SANGAIYA THIRUPPATHI
67	Japan	6106262	PRODUCTION OF HIGH PURITY SALT WITH REDUCED LEVELS OF IMPURITIES	PUSHPITO KUMAR GHOSH, SUMESH CHANDRA UPADHYAY, VADAKKE PUTHOOR MOHANDAS, RAHUL JASVANTRAI SANGHAVI, BABULAL REBARY
68	South Korea	10-1670527	AN IMPROVED PROCESS FOR THE PREPARATION OF PARA-	MANOJ KUNJABIHARI AGRAWAL, PUSHPITO KUMAR GHOSH,

			NITROBENZYL BROMIDE	MAHESHKUMAR RAMNIKLAL GANDHI, SUMESH CHANDRA UPADHYAY, SUBBARAYAPPA ADIMURTHY, GADDE RAMACHANDRAIAH, PARESH U PATOLIYA, GIRDHAR JOSHI, HARSHAD BRAHMBHATT, RAHUL JASVANTRAI SANGHAVI
69	Sri Lanka	15128	IMPROVED K-CARRAGEENASE PRODUCTION AND A METHOD OF PREPARATION THEREOF	YASMIN NAJMUDDIN KHAMBHATY, KALPANA HARESH MODY, BHAVANATH JHA
70	Mexico	342908	PROCESS FOR ENGINE WORTHY FATTY ACID METHYL ESTER (BIODIESEL) FROM NATURALLY OCCURRING AND CULTURED MICROALGAL MAT	MISHRA SANDHYA CHANDRIKA PRASAD, GHOSH PUSHPITO KUMAR, GANDHI MAHESH RAMNIKLAL, BHATTACHARYA SOURISH, MAITI SUBARNA, UPADHYAY SUMESH CHANDRA, MISHRA SANJIV KUMAR, SHRIVASTAV ANUPAMA VIJAYAKUMAR, PANCHA IMRAN, PALIWAL CHETAN, GHOSH TONMOY, MAURYA RAHUL, JAIN DEEPTI, GUPTA PRABUDDHA, PATIDAR SHAILESH KUMAR, SHAH ADITI, SAHU ABHISHEK, VEKARIYA VIJAY, DAVE KIRTAN, BOSAMIYA HETAL, ZALA KRUSHNADEVSINH
71	Mexico	338892	PRODUCTION OF HIGH PURITY SALT WITH REDUCED LEVELS OF IMPURITIES	PUSHPITO KUMAR GHOSH, SUMESH CHANDRA UPADHYAY, VADAKKE PUTHOOR MOHANDAS, RAHUL JASVANTRAI SANGHAVI, BABULAL REBARY
72	Russia	2603748	PROCESS FOR ENGINE WORTHY FATTY ACID METHYL ESTER (BIODIESEL) FROM NATURALLY OCCURRING AND CULTURED MICROALGAL MAT	MISHRA SANDHYA CHANDRIKA PRASAD, GHOSH PUSHPITO KUMAR, GANDHI MAHESH RAMNIKLAL, BHATTACHARYA SOURISH, MAITI SUBARNA, UPADHYAY SUMESH CHANDRA, MISHRA SANJIV KUMAR, SHRIVASTAV ANUPAMA VIJAYAKUMAR, PANCHA IMRAN, PALIWAL CHETAN, GHOSH TONMOY, MAURYA RAHUL, JAIN DEEPTI, GUPTA PRABUDDHA, PATIDAR SHAILESH KUMAR, SHAH ADITI, SAHU ABHISHEK, VEKARIYA VIJAY, DAVE KIRTAN, BOSAMIYA HETAL, ZALA KRUSHNADEVSINH
73	Ukraine	113204	PROCESS FOR PRODUCTION OF SULPHATE OF POTASH FROM BITTERN THROUGH SELECTIVE EXTRACTION OF POTTASIUM	PRATYUSH MAITI, PUSHPITO KUMAR GHOSH, MAHESH RAMNIKLAL GANDHI, JIGNESH SOLANKI, HARSHAD RAMAN RAHMBHATT
74	United States Of America	9517943	INTEGRATED PROCESS OF PRODUCTION OF POTASSIUM SULPHATE AND AMMONIUM SULPHATE FROM KAINITE MIXED SALT	PUSHPITO KUMAR GHOSH, PRATYUSH MAITI, MAHESHKUMAR RAMNIKLAL GANDHI
75	United States Of America	9556328	Biodegradable hydrophobic composite materials and process for the preparation thereof	MEENA RAMAVATAR, GHOSH PUSHPITO KUMAR, CHEJARA DHARMESH, ESWARAN KARUPPANAN, SIDDHANTA ARUP KUMAR, PRASAD KAMALESH, CHAUDHARY JAI

				PRAKASH
76	United States Of America	9527073	ANION EXCHANGE MEMBRANE AND PREPARATION THEREOF	PUSHPITO KUMAR GHOSH, SAROJ SHARMA, MILAN DINDA, CHIRAGKUMAR RAMESHBHAI SHARMA, UMA CHATTERJEE, VAIBHAV KULSHRESHTHA, SOUMYADEB GHOSH, BABULAL SURABHAI MAKWANA, SREEKUMARAN THAMPY, GIRISH RAJANIKANT DESALE
77	United States Of America	9540248	PROCESS FOR PRODUCTION OF SULPHATE OF POTASH FROM BITTERN THROUGH SELECTIVE EXTRACTION OF POTTASIUM	PRATYUSH MAITI, PUSHPITO KUMAR GHOSH, MAHESH RAMNIKLAL GANDHI, JIGNESH SOLANKI, HARSHAD RAMAN RAHMBHATT
78	United States Of America	9567233	A PROCESS FOR PREPARATION OF SYNTHETIC HYDROTALCITE USING INDUSTRIAL WASTE	MAHESHKUMAR RAMNIKLAL GANDHI, JATIN RAMESHCHANDRA CHUNAWALA, SATISH HARIRAY MEHTA
79	United States Of America	9433919	PREPARATION OF AC@MOF COMPOSITE WITH ENHANCED METHANE STORAGE CAPACITY	BAJAJ HARI CHAND, SOMANI RAJESH SHANTILAL, RALLAPALLI PHANI BS, PATIL DINESH, PRASANTH KP, RAJ MANOJ C, THAKUR RAJENDRA SINGH, NEWALKAR BHARAT L, CHAUDHARY NV
80	United States Of America	9364797	HIGH FLUX HOLLOW FIBER ULTRAFILTRATION MEMBRANES AND PROCESS FOR THE PREPARATION THEREOF	ALAMURU VENKTARAMI REDDY, PARAMITA RAY, PUYAM SOBHINDRO SINGH, KALLEM PARASHURAM, SANDIPKUMAR MAURYA, JITENDRA JAYDEVPRASAD TRIVEDI
81	United States Of America	9409143	STANDALONE LABORATORY SCALE DEVICE FOR CONDUCTING SOLAR-DRIVEN ORGANIC REACTIONS PROMOTED BY ELEVATED TEMPERATURE, LIGHT AND AGITATION AND PROCESS THEREOF	PUSHPITO KUMAR GHOSH, SUPRATIM CHAKRABORTY, MILAN DINDA, SUBARNA MAITI, CHITRANGI BHATT, JITENDRA NARSIBHAI BHARADIA, PANKAJ ARVINDBHAI PATEL, PRATAP SHASHIKANT BAPAT
82	United States Of America	9452993	PROCESS FOR IMPROVED SEAWEED BIOMASS CONVERSION FOR FUEL INTERMEDIATES AND FERTILIZER	PUSHPITO KUMAR GHOSH, DIBYENDU MONDAL, PRATYUSH MAITI, KAMALESH PRASAD, SUBARNA MAITI, BHARTI GUNVANTRAY SHAH, ARUP KUMAR SIDDHANTA
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SNo	**Country**	**Patent No**	**Title of Invention**	**Inventors**
83	China	ZL2012800525117	COST-EFFECTIVE NATURAL SALT FORMULATIONS FOR SEAWATER SUBSTITUTION, MINERAL FORTIFICATION AND PROCESSES THEREOF	PUSHPITO KUMAR GHOSH, SUMESH CHANDRA UPADHYAY, SANDHYA CHANDRIKAPRASAD MISHRA, VADAKKE PUTHOOR MOHANDAS, DIVESH NARAYAN SRIVASTAVA, VINOD KUMAR SHAHI, RAHUL JASVANTRAI SANGHAVI, SREEKUMARAN THAMPY, BABULAL SURABHAI MAKWANA, IMRAN PANCHA, RUMA PAL, RAMKRISHNA SEN
84	Japan	6117239	COST-EFFECTIVE NATURAL SALT FORMULATIONS FOR SEAWATER SUBSTITUTION, MINERAL	PUSHPITO KUMAR GHOSH, SUMESH CHANDRA UPADHYAY, SANDHYA CHANDRIKAPRASAD MISHRA, VADAKKE

			FORTIFICATION AND PROCESSES THEREOF	PUTHOOR MOHANDAS, DIVESH NARAYAN SRIVASTAVA, VINOD KUMAR SHAHI, RAHUL JASVANTRAI SANGHAVI, SREEKUMARAN THAMPY, BABULAL SURABHAI MAKWANA, IMRAN PANCHA, RUMA PAL, RAMKRISHNA SEN
CSIR-IGIB				
SNo	**Country**	**Patent No**	**Title of Invention**	**Inventors**
85	Brazil	PI0205820-0	NOVEL PRIMERS FOR SCREENING SCHIZOPHRENIA AND A METHOD THEREOF	BRAHMACHARI SK, RANJANA, CHITRA, SALIM Q, JAIN S
86	China	ZL201280029596.7	METHOD TO MODULATE PIGMENTATION PROCESS IN THE MELANOCYTES OF SKIN	GOKHALE RAJESH SUDHIR, NATARAJAN VIVEK TURUNELVELI, GANJU PARUL
87	Eurasian Patent Organization	023630	GENE VARIANTS OF EGLN1 GENE AS PREDICTIVE MARKERS FOR DETECTING HIGH ALTITUDE ADAPTATION AND HYPOXIA RESPONSIVENESS AND THE METHOD THEREOF	BHAVANA PRASHER, SHILPI AGGARWAL, MOHAMMED ABDUL QADAR PASHA, MITALI MUKERJI
88	Russia	023630	GENE VARIANTS OF EGLN1 GENE AS PREDICTIVE MARKERS FOR DETECTING HIGH ALTITUDE ADAPTATION AND HYPOXIA RESPONSIVENESS AND THE METHOD THEREOF	BHAVANA PRASHER, SHILPI AGGARWAL, MOHAMMED ABDUL QADAR PASHA, MITALI MUKERJI
89	United States Of America	9572893	NOVEL ARGININE-HISTIDINE-CYSTEINE BASED PEPTIDE CARRIER FOR DELIVERY OF DNA WITH HIGH EFFICIENCY AND LOW TOXICITY	GANGULI MUNIA, ANITA MANN, VASUNDHARA SHUKLA, MANIKA VIJ
CSIR-IHBT				
SNo	**Country**	**Patent No**	**Title of Invention**	**Inventors**
90	China	ZL201380008598.2	AN ECONOMICAL PROCESS FOR PURIFICATION OF BIO AMINO ACIDS	HARSH PRATAP SINGH, AJAY RANA
91	European Patent Office	EP2536850B1	A UNIVERSAL FUNGAL PATHOGEN DETECTION SYSTEM	KARNIKA THAKUR, GOPALJEE JHA
92	Japan	5981653	A BIOREACTOR VESSEL FOR LARGE SCALE GROWING OF PLANTS UNDER ASEPTIC CONDITIONS	RAJESH THAKUR, ANIL SOOD, PARAMVIR SINGH AHUJA
93	Poland	EP2536850B1	A UNIVERSAL FUNGAL PATHOGEN DETECTION SYSTEM	KARNIKA THAKUR, GOPALJEE JHA
94	Russia	2599835	PROCESS FOR THE MODIFICATION OF CURCUMA AROMATICA ESSENTIAL OIL	VIJAI KANT AGNIHOTRI, BIKRAM SINGH, GARIKAPATI DYVA KIRAN BABU, GOPI CHAND, RAKESH DEOSHARAN SINGH, PARAMVIR SINGH AHUJA
95	Russia	2591465	METHOD AND APPARATUS FOR THE SEPARATION OF SEEDS FROM FRUIT PULP/SLURRY/POMACE	SHASHI BHUSHAN, SAKSHI GUPTA, GARIKAPATI DYVA KIRAN BABU, MOHIT SHARMA, PARAMVIR SINGH AHUJA

96	Turkey	EP2536850B1	A UNIVERSAL FUNGAL PATHOGEN DETECTION SYSTEM	KARNIKA THAKUR, GOPALJEE JHA

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SNo	Country	Patent No	Title of Invention	Inventors
97	Australia	AU2010344321	TRIAZINE-ARYL-BIS-INDOLES AND PROCESS FOR PREPARATION THEREOF	VASANTA MADHAVA SHARMA GANGAVARAM, JHILLU SINGH YADAV, RADHA KRISHNA PALAKODETY, ARUN BANDYOPADHYAY, SIDDHARTHA ROY, SANTU BANDYOPADHYAY, RAKESH KAMAL JOHRI, SUBHASH CHANDER SHARMA, BALARAM GHOSH, MABALIRAJAN ULAGANATHAN, SAKSHI BALWANI, BHOLANATH PAUL, ASHOK KUMAR SAXENA
98	Germany	2329023	COMPOSITIONS AND METHODS FOR DELIVERY OF PROTEIN-CODING RNAS TO CORRECT MITOCHONDRIAL DYSFUNCTION	ADHYA SAMIT
99	Germany	2224938	METHANOLIC EXTRACT OF PIPER BETEL LEAVES FOR THE TREATMENT OF HUMAN MALIGNANCIES BY INDUCING OXIDATIVE STRESS	SANTU BANDYOPADHYAY, BIKAS CHANDRA PAL, JAYASHREE BAGCHI CHAKRABORTY, SRABANTI RAKSHIT, LABANYA MANDAL, KAUSIK PAUL, NABENDU BISWAS, ANIRBAN MANNA,
100	European Patent Office	2224938	METHANOLIC EXTRACT OF PIPER BETEL LEAVES FOR THE TREATMENT OF HUMAN MALIGNANCIES BY INDUCING OXIDATIVE STRESS	SANTU BANDYOPADHYAY, BIKAS CHANDRA PAL, JAYASHREE BAGCHI CHAKRABORTY, SRABANTI RAKSHIT, LABANYA MANDAL, KAUSIK PAUL, NABENDU BISWAS, ANIRBAN MANNA,
101	European Patent Office	2329023	COMPOSITIONS AND METHODS FOR DELIVERY OF PROTEIN-CODING RNAS TO CORRECT MITOCHONDRIAL DYSFUNCTION	ADHYA SAMIT
102	European Patent Office	2670416	A SYNTHETIC PEPTIDE FORMULATION AGAINST MELANOMA AND OTHER CANCERS OVER-EXPRESSING S100B	AMLANJYOTI DHAR, SHAMPA MALLICK, ISRAR AHMED, ADITYA KONAR, SANTU BANDYOPADHYAY, SIDDHARTHA ROY
103	France	2329023	COMPOSITIONS AND METHODS FOR DELIVERY OF PROTEIN-CODING RNAS TO CORRECT MITOCHONDRIAL DYSFUNCTION	ADHYA SAMIT
104	France	2224938	METHANOLIC EXTRACT OF PIPER BETEL LEAVES FOR THE TREATMENT OF HUMAN MALIGNANCIES BY INDUCING OXIDATIVE STRESS	SANTU BANDYOPADHYAY, BIKAS CHANDRA PAL, JAYASHREE BAGCHI CHAKRABORTY, SRABANTI RAKSHIT, LABANYA MANDAL, KAUSIK PAUL, NABENDU BISWAS, ANIRBAN MANNA,
105	France	2670416	A SYNTHETIC PEPTIDE FORMULATION AGAINST MELANOMA AND OTHER CANCERS OVER-EXPRESSING S100B	AMLANJYOTI DHAR, SHAMPA MALLICK, ISRAR AHMED, ADITYA KONAR, SANTU BANDYOPADHYAY, SIDDHARTHA ROY
106	United Kingdom	2670416	A SYNTHETIC PEPTIDE	AMLANJYOTI DHAR, SHAMPA MALLICK,

			FORMULATION AGAINST MELANOMA AND OTHER CANCERS OVER-EXPRESSING S100B	ISRAR AHMED, ADITYA KONAR, SANTU BANDYOPADHYAY, SIDDHARTHA ROY
107	United Kingdom	2224938	METHANOLIC EXTRACT OF PIPER BETEL LEAVES FOR THE TREATMENT OF HUMAN MALIGNANCIES BY INDUCING OXIDATIVE STRESS	SANTU BANDYOPADHYAY, BIKAS CHANDRA PAL, JAYASHREE BAGCHI CHAKRABORTY, SRABANTI RAKSHIT, LABANYA MANDAL, KAUSIK PAUL, NABENDU BISWAS, ANIRBAN MANNA,
108	United Kingdom	2329023	COMPOSITIONS AND METHODS FOR DELIVERY OF PROTEIN-CODING RNAS TO CORRECT MITOCHONDRIAL DYSFUNCTION	ADHYA SAMIT
109	United States Of America	9,302,967	INHIBITORS OF IL-4 AND IL-5 FOR THE TREATMENT OF BRONCHIAL ASTHMA	SANTU BANDYOPADHYAY, BALARAM GHOSH, PARASURAMAN JAISANKAR, BIKAS CHANDRA PAL, SIDDHARTHA ROY, BHOLANATH PAUL, ARJUN RAM, ULAGANATHAN MABALIRAJAN, NAHID ALI, ARUN BANDYOPADHYAY, ADITYA KONAR, JAYASHREE BAGCHI CHAKRABOTRY, INDRANI CHAUDHURY MUKHERJEE, JAYDEEP CHAUDHURI, SANJIT KUMAR MAHATO, ANIRBAN MANNA, ROMA SINHA, PRADYOT BHATTACHARYA, JAYARAMAN VINAYAGAM, DEBA PRASAD JANA, SUSHOVAN CHOWDHURY
110	United States Of America	9408888	A SYNTHETIC PEPTIDE FORMULATION AGAINST MELANOMA AND OTHER CANCERS OVER-EXPRESSING S100B	AMLANJYOTI DHAR, SHAMPA MALLICK, ISRAR AHMED, ADITYA KONAR, SANTU BANDYOPADHYAY, SIDDHARTHA ROY

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SNo	Country	Patent No	Title of Invention	Inventors
111	Canada	2682384	SYNTHESIS AND BIOLOGICAL EVALUATION OF BENZOPHENONE HYDRIDES AS POTENTIAL ANTICANCER AGENTS	AHMED KAMAL, BANDARI RAJENDRA PRASAD
112	China	ZL200980123247.X	CASTOR OIL FATTY ACID-BASED ESTOLIDE ESTERS AND THEIR ACETATES AS POTENTIAL LUBRICANT BASE STOCKS	POTULA SATYA BHASKAR, KORLIPARA VENKATA PADMAJA, BHAMIDIPATI VENKATA SURYA KOPPESWARA RAO, KRISHNASAMY SARAVANAN, RACHAPUDI BADARI NARAYANA PRASAD
113	Germany	2928871	PROCESS FOR SYNTHESIZING HISTIDINYLATED CATIONIC AMPHIPHILES, A NEW CLASS OF ANTI-CANCER COMPOUNDS	ARUP GARU, GOPIKRISHNA MOKU, Sachin Barad Agawane, ARABINDA CHAUDHURI
114	Germany	2649078	4-AZA-2,3-DIDEHYDROPODOPHYLLOTOXIN COMPOUNDS AND PROCESS FOR THE PREPARATION THEREOF	AHMED KAMAL, PAIDAKULA SURESH, BANALA ASHWINI KUMAR, ADLA MALLAREDDY, PAPAGARI VENKAT REDDY, JAKI RASHEED TAMBOLI
115	Germany	2215195	DEACIDIFICATION OF JATROPHA AND KARANJA OILS AND PURIFICATION OF	RAO KASTURI VENKATA SESHA ADINARAYANA, SARAVANAN

			CRUDE BIODIESEL BY LIQUID-LIQUID EXTRACTION	KRISHNASAMY, VIJAYALAKSHMI PENUMARTHY
116	Germany	2350030	ISOXAZOLE/ISOXAZOLINE/COMBRETASTATIN LINKED DIHYDROQUINAZOLINONE HYBRIDS AS POTENTIAL ANTICANCER AGENTS AND PROCESS FOR THE PREPARATION THEREOF	AHMED KAMAL, EARLA VIJAYA BHARATHI, JONNALA SURENDRANADHA REDDY, DUDEKULA DASTAGIRI, ARUTLA VISWANATH
117	Germany	2966073	ANTICANCER AGENT AND PROCESS FOR THE PREPARATION THEREOF	AHMED KAMAL, TELUKUTLA SRINIVASA REDDY, VUNNAM SRINIVASULU, AYINAMPUDI VENKATA SUBBARAO, NAGULA SHANKARAIAH, MADUGULLA VENKATA PHANI SURYA VISHNU VARDHAN
118	European Patent Office	2928871	PROCESS FOR SYNTHESIZING HISTIDINYLATED CATIONIC AMPHIPHILES, A NEW CLASS OF ANTI-CANCER COMPOUNDS	ARUP GARU, GOPIKRISHNA MOKU, Sachin Barad Agawane, ARABINDA CHAUDHURI
119	European Patent Office	2215195	DEACIDIFICATION OF JATROPHA AND KARANJA OILS AND PURIFICATION OF CRUDE BIODIESEL BY LIQUID-LIQUID EXTRACTION	RAO KASTURI VENKATA SESHA ADINARAYANA, SARAVANAN KRISHNASAMY, VIJAYALAKSHMI PENUMARTHY
120	European Patent Office	2966073	ANTICANCER AGENT AND PROCESS FOR THE PREPARATION THEREOF	AHMED KAMAL, TELUKUTLA SRINIVASA REDDY, VUNNAM SRINIVASULU, AYINAMPUDI VENKATA SUBBARAO, NAGULA SHANKARAIAH, MADUGULLA VENKATA PHANI SURYA VISHNU VARDHAN
121	European Patent Office	2350030	ISOXAZOLE/ISOXAZOLINE/COMBRETASTATIN LINKED DIHYDROQUINAZOLINONE HYBRIDS AS POTENTIAL ANTICANCER AGENTS AND PROCESS FOR THE PREPARATION THEREOF	AHMED KAMAL, EARLA VIJAYA BHARATHI, JONNALA SURENDRANADHA REDDY, DUDEKULA DASTAGIRI, ARUTLA VISWANATH
122	European Patent Office	2649078	4-AZA-2,3-DIDEHYDROPODOPHYLLOTOXIN COMPOUNDS AND PROCESS FOR THE PREPARATION THEREOF	AHMED KAMAL, PAIDAKULA SURESH, BANALA ASHWINI KUMAR, ADLA MALLAREDDY, PAPAGARI VENKAT REDDY, JAKI RASHEED TAMBOLI
123	France	2928871	PROCESS FOR SYNTHESIZING HISTIDINYLATED CATIONIC AMPHIPHILES, A NEW CLASS OF ANTI-CANCER COMPOUNDS	ARUP GARU, GOPIKRISHNA MOKU, Sachin Barad Agawane, ARABINDA CHAUDHURI
124	France	2649078	4-AZA-2,3-DIDEHYDROPODOPHYLLOTOXIN COMPOUNDS AND PROCESS FOR THE PREPARATION THEREOF	AHMED KAMAL, PAIDAKULA SURESH, BANALA ASHWINI KUMAR, ADLA MALLAREDDY, PAPAGARI VENKAT REDDY, JAKI RASHEED TAMBOLI
125	France	2966073	ANTICANCER AGENT AND PROCESS FOR THE PREPARATION THEREOF	AHMED KAMAL, TELUKUTLA SRINIVASA REDDY, VUNNAM SRINIVASULU, AYINAMPUDI VENKATA SUBBARAO, NAGULA SHANKARAIAH, MADUGULLA VENKATA PHANI SURYA VISHNU VARDHAN

126	France	2215195	DEACIDIFICATION OF JATROPHA AND KARANJA OILS AND PURIFICATION OF CRUDE BIODIESEL BY LIQUID-LIQUID EXTRACTION	RAO KASTURI VENKATA SESHA ADINARAYANA, SARAVANAN KRISHNASAMY, VIJAYALAKSHMI PENUMARTHY
127	France	2350030	ISOXAZOLE/ISOXAZOLINE/COMBRETASTATIN LINKED DIHYDROQUINAZOLINONE HYBRIDS AS POTENTIAL ANTICANCER AGENTS AND PROCESS FOR THE PREPARATION THEREOF	AHMED KAMAL, EARLA VIJAYA BHARATHI, JONNALA SURENDRANADHA REDDY, DUDEKULA DASTAGIRI, ARUTLA VISWANATH
128	United Kingdom	2215195	DEACIDIFICATION OF JATROPHA AND KARANJA OILS AND PURIFICATION OF CRUDE BIODIESEL BY LIQUID-LIQUID EXTRACTION	RAO KASTURI VENKATA SESHA ADINARAYANA, SARAVANAN KRISHNASAMY, VIJAYALAKSHMI PENUMARTHY
129	United Kingdom	2350030	ISOXAZOLE/ISOXAZOLINE/COMBRETASTATIN LINKED DIHYDROQUINAZOLINONE HYBRIDS AS POTENTIAL ANTICANCER AGENTS AND PROCESS FOR THE PREPARATION THEREOF	AHMED KAMAL, EARLA VIJAYA BHARATHI, JONNALA SURENDRANADHA REDDY, DUDEKULA DASTAGIRI, ARUTLA VISWANATH
130	United Kingdom	2649078	4-AZA-2,3-DIDEHYDROPODOPHYLLOTOXIN COMPOUNDS AND PROCESS FOR THE PREPARATION THEREOF	AHMED KAMAL, PAIDAKULA SURESH, BANALA ASHWINI KUMAR, ADLA MALLAREDDY, PAPAGARI VENKAT REDDY, JAKI RASHEED TAMBOLI
131	United Kingdom	2928871	PROCESS FOR SYNTHESIZING HISTIDINYLATED CATIONIC AMPHIPHILES, A NEW CLASS OF ANTI-CANCER COMPOUNDS	ARUP GARU, GOPIKRISHNA MOKU, Sachin Barad Agawane, ARABINDA CHAUDHURI
132	Indonesia	IDP000043500	SELF MIXED ANAEROBIC DIGESTER FOR THE TREATMENT OF ORGANIC SOLID WASTE	ANUPOJU GANGAGNI RAO, JOHNY JOSEPH, SUNKAVALLI SURYA PRAKASH, ANNAPURNA JETTY, PONNAPALLI NAGESWARA SARMA
133	Japan	5941058	PYRROLO[2,1-C][1,4]BENZODIAZEPINE LINKED IMIDAZO[1,5-A]PYRIDINE CONJUGATES AS POTENTIAL ANTITUMOUR AGENTS AND PROCESS FOR THE PREPARATION THEREOF	AHMED KAMAL, GADUPUDI RAMAKRISHNA, PAIDAKULA RAJU, AYINAMPUDI VENKATA SUBBA RAO, ARUTLA VISHWANATH, GORRE BALAKISHAN
134	United States Of America	9403869	NOVEL INTEGRIN BINDING RGD-LIPOPEPTIDES WITH A GENE TRANSFER ACTIVITIES	BHARAT KUMAR MAJETI, PRIYA PRAKASH KARMALI, DIPANKAR PRAMANIK, ARABINDA CHAUDHARI
135	United States Of America	9522907	ANTICANCER AGENT AND PROCESS FOR THE PREPARATION THEREOF	AHMED KAMAL, TELUKUTLA SRINIVASA REDDY, VUNNAM SRINIVASULU, AYINAMPUDI VENKATA SUBBARAO, NAGULA SHANKARAIAH, MADUGULLA VENKATA PHANI SURYA VISHNU VARDHAN
136	United States Of America	9364566	GLUCOCORTICOID RECEPTOR TARGETING FORMULATIONS FOR DELIEVERING GENES TO CANCER CELLS	AMARNATH MUKHERJEE, RAJKUMAR BANERJEE
137	United States Of America	9580452	AN ANTIOXIDANT COMPOUND HAVING ANTI ATHEROSCLEROTIC EFFECT AND PREPARATION THEREOF	KOTAMRAJU SRIGIRIDHAR, KARNEWAR SANTOSH, VASAMSETTI SATHISH BABU, TOGAPUR PAVAN KUMAR, BASI VENKATA SUBBA

				REDDY, JERALD MAHESH KUMAR
138	United States Of America	9,309,225	N-((1-BENZYL-1H-1,2,3-TRIAZOL-4-YL)METHYL)ARYLAMIDE COMPOUNDS AS POTENTIAL ANTICANCER AGENTS AND A PROCESS FOR THE PREPARATION THEREOF	AHMED KAMAL, NARRIKOLLA VENKATA SUBBA REDDY, BUDAGANABOYINA PRASAD, VADITHE LAKSHMA NAYAK, VANGALA SAIDI REDDY
139	United States Of America	9604933	PYRAZOLOCHALCONES AS POTENTIAL ANTICANCER AGENTS	AHMED KAMAL, SHAIK ANVER BASHA, GAJJELA BHARATH KUMAR, VANGALA SANTHOSH REDDY, CHITYAL GANESH KUMAR
140	United States Of America	9487482	Novel 3,4,5-trimethoxystyrylarylaminopropenones as potential anticancer agents	AHMED KAMAL, GAJJELA BHARATH KUMAR, ANVER BASHA. SHAIK, VANGALA SANTHOSH REDDY, MAHESH RASALA
141	United States Of America	9428603	PROCESS FOR THE PREPARATION OF POLYTHIOPHENE AND ITS COPOLYMER DISPERSIONS WITH REACTIVE SURFACTANTS	ITTARA SURESH KATTIMUTTATHU, MANDAPATI VENKATESWARA REDDY
142	United States Of America	9505760	Pyridopyrimidine based derivatives useful as potential Phosphodiesterase3 (PDE3) inhibitors and a process for the preparation thereof	BUDDE MAHENDAR, SAIDULU MATTAPALLY, METTU RAVINDER, SANJAY KUMAR BANERJEE, VAIDYA JAYATHIRTHA RAO
143	United States Of America	9562045	INDOLIZINE BASED DERIVATIVES USEFUL AS POTENTIAL PHOSPHODIESTERASE3 (PDE3) INHIBITORS AND A PROCESS FOR THE PREPARATION THEREOF	BUDDE MAHENDAR, SAIDULU MATTAPALLY, METTU RAVINDER, SANJAY KUMAR BANERJEE, VAIDYA JAYATHIRTHA RAO

CSIR-IIIM

SNo	Country	Patent No	Title of Invention	Inventors
144	Canada	2728855	SPIRO DERIVATIVES OF PARTHENIN AS NOVEL ANTICANCER AGENTS;DESIGN AND SYNTHESIS	HALMUTHUR MAHABALARAO SAMPATH KUMAR, SAXENA AJIT KUMAR, TANEJA SUBHASH CHANDRA, SINGH SHASHANK KUMAR, SETHI VIJAY KUMAR, QAZI NAVEED AHMED, SAWANT SANGHAPAL DAMODAR, DOMA MAHENDER REDDY, BANDAY ABID HUSSAIN, VERMA MONIKA, QAZI GHULAM NABI
145	China	ZL2013800262915	DESIGN, SYNTHESIS AND BIOLOGICAL EVALUATION OF ISOFORM SELECTIVE ANALOGS OF LIPHAGANE SCAFFOLD AS ANTICANCER AGENTS: P13K-ALPHA/BETA INHIBITORS	RAM A VISHWAKARMA, SANGHAPAL DAMODHAR SAWANT, PARVINDER PAL SINGH, ABID HAMID DAR, PARDUMAN RAJ SHARMA, AJIT KUMAR SAXENA, AMIT NARGOTRA, KOLLURU ANJANEYA ARAVIND KUMAR, MUDUDUDDLA RAMESH, ASIF KHURSHID QAZI, AASHIQ HUSSAIN, NAYAN CHANAURIA

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SNo	Country	Patent No	Title of Invention	Inventors
146	Germany	10115893	PROCESS FOR THE PREPARATION OF A CATALYST USEFUL FOR LIQUID-LIQUID SWEETENING LPG AND LIGHT PETROLEUM DISTILLATES	SAIN; BIR (DEHRADUN, IN); PURI; SOM NATH (DEHRADUN, IN); DAS; GAUTAM (DEHRADUN, IN); BALODI; BHAGWATI PRASAD (DEHRADUN, IN); KUMAR; SUNIL (DEHRADUN, IN); KUMAR; ANIL (DEHRADUN, IN); KAPOOR; VIRENDRA

				KUMAR (DEHRADUN, IN); BHATIA; VIRENDRA KUMAR (DEHRADUN, IN); RAO; TURUGA SUNDARA RAMA PRASADA (DEHRADUN, IN); RAI; GUR PRATAP (MUMBAI, IN)
147	United States Of America	9546324	New method for increasing gas oil/diesel yield and energy efficiency in crude oil distillation	SUNIL KUMAR, NANOTI SHRIKANT MADHUSUDAN, GARG MADHUKAR ONKARNATH
148	United States Of America	9434668	An improved process for the production of tertiary butyl phenols	KHATRI PRAVEEN KUMAR, JAIN SUMAN LATA, GHOSH INDRAJIT KUMAR
149	United States Of America	9468914	An improved process for the preparation of phosphorous containing mesoporous alumina catalyst for selective dehydration of methanol to dimethyl ether	BORDOLOI ANKUR, GOYAL REENA, DAS SUBHASIS, SINGHA RAJIB KUMAR, PENDEM CHANDRASHEKAR, KONATHALA LAXMI NARAYAN SIVAKUMAR, BA RAJARAM, SARAN SANDEEP, GARG MADHUKAR ONKARNATH
150	United States Of America	9480974	Nano Ni-CeO2 catalyst and its preparation thereof useful for syngas production Nano Ni-CeO2 catalyst and its preparation thereof useful for syngas production	BAL RAJARAM, SINGHA RAJIB KUMAR, PENDEM CHANDRASHEKAR, KONATHALA LAXMI NARAYAN SIVAKUMAR, BORDOLOI ANKUR
151	United States Of America	9598649	A SINGLE STEP CATALYTIC PROCESS FOR THE CONVERSION OF NAPHTHA TO DIESEL RANGE HYDROCARBONS	NAGABHATLA VISWANADHAM, PETA SREENIVASULU, SAXENA SANDEEP KUMAR, PANWAR RAJIV, NANDAN DEVAKI, JADGISH KUMAR
152	United States Of America	9409847	AN IMPROVED PROCESS AND CATALYST FOR SINGLE STEP CONVERSION OF GLYCEROL TO ACRYLIC ACID	BAL RAJARAM, SARKAR BIPUL, SINGHA RAJIB KUMAR, PENDEM CHANDRASHEKAR, SHANKHA SHUBHRA ACHARYYA, GHOSH SHILPI

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SNo	Country	Patent No	Title of Invention	Inventors
153	Belgium	2274336	CYSTEINE VARIANTS OF STREPTOKINASE AND ITS COVALENTLY MODIFIED FORMS	SHEKHAR KUMAR, NEERAJ MAHESHWARI, GIRISH SAHNI
154	Canada	2668690	CRETION OF A MESO-ACTIVE THERMO-STABLE CHIMERA THROUGH TRANSPLANTATION OF THE ENTIRE ACTIVE SURFACE OF A MESOPHILE ENZYME ONTO ITS THERMOPHILE HOMOLOG	DIVYA KAPOOR, SANJEEV KUMAR, SHUBBIR AHMED, SWATI SHARMA, MANISH DUTT, BALVINDER SINGH, KARTHIKEYAN SUBRAMANIAN, PURNANANDA GUPTASARMA
155	Switzerland	2274336	CYSTEINE VARIANTS OF STREPTOKINASE AND ITS COVALENTLY MODIFIED FORMS	SHEKHAR KUMAR, NEERAJ MAHESHWARI, GIRISH SAHNI
156	China	ZL200980120111.3	CYSTEINE VARIANTS OF STREPTOKINASE AND ITS COVALENTLY MODIFIED FORMS	SHEKHAR KUMAR, NEERAJ MAHESHWARI, GIRISH SAHNI
157	China	ZL201180054827.5	A SYNTHETIC IMMUNOGEN USEFUL FOR GENERATING LONG LASTING IMMUNITY AND PROTECTION AGAINST PATHOGENS	JAVED NAIM AGREWALA, UTHAMAN GOWTHAMAN, DAVID JACKSON, WEIGUANG ZENG

158	China	ZL200780048162.0	CRETION OF A MESO-ACTIVE THERMO-STABLE CHIMERA THROUGH TRANSPLANTATION OF THE ENTIRE ACTIVE SURFACE OF A MESOPHILE ENZYME ONTO ITS THERMOPHILE HOMOLOG	DIVYA KAPOOR, SANJEEV KUMAR, SHUBBIR AHMED, SWATI SHARMA, MANISH DUTT, BALVINDER SINGH, KARTHIKEYAN SUBRAMANIAN, PURNANANDA GUPTASARMA
159	Germany	2616098	A SYNTHETIC IMMUNOGEN USEFUL FOR GENERATING LONG LASTING IMMUNITY AND PROTECTION AGAINST PATHOGENS	JAVED NAIM AGREWALA, UTHAMAN GOWTHAMAN, DAVID JACKSON, WEIGUANG ZENG
160	Germany	2274336	CYSTEINE VARIANTS OF STREPTOKINASE AND ITS COVALENTLY MODIFIED FORMS	SHEKHAR KUMAR, NEERAJ MAHESHWARI, GIRISH SAHNI
161	European Patent Office	2274336	CYSTEINE VARIANTS OF STREPTOKINASE AND ITS COVALENTLY MODIFIED FORMS	SHEKHAR KUMAR, NEERAJ MAHESHWARI, GIRISH SAHNI
162	European Patent Office	2616098	A SYNTHETIC IMMUNOGEN USEFUL FOR GENERATING LONG LASTING IMMUNITY AND PROTECTION AGAINST PATHOGENS	JAVED NAIM AGREWALA, UTHAMAN GOWTHAMAN, DAVID JACKSON, WEIGUANG ZENG
163	France	2274336	CYSTEINE VARIANTS OF STREPTOKINASE AND ITS COVALENTLY MODIFIED FORMS	SHEKHAR KUMAR, NEERAJ MAHESHWARI, GIRISH SAHNI
164	United Kingdom	2274336	CYSTEINE VARIANTS OF STREPTOKINASE AND ITS COVALENTLY MODIFIED FORMS	SHEKHAR KUMAR, NEERAJ MAHESHWARI, GIRISH SAHNI
165	Indonesia	IDP000040873	A SYNTHETIC IMMUNOGEN USEFUL FOR GENERATING LONG LASTING IMMUNITY AND PROTECTION AGAINST PATHOGENS	JAVED NAIM AGREWALA, UTHAMAN GOWTHAMAN, DAVID JACKSON, WEIGUANG ZENG
166	Japan	5991976	A SYNTHETIC IMMUNOGEN USEFUL FOR GENERATING LONG LASTING IMMUNITY AND PROTECTION AGAINST PATHOGENS	JAVED NAIM AGREWALA, UTHAMAN GOWTHAMAN, DAVID JACKSON, WEIGUANG ZENG
167	United States Of America	9518255	NEW STAPHYLOKINASES CARRYING AMINO AND CARBOXY-TERMINAL EXTENSION AND THEIR PEG (POLYETHYLENE GLYCOL) CONJUGATED FORMS	SATISH SINGH, KANAK LATA DIKSHIT
168	United States Of America	9458196	STRAIN INDEPENDENT ANTI-INFLUENZA PEPTIDES FOR TARGETING A NOVEL DRUG SITE IN HEMAGGLUTININ TRIMER	ASHISH, PANDEY KALPANA, RATHORE YOGENDRA SINGH
169	United States Of America	9340622	A SYNTHETIC IMMUNOGEN USEFUL FOR GENERATING LONG LASTING IMMUNITY AND PROTECTION AGAINST PATHOGENS	JAVED NAIM AGREWALA, UTHAMAN GOWTHAMAN, DAVID JACKSON, WEIGUANG ZENG
170	South Africa	2014/05968	STRAIN INDEPENDENT ANTI-	ASHISH, PANDEY KALPANA, RATHORE

			INFLUENZA PEPTIDES FOR TARGETING A NOVEL DRUG SITE IN HEMAGGLUTININ TRIMER	YOGENDRA SINGH

CSIR-NAL

SNo	Country	Patent No	Title of Invention	Inventors
171	China	ZL201280061780X	AN IMPROVED SOLAR SELECTIVE COATING HAVING HIGH THERMAL STABILITY AND A PROCESS FOR THE PREPARATION THEREOF	BARSHILIA HARISH CHANDRA
172	Germany	2791384	AN IMPROVED SOLAR SELECTIVE COATING HAVING HIGH THERMAL STABILITY AND A PROCESS FOR THE PREPARATION THEREOF	BARSHILIA HARISH CHANDRA
173	European Patent Office	2791384	AN IMPROVED SOLAR SELECTIVE COATING HAVING HIGH THERMAL STABILITY AND A PROCESS FOR THE PREPARATION THEREOF	BARSHILIA HARISH CHANDRA
174	Spain	2791384	AN IMPROVED SOLAR SELECTIVE COATING HAVING HIGH THERMAL STABILITY AND A PROCESS FOR THE PREPARATION THEREOF	BARSHILIA HARISH CHANDRA
175	France	2791384	AN IMPROVED SOLAR SELECTIVE COATING HAVING HIGH THERMAL STABILITY AND A PROCESS FOR THE PREPARATION THEREOF	BARSHILIA HARISH CHANDRA
176	Portugal	2791384	AN IMPROVED SOLAR SELECTIVE COATING HAVING HIGH THERMAL STABILITY AND A PROCESS FOR THE PREPARATION THEREOF	BARSHILIA HARISH CHANDRA
177	United States Of America	9476115	AN IMPROVED MULTILAYER SOLAR SELECTIVE COATING FOR HIGH TEMPERATURE SOLAR THERMAL APPLICATIONS	BARSHILIA HARISH CHANDRA

CSIR-NBRI

SNo	Country	Patent No	Title of Invention	Inventors
178	Australia	2009321261	A GENE FOR INDUCING MALE STERILITY IN PLANTS	SAMIR V SAWANT, RAKESH TULI, SUDHIR PRATAP SINGH
179	United States Of America	9545107	ALLIUM FISTULOSUM LEAF AGGLUTININ PROTEIN, ITS ENCODING GENE, PRIMER AND PROCESS FOR PREPATION THEREOF	SINGH PRADHYUMNA KUMAR, RAI PREETI, SINGH RAHUL, UPADHYAY SANTOSH KUMAR, SAURABH SHARAD, SINGH HARPAL, VERMA PRAVEEN CHANDRA, KRISHNAPPA CHANDRASHEKAR, TULI RAKESH

CSIR-NCL

SNo	Country	Patent No	Title of Invention	Inventors

180	Australia	2010227195	SUBSTITUTED 1,4-DIOXA-8-AZASPIRO[4,5]DECANES USEFUL AS FUNGICIDES AND A PROCESS FOR THE PREPARATION THEREOF	MUKUND VINAYAK DESHPANDE, SUNITA RANJAN DESHPANDE, FAZAL SHIRAZI, PREETI MADHUKAR CHAUDHARY, NELAVELLI MALLESWARA RAO, BAIDYANATH MOHANTY, NAGESHWAR NATH SHARMA, ANAND KUMAR BACHHAWAT, KALIANNAN GANESAN, SANJOY PAUL, RAJ KUMAR, BOMMENA VITTAL RAO, BHIMRAO BODHANRAO GAWALI, VADDU VENKATA NARAYANA REDDY, JHILLU SINGH YADAV
181	Australia	2013207052	A NOVEL PLANT PROTEINASE INHIBITOR AGAINST INSECTS GUT PROTEASES	ASHOK PRABHAKAR GIRI, VIDYA SHRIKANT GUPTA, VAIJAYANTI ABHIJIT TAMHANE, RAKESH SHAMSUNDER JOSHI, MANASI MISHRA, RAJENDRA RAMCHANDRA JOSHI, UDDHAVESH BHASKAR SONAVANE, ANIRBAN GHOSH
182	Belgium	2539309	PROCESS FOR THE PREPARATION OF HYDROXYACETONE	CHANDRASHEKHAR VASANT RODE, AMOL MAHALINGAPPA HENGNE, AJAY ASHOK GHALWADKAR, RASIKA BHARAT MANE, PRAVINKUMAR HANSRAJ MOHITE, HARI SHANKAR POTDAR
183	Belgium	EP2807222B	ENERGY LEVEL MODULATED CONJUGATED POLYMERS FOR OXIDATION RESISTANCE	K.KRISHNAMOORTHY
184	China	ZL201180054837.9	AN IMPROVED PROCESS FOR PRODUCTION OF EPOXY FUNCTIONALIZED FATTY ACIDS, THEIR ESTERS AND MIXTURES THEREOF	DARBHA SRINIVAS, JITENDRA KUMAR SATYARTHI
185	China	ZL 201080003049.2	A PROCESS FOR DEACIDIFICATION USING MEMBRANES	ULHAS KANHAIYALAL KHARUL, RAMCHANDRA VITTHAL GADRE, VITHAL VENKATRAO JOGDAND, YOGESH JAYASING CHENDAKE
186	China	CN102575247	DNA LOADED SUPPORTED GOLD NANOPARTICLES, PROCESS FOR THE PREPARATION AND USE THEREOF	PRASAD LV BHAGAVATULA, PERIYASAMY SHANMUGHAM VIJAYAKUMAR, OTHALATHARA USHAR RAJ ABHILASH, BASHIR MOHAMMAD KHAN
187	China	ZL201180021336.0	ENZYMES FROM CONIDIOBOLUS BREFELDIANUS AND PROCESS FOR PREPARATION THEREOF	SEETA LAXMAN RYALI, HARISH BANSILAL KHANDELWAL, SNEHAL VIJAY MORE, KAMALAKAR MOTIRAM KALAL, CHANDRA BABU KANNAN NARASIMHAN, SARAVANAN PALANIVEL, PADMANABHAN BALARAM
188	China	ZL201180010541.7	ABPBI BASED POROUS MEMBRANES	ULHAS KANHAIYALAL KHARUL, HARSHADA RAMESH LOHOKARE
189	China	ZL201280026076.0	AN IMPROVED PROCESS FOR THE PREPARATION OF MEMBRANE ELECTRODE ASSEMBLIES (MEAs)	VIJAYAMOHANAN KUNJU KRISHNA, ULHAS KANHAIYALAL KHARUL, SREEKUMAR KURUNGOT, HARSHAL DILIP CHAUDHARI, SREEKUTTAN MARAVEEDU UNNI, BIPINLAL UNNI, HUSAIN NOMAN KAGALWALA
190	Germany	2906565	CHEMICALLY STABLE POROUS	RAHUL BANERJEE, SHARATH

			CRYSTALLINE FRAME WORK	KANDAMBETH, SUMAN CHANDRA
191	Germany	2872591	FLUORESCENT GRAFTING AND CHEMICAL MODIFICATION OF POLYPEPTIDES	ASHA SYAMAKUMARI, KAUSHLENDRA KUMAR, ANUYA NISAL
192	Germany	2766373	SILA ANALOGS OF OXAZOLIDINE DERIVATIVES AND SYNTHESIS THEREOF	DUMBALA SRINIVASA REDDY, SEETHARAM SINGH BALAMKUNDU, REMYA RAMESH
193	Germany	2870444	FLOW DEVICE FOR THERMOKINETIC PROPERTY MEASUREMENT	AMOL ARVIND KULKARNI, YACHITA SHARMA, VIKASH KUMAR, VINAY GULAB BHAYA
194	Germany	EP2807222B	ENERGY LEVEL MODULATED CONJUGATED POLYMERS FOR OXIDATION RESISTANCE	K.KRISHNAMOORTHY
195	Germany	2917175	2,2'-BIS(4-HYDROXYPHENYL) ALKYL AZIDES AND PROCESS FOR THE PREPARATION THEREOF	SAMADHAN SURESH NAGANE, PRAKASH SUDHIR SANE, BHAUSAHEB VILAS TAWADE, PRAKASH PURUSHOTTAM WADGAONKAR
196	European Patent Office	2870444	FLOW DEVICE FOR THERMOKINETIC PROPERTY MEASUREMENT	AMOL ARVIND KULKARNI, YACHITA SHARMA, VIKASH KUMAR, VINAY GULAB BHAYA
197	European Patent Office	2872591	FLUORESCENT GRAFTING AND CHEMICAL MODIFICATION OF POLYPEPTIDES	ASHA SYAMAKUMARI, KAUSHLENDRA KUMAR, ANUYA NISAL
198	European Patent Office	2830795	CAPPED GOLD NANOCLUSTERS	Arti Harle
199	European Patent Office	2906565	CHEMICALLY STABLE POROUS CRYSTALLINE FRAME WORK	RAHUL BANERJEE, SHARATH KANDAMBETH, SUMAN CHANDRA
200	European Patent Office	2917178	HIGH REFRACTIVE INDEX MONOMER: 2-PHENYL-2-(PHENYLTHIO)ETHYL ACRYLATE	SURENDRA PONRATHNAM, RAVINDRA VASANT GHORPADE, NAYAKU NIVRATI CHAVAN, KISHOR SUDAM RAJDEO, SUNIL SITARAM BHONGALE
201	European Patent Office	2917175	2,2'-BIS(4-HYDROXYPHENYL) ALKYL AZIDES AND PROCESS FOR THE PREPARATION THEREOF	SAMADHAN SURESH NAGANE, PRAKASH SUDHIR SANE, BHAUSAHEB VILAS TAWADE, PRAKASH PURUSHOTTAM WADGAONKAR
202	European Patent Office	EP2807222B	ENERGY LEVEL MODULATED CONJUGATED POLYMERS FOR OXIDATION RESISTANCE	K.KRISHNAMOORTHY
203	European Patent Office	2410854	SUBSTITUTED 1,4-DIOXA-8-AZASPIRO[4,5]DECANES USEFUL AS FUNGICIDES AND A PROCESS FOR THE PREPARATION THEREOF	MUKUND VINAYAK DESHPANDE, SUNITA RANJAN DESHPANDE, FAZAL SHIRAZI, PREETI MADHUKAR CHAUDHARY, NELAVELLI MALLESWARA RAO, BAIDYANATH MOHANTY, NAGESHWAR NATH SHARMA, ANAND KUMAR BACHHAWAT, KALIANNAN GANESAN, SANJOY PAUL, RAJ KUMAR, BOMMENA VITTAL RAO, BHIMRAO BODHANRAO GAWALI, VADDU VENKATA NARAYANA REDDY, JHILLU SINGH YADAV
204	European Patent Office	2766373	SILA ANALOGS OF OXAZOLIDINE DERIVATIVES AND SYNTHESIS THEREOF	DUMBALA SRINIVASA REDDY, SEETHARAM SINGH BALAMKUNDU, REMYA RAMESH
205	European	2539431	ENZYMES FROM CONIDIOBOLUS	SEETA LAXMAN RYALI, HARISH BANSILAL

	Patent Office		BREFELDIANUS AND PROCESS FOR PREPARATION THEREOF	KHANDELWAL, SNEHAL VIJAY MORE, KAMALAKAR MOTIRAM KALAL, CHANDRA BABU KANNAN NARASIMHAN, SARAVANAN PALANIVEL, PADMANABHAN BALARAM
206	European Patent Office	2539309	PROCESS FOR THE PREPARATION OF HYDROXYACETONE	CHANDRASHEKHAR VASANT RODE, AMOL MAHALINGAPPA HENGNE, AJAY ASHOK GHALWADKAR, RASIKA BHARAT MANE, PRAVINKUMAR HANSRAJ MOHITE, HARI SHANKAR POTDAR
207	France	2906565	CHEMICALLY STABLE POROUS CRYSTALLINE FRAME WORK	RAHUL BANERJEE, SHARATH KANDAMBETH, SUMAN CHANDRA
208	France	EP2807222B	ENERGY LEVEL MODULATED CONJUGATED POLYMERS FOR OXIDATION RESISTANCE	K.KRISHNAMOORTHY
209	France	2870444	FLOW DEVICE FOR THERMOKINETIC PROPERTY MEASUREMENT	AMOL ARVIND KULKARNI, YACHITA SHARMA, VIKASH KUMAR, VINAY GULAB BHAYA
210	France	2766373	SILA ANALOGS OF OXAZOLIDINE DERIVATIVES AND SYNTHESIS THEREOF	DUMBALA SRINIVASA REDDY, SEETHARAM SINGH BALAMKUNDU, REMYA RAMESH
211	United Kingdom	2870444	FLOW DEVICE FOR THERMOKINETIC PROPERTY MEASUREMENT	AMOL ARVIND KULKARNI, YACHITA SHARMA, VIKASH KUMAR, VINAY GULAB BHAYA
212	United Kingdom	2766373	SILA ANALOGS OF OXAZOLIDINE DERIVATIVES AND SYNTHESIS THEREOF	DUMBALA SRINIVASA REDDY, SEETHARAM SINGH BALAMKUNDU, REMYA RAMESH
213	United Kingdom	2872591	FLUORESCENT GRAFTING AND CHEMICAL MODIFICATION OF POLYPEPTIDES	ASHA SYAMAKUMARI, KAUSHLENDRA KUMAR, ANUYA NISAL
214	United Kingdom	2906565	CHEMICALLY STABLE POROUS CRYSTALLINE FRAME WORK	RAHUL BANERJEE, SHARATH KANDAMBETH, SUMAN CHANDRA
215	Indonesia	IDP000043044	TRANSESTERIFICATION CATALYST, PROCESS FOER PREPARATION THEREOF AND A PROCESS FOR TRANSESTERIFICATION USING THE CATALYST	DARBHA SRINIVAS, RAJENDRA SRIVASTAVA, PAUL RATNASAMY
216	Japan	5964425	Novel compounds from Leucas	SWATI PRAMOD JOSHI, ROSHAN RAJAN KULKARNI, KETKI DILIP SHURPALI, SAMPA SARKAR, DHIMAN SARKAR
217	Japan	5917511	ORDERED MESOPOROUS TITANOSILICATE AND THE PROCESS FOR THE PREPARATION THEREOF	DARBHA SRINIVAS, ANUJ KUMAR
218	Japan	5933695	CATALYTIC DEHYDRATION OF LACTIC ACID TO ACRYLIC ACID	MOHAN KERABA DONGARE, SHUBHANGI BHALCHANDRA UMBARKAR, SAMADHAN TANAJI LOMATE
219	Japan	5931745	A NOVEL FUNGAL STRAIN BEAUVERIA SP. MTCC 5184 AND A PROCESS FOR THE PREPARATION OF ENZYMES THEREFROM	SEETA LAXMAN RYALI, SHIV SHANKAR, SNEHAL VIJAY MORE, HARISH BANSILAL KHANDELWAL, CHANDRA BABU KANNAN NARASIMHAN, SARAVANAN PALANIVEL, PADMANABHAN BALARAM

220	Japan	6092856	HIGHLY SENSITIVE MAGNETIC TUNABLE HETEROJUNCTION DEVICE FOR RESISTIVE SWITCHING	OGALE SATISHCHANDRA BALKRISHNA, SARMA DIPANKAR DAS, RANA ABHIMANYU SINGH, THAKARE VISHAL PRABHAKAR, ANIL KUMAR PURI
221	Japan	6027119	SYNTHESIS OF 10-?/?-D-ARABINOFURANOSYL-UNDECENES AS POTENTIAL ANTI-MYCOBACTERIAL AGENTS	RAMANA VENKATA CHEPURI, DHIMAN SARKAR, RAHUL SHIVAJI PATIL, SAMPA SARKAR
222	Japan	6050363	ALPHA-ARYLATION OF BETA-DICARBONYL COMPOUNDS	SANTOSH BABURAO MHASKE, RANJEET ASHOKRAO DHOKALE, PRAMOD RAMESHRAO THAKARE
223	Japan	6049719	Pimarane diterpenes from Anisochilus verticillatus	SWATI PRAMOD JOSHI, ROSHAN RAJAN KULKARNI
224	South Korea	10-1688882	SELF STANDING NANOPARTICLE NETWORKS/SCAFFOLDS WITH CONTROLLABLE VOID DIMENSIONS	GURUSWAMY KUMARASWAMY, KAMENDRA PRAKASH SHARMA
225	South Korea	10-1693913	CONTINUOUS FLOW PROCESS FOR THE PREPARATION OF SULPHOXIDE COMPOUNDS	AMOL ARVIND KULKARNI, RAMESH ANNA JOSHI, ROHINI RAMESH JOSHI, NAYANA TUSHAR NIVANGUNE, MANISHA ABHIMAN JAGTAP
226	Mexico	345089	METHOD FOR THE PREPARATION OF BIOFUELS FROM GLYCEROL	DHARBHA SRINIVAS, LAKSHMI SAIKIA, PAUL RATNASAMY
227	Malaysia	MY-160338-A	PROCESS FOR PRODUCING FATTY ACIDS	SRINIVAS DARBHA, JITENDRA KUMAR SATYARTHI, RAJA THIRUMALAISWAMY, SHILPA SHIRISH DESHPANDE
228	Russia	2605094	AN IMPROVED PROCESS FOR PRODUCTION OF EPOXY FUNCTIONALIZED FATTY ACIDS, THEIR ESTERS AND MIXTURES THEREOF	DARBHA SRINIVAS, JITENDRA KUMAR SATYARTHI
229	Russia	2590163	ANTITUBERCULAR AGENTS	DHIMAN SARKAR, SAMPA SARKAR, ROHIT RAMESH JOSHI, VIJAY MURLIDHAR KHEDKAR, RAGHUVIR RAMAKANT PISSURLENKAR, EVANS CLIFFTON COUTINHO, ANAMIK KANTILAL SHAH
230	Russia	2596831	PROCESS FOR PREPARING HYPERBRANCHED POLYESTERS	DARBHA SRINIVAS, JOBY SEBASTIAN
231	United States Of America	9334361	PROCESS FOR PREPARING HYPERBRANCHED POLYESTERS	DARBHA SRINIVAS, JOBY SEBASTIAN
232	United States Of America	9,305,777	A NOVEL NANO-HETEROJUNCTION SYNTHESIS OF CATALYST FREE VERTICALLY ALIGNED CNTS ON SINW ARRAYS	MANJUSHA VILAS SHELKE
233	United States Of America	9490488	AN IMPROVED PROCESS FOR THE PREPARATION OF MEMBRANE ELECTRODE ASSEMBLIES (MEAs)	VIJAYAMOHANAN KUNJU KRISHNA, ULHAS KANHAIYALAL KHARUL, SREEKUMAR KURUNGOT, HARSHAL DILIP CHAUDHARI, SREEKUTTAN MARAVEEDU UNNI, BIPINLAL UNNI, HUSAIN NOMAN KAGALWALA
234	United States Of America	9419232	NOVEL ORGANIC MATERIALS AND THEIR APPLICATION IN	KOTHANDAM KRISHNAMOORTHY, ARULRAJ ARULKASHMIR, BHAN PRAKASH

			CHARGE TRANSPORT	JAIN
235	United States Of America	9594129	HIGHLY SENSITIVE MAGNETIC TUNABLE HETEROJUNCTION DEVICE FOR RESISTIVE SWITCHING	OGALE SATISHCHANDRA BALKRISHNA, SARMA DIPANKAR DAS, RANA ABHIMANYU SINGH, THAKARE VISHAL PRABHAKAR, ANIL KUMAR PURI
236	United States Of America	9409836	CATALYST FOR HYDROGENATION OF OLEFINIC AND ACETYLENIC BONDS AND PROCESS THEREOF	SHUBHANGI BHALCHANDRA UMBARKAR, MOHAN KERABA DONGARE, VAIBHAV RAVINDRAKUMAR ACHAM
237	United States Of America	9447105	A METHOD TO SYNTHESIZE TRIAZINES	Pradeep Kumar, Anand Harbindu, Brijesh Sharma
238	United States Of America	9527826	SINGLE STEP PROCESS FOR CONVERSION OF FURFURAL TO TETRAHYDROFURAN	Chandrasekhar Vasant Rode, Narayan Shamrao Biradar, Amol Mahalingappa Hengne
239	United States Of America	9468691	CURCUMIN COATED SUPERPARAMAGNETIC IRON OXIDE NANOPARTICLES FOR BIOMEDICAL APPLICATIONS	PATTAYIL ALIAS JOY, JAYAPRABHA KUNNOTH NADUVILIDAM
240	United States Of America	9522922	Stereospecific and proficient synthesis of seven membered sulfide: its application for Tamiflu synthesis	Subhash Prataprao Chavan, Prakash Narsing Chavan
241	United States Of America	9550719	NOVEL PROCESS FOR THE PREPARATION OF 3-ARYL-2-HYDROXY PROPANOIC ACID DERIVATIVES	Muthukrishnan Murugan, Mujahid Mohammad
242	United States Of America	9562030	Improved process for synthesis of olopatadine	Subhash Prataprao Chavan, Pradeep Bhaskarrao Lasonkar
243	United States Of America	9388298	NUCLEATING AGENTS	MOHAN RAJ MANI, RAMESH CHELLASWAMY, VIJAYAMOHANAN KUNJIKRISHNAN PILLAI
244	United States Of America	9527827	Novel compounds from Leucas	SWATI PRAMOD JOSHI, ROSHAN RAJAN KULKARNI, KETKI DILIP SHURPALI, SAMPA SARKAR, DHIMAN SARKAR
245	United States Of America	9446375	CONTINUOUS MODULAR REACTOR	VIVEK VINAYAK RANADE, AMOL ARVIND KULKARNI
246	United States Of America	9353077	ORGANOCATALYTIC PROCESS FOR ASYMMETRIC SYNTHESIS OF DECANOLIDES	VARUN RAWAT, SOUMEN DEY, ANIL MARUTI SHELKE, GURUNATH MALLAPA SURYAVANSHI, ARUMUGAM SUDALAI
247	United States Of America	9558403	CHEMICAL STRUCTURE RECOGNITION TOOL	MUTHUKUMARASAMY KARTHIKEYAN
248	United States Of America	9449730	ENERGY LEVEL MODULATED CONJUGATED POLYMERS FOR OXIDATION RESISTANCE	K.KRISHNAMOORTHY
249	United States Of America	9352394	CAPPED GOLD NANOCLUSTERS	Arti Harle
250	United States Of America	9422230	New process for the preparation of an anticonvulsant agent Pregabalin	Muthukrishnan Murugan, Mujahid Mohammad
251	United States Of America	9409791	PHOTOCATALYTIC DEGRADATION OF PHARMACEUTICAL DRUGS &	Sanjay Pandurang Kamble

			DYES USING VISIBLE ACTIVE BiOX PHOTOCATALYST	
252	United States Of America	9409855	ASYMMETRIC TOTAL SYNTHESIS OF (-)-VENLAFAXINE USING ORGANOCATALYST	SUBHASH PRATAPRAO CHAVAN, SUMANTA GARAI, KAILASH PRALHAD PAWAR
253	United States Of America	9527800	Novel total synthesis of (-)-venlafaxine	Subhash Prataprao Chavan, Kailash Pralhad Pawar
254	United States Of America	9518051	PYRROLOQUINOLINE ALKALOIDS AND PROCESS FOR THE PREPARATION THEREOF	SANTOSH B.MHASKE, JYOTI R. LANDE
255	United States Of America	9415442	Stable oxide encapsulated metal clusters and nanoparticles	NANDINI R DEVI, ANUPAM SAMANTA
256	United States Of America	9585903	Pharmaceutical composition comprising sophorolipid in combination with an antibiotic	Asmita Ashutosh Prabhune, Kasturi Joshi-Navare
257	United States Of America	9346847	LIBRARY OF SPIROANNULATED NUCLEOSIDES	CHEPURI VENKATA RAMANA, MANGESH PANDURANG DUSHING
258	United States Of America	9422952	VORTEX DIODES AS REACTORS AND EFFLUENT TREATMENT DEVICES	VIVEK VINAYAK RANADE, AMOL ARVIND KULKARNI, VINAY MANOHARRAO BHANDARI
259	United States Of America	9415352	A PROCESS FOR DEACIDIFICATION USING MEMBRANES	ULHAS KANHAIYALAL KHARUL, RAMCHANDRA VITTHAL GADRE, VITHAL VENKATRAO JOGDAND, YOGESH JAYASING CHENDAKE
260	United States Of America	9,302,255	A GREEN PROCESS FOR THE PRODUCTION OF 2, 5-FURANDICARBOXYLIC ACID USING NOVEL CATALYST	Narasimharao Kanna, Satyanarayana Vera Venkata Chilukuri, Ganesh Dattatreya Kokate, Lakshmiprasad Gurrala
261	United States Of America	9409854	Sol-gel synthesized WO3/SiO2 catalysts for nitration of aromatics	Shubhangi Bhalchandra Umbarkar, Mohan Keraba Dongare, Ankush Venkatrao Biradar, Atul Balasaheb Kulal, Trupti Vyankatesh Kotbagi, Ashvini Ramesh Bhosale, Macchindra Gulabrao Chandgude
262	United States Of America	9550710	Acidic Ionic Liquids catalyzed depolymerization of lignin	Dhepe Paresh Laxmikant, Ashutosh Anant Kelkar, Babasaheb Mansub Matsagar, Sandip Kumar Singh
263	United States Of America	9569906	PCDA-PHBV electrospun adherent mats as authentication feature	Premnath Venugopalan, Jyoti Prakash Jog, Sachin Dubey, Usman Khan
264	United States Of America	9505794	Novel Ruthenium (II) complexes, preparation and uses thereof.	Amitava Das, Samit Chattopadhyay, Vadde Ramu, Nandaraj Taye
265	United States Of America	9562004	2,2'-BIS(4-HYDROXYPHENYL) ALKYL AZIDES AND PROCESS FOR THE PREPARATION THEREOF	SAMADHAN SURESH NAGANE, PRAKASH SUDHIR SANE, BHAUSAHEB VILAS TAWADE, PRAKASH PURUSHOTTAM WADGAONKAR
266	United States Of America	9505700	HIGH REFRACTIVE INDEX MONOMERS	PONRATHNAM SURENDRA, GHORPADE RAVINDRA VASANT, CHAVAN NAYAKU NIVRATI, CHELANATTUKIZHAKKEMADATH RAJAN, BHOSALE SONALI MADHAVRAO, BHONGALE SUNIL SITARAM
267	United States Of America	9421270	SURFACTANT-COPOLYMER COMPLEXES AS DELIVERY DEVICES	KUMARASWAMY GURUSWAMY, VENUGOPAL EDAKKAL

268	United States Of America	9475757	AN IMPROVED SYNTHESIS OF ANTI-PARKINSON AGENT	Muthukrishnan Murugan, Mujahid Mohammad
269	United States Of America	9499555	CHEMICALLY STABLE POROUS CRYSTALLINE FRAME WORK	RAHUL BANERJEE, SHARATH KANDAMBETH, SUMAN CHANDRA
270	United States Of America	9357777	A NOVEL PLANT PROTEINASE INHIBITOR AGAINST INSECTS GUT PROTEASES	ASHOK PRABHAKAR GIRI, VIDYA SHRIKANT GUPTA, VAIJAYANTI ABHIJIT TAMHANE, RAKESH SHAMSUNDER JOSHI, MANASI MISHRA, RAJENDRA RAMCHANDRA JOSHI, UDDHAVESH BHASKAR SONAVANE, ANIRBAN GHOSH
271	United States Of America	9598346	PREPARATION OF ENANTIOMERS OF SEX PHEROMONES	Dumbala Srinivasa Reddy
272	United States Of America	9,302,970	A HETEROGENEOUS CATALYTIC PROCESS FOR PRODUCTION OF PROPIOLIC ACIDS	RAVINDRA DATTATRAY AHER, MADHURI HANUMANT GADE, REDDY SANTHOSH REKULA, PRATIBHA UTTAM KARABAL, GURUNATH MALLAPPA SURYAVANSHI, ARUMUGAM SUDALAI
273	United States Of America	9376402	ANTIMYCOBACTERIAL ACTIVITY OF PROPARGYLATED 1,2,3,-TRIAZOLETHIOLS AND THE CORRESPONDING 1,2,3,-TRIAZOLE DERIVATIVES	DHIMAN SARKAR, SUNITA RANJAN DESHPANDE, SHAILAJA PRAMOD MAYBHATE, ANJALI PRABHAKAR LIKHITE, SAMPA SARKAR, ARSHAD KHAN, PREETI MADHUKAR CHAUDHARY, SAYALEE RAMCHANDRA CHAVAN
274	United States Of America	9505733	A SINGLE STEP ENANTIOSELECTIVE PROCESS FOR THE PREPARATION OF 3-SUBSTITUTED CHIRAL PHTHALIDES	REKULA SANTOSH REDDY, CHITHANYA KIRAN INDUKURU NAGA, SUDALAI ARUMUGAM

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SNo	Country	Patent No	Title of Invention	Inventors
275	China	ZL201180066897.2	ORGANIC-INORGANIC COMPOSITE MATERIAL FOR REMOVAL OF ANIONIC POLLUTANTS FROM WATER AND PROCESS FOR THE PREPARATION THEREOF	RAYALU SADHANA SURESH, LABHASETWAR NITIN KUMAR, BANSIWAL AMIT KUMAR, THAKRE KASHINATH DILIP, JAGTAP MANOHAR SNEHA
276	European Patent Office	2091624	AN IMPROVED CIRCULAR SECONDARY CLARIFIER FOR WASTEWATER TREATMENT AND AN IMPROVED SOLIDS-LIQUID SEPERATION PROCESS THEREOF	GIRISH RAMESH POPHALI, TAPAS NANDY, SANTOSH NARAIN KAUL, SUKUMAR DEVOTTA

CSIR-NIIST

SNo	Country	Patent No	Title of Invention	Inventors
277	China	201480003400.6	A NOVEL AZA BODIPY DERIVATIVE FOR THE SELECTIVE DETECTION OF NITRITE IONS IN WATER: A PROCESS THEREOF AND ITS APPLICATION IN WASTE WATER MANAGEMENT	DANABOYINA RAMAIAH, NAGAPPANPILLAI ADARSH, MADHESH SHANMUGASUNDARAM
278	Germany	2411332	A PROCESS FOR THE PREPARATION OF NOVEL NON-TOXIC YELLOW INORGANIC	MUNDLAPUDI LAKSHMIPATHI REDDY

			COLORANT/PIGMENT FROM SAMARIUM AND MOLYBDENUM COMPOUNDS	
279	Germany	11 2008 000 860	A NOVEL ECONOMICICAL AND EFFICIENT PROCESS FOR COMMERCIAL PRODUCTION OF HIGH PURITY LIGNANS FRM SESAME OIL	CHAMI ARUMUGHAM, CHANDRASEKHARAN PILLAI BALACHANDRAN, MULLAN VELANDY RESHMA, ANDIKANNU SUNDARESAN, SHINY THOMAS, DIVYA SUKUMAR, SYAMALA KUMARI SATHYANANDAN SARITHA
280	European Patent Office	2411332	A PROCESS FOR THE PREPARATION OF NOVEL NON-TOXIC YELLOW INORGANIC COLORANT/PIGMENT FROM SAMARIUM AND MOLYBDENUM COMPOUNDS	MUNDLAPUDI LAKSHMIPATHI REDDY
281	United Kingdom	2411332	A PROCESS FOR THE PREPARATION OF NOVEL NON-TOXIC YELLOW INORGANIC COLORANT/PIGMENT FROM SAMARIUM AND MOLYBDENUM COMPOUNDS	MUNDLAPUDI LAKSHMIPATHI REDDY
282	Japan	6022480	METAL OXIDE MODIFIED AND UNMODIFIED MOLECULARLY IMPRINTED CONDUCTING POLYMER FILM BASED AQUEOUS AMINOACID SENSORS	VARGHESE SAUMYA, KRISHNA PILLAI PADMAJA KUMARI PRATHISH, TALASILA PRASADA RAO
283	Japan	6101268	DYE ENTRAPPED SOL-GEL FILM BASED TEST STRIP SENSOR FOR NITRITE AND A PROCESS THEREOF	SANTHAKUMAR DHANYA, TALASILA PRASADA RAO
284	Taiwan	I 542564	SEMICONDUCTOR OXIDE NANOTUBES-FLYASH AND SEMICONDUCTOR OXIDE NANOTUBES-METAL OXIDE COMPOSITE PARTICLES, THEIR PROCESSING VIA ION-EXCHANGE MECHANISM, AND METHODS FOR THEIR RECYCLING IN THE DYE-REMOVAL APPLICATION THEREOF	SHUKLA SATYAJIT VISHNU, PADINHATTAYIL HAREESH, NARAYANI HARSHA, JOSE MANU, KARUNAKARAN REMYA
285	United States Of America	9604859	A PROCESS FOR DECOMPOSITION OF ORGANIC SYNTHETIC DYES USING SEMICONDUCTOR-OXIDES NANOTUBES VIA DARK CATALYSIS.	SHUKLA SATYAJIT VISHNU, WARRIER KRISHNA GOPAKUMAR, BABU BABITHA KUNNATHUPARAMBIL
286	United States Of America	9493488	MOLECULAR PROBES WITH HIGH FLUORESCENCE FOR SOLID-STATE LIGHTING, SELECTIVE DISCRIMINATION OF COUNTERIONS OF ZINC, TWO PHOTON IMAGING	AYYAPPANPILLAI AJAYAGHOSH, KIZHUMURI P. DIVYA, SAMPATH SRINIVASAN

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SNo	**Country**	**Patent No**	**Title of Invention**	**Inventors**
287	Germany	2526103	NOVEL PORPHYRIN DERIVATIVES FOR PHOTODYNAMIC THERAPY (PDT): A PROCESS FOR THE PREPARATION THEREOF AND THEIR USE AS PDT AGENTS AND FLUORESCENCE PROBES FOR BIOLOGICAL APPLICATIONS	DANOBOYINA RAMAIAH, SUNEESH C KARUNAKARAN, VADAKKANCHERIL S JISHA, TAVAREKERE K CHANDRASHEKHAR, ALAGAR SRINIVASAN, MADHAVAN RADHAKRISHNA PILLAI, SIVAKUMARI ASHA NAIR, SANEESH BABU P SARAS, CHINTALAGIRI MOHAN RAO, KUNCHALA SRIDHAR RAO
288	European Patent Office	2526103	NOVEL PORPHYRIN DERIVATIVES FOR PHOTODYNAMIC THERAPY (PDT): A PROCESS FOR THE PREPARATION THEREOF AND THEIR USE AS PDT AGENTS AND FLUORESCENCE PROBES FOR BIOLOGICAL APPLICATIONS	DANOBOYINA RAMAIAH, SUNEESH C KARUNAKARAN, VADAKKANCHERIL S JISHA, TAVAREKERE K CHANDRASHEKHAR, ALAGAR SRINIVASAN, MADHAVAN RADHAKRISHNA PILLAI, SIVAKUMARI ASHA NAIR, SANEESH BABU P SARAS, CHINTALAGIRI MOHAN RAO, KUNCHALA SRIDHAR RAO
289	France	2526103	NOVEL PORPHYRIN DERIVATIVES FOR PHOTODYNAMIC THERAPY (PDT): A PROCESS FOR THE PREPARATION THEREOF AND THEIR USE AS PDT AGENTS AND FLUORESCENCE PROBES FOR BIOLOGICAL APPLICATIONS	DANOBOYINA RAMAIAH, SUNEESH C KARUNAKARAN, VADAKKANCHERIL S JISHA, TAVAREKERE K CHANDRASHEKHAR, ALAGAR SRINIVASAN, MADHAVAN RADHAKRISHNA PILLAI, SIVAKUMARI ASHA NAIR, SANEESH BABU P SARAS, CHINTALAGIRI MOHAN RAO, KUNCHALA SRIDHAR RAO
290	United Kingdom	2526103	NOVEL PORPHYRIN DERIVATIVES FOR PHOTODYNAMIC THERAPY (PDT): A PROCESS FOR THE PREPARATION THEREOF AND THEIR USE AS PDT AGENTS AND FLUORESCENCE PROBES FOR BIOLOGICAL APPLICATIONS	DANOBOYINA RAMAIAH, SUNEESH C KARUNAKARAN, VADAKKANCHERIL S JISHA, TAVAREKERE K CHANDRASHEKHAR, ALAGAR SRINIVASAN, MADHAVAN RADHAKRISHNA PILLAI, SIVAKUMARI ASHA NAIR, SANEESH BABU P SARAS, CHINTALAGIRI MOHAN RAO, KUNCHALA SRIDHAR RAO
CSIR-NMITLI				
SNo	**Country**	**Patent No**	**Title of Invention**	**Inventors**
291	Japan	5927243	DETECTION OF PATHOGENS USING DNA MACROARRAYS	CHINTALAGIRI MOHAN RAO, KUNCHALA SRIDHAR RAO, PUPPALA VENKAT RAMCHANDER, HAJIB NARAHARIRAO MADHAVAN, SAVITRI SHARMA, GITA SATPATHY, RAVI KUMAR VENKATA BANDA
292	United States Of America	9487818	TOP2A INHIBITION BY TEMOZOLOMIDE AND ITS PREDICTIVE VALUE OF GBM PATIENT'S SURVIVAL	KUMARAVEL SOMASUNDARAM, ARIVAZHAGAN A, KANDAVEL THENNARASU, ALANGAR SATHYARANJANDAS HEGDE, ASHWATHNARAYANA RAO CHANDRAMOULI, VANI SANTOSH, PATURU KONDAIAH, MANCHANAHALLI RANGASWAMY SATYANARAYANA RAO
CSIR-NPL				
SNo	**Country**	**Patent No**	**Title of Invention**	**Inventors**

293	Japan	5934352	AN IMPROVED PROCESS FOR JOINING OF TUBES OF OXIDE HIGH TEMPERATURE SUPERCONDUCTORS WITH IMPROVED SUPERCONDUCTING PROPERTIES	GURSHARAN KAUR PADAM, NARINDER KUMAR ARORA, RAMESH KUMAR SETHI, SHRIKANT NARAYAN EKBOTE
294	Japan	6114830	LIGHT WEIGHT CARBON FOAM AS ELECTROMAGNETIC INTERFERENCE (EMI) SHIELDING AND THERMAL INTERFACE MATERIAL	SANJAY RANGNATH DHAKATE, RAJEEV KUMAR, RAKESH BEHARI MATHUR, PARVEEN SAINI
295	South Korea	1700922	A LONG DURRATION OPTICAL MEMORY DEVICE BASED ON DEFORMED HELIX FERROELECTRIC LIQUID CRYSTAL MATERIAL AND A METHOD FOR THE DEVELOPMENT THEREOF	JAI PRAKASH, AJAY KUMAR, CHOUDHARY AMIT, MALIK ANU, COONDOO INDRANI, BIRADAR ASHOK MANIKRAO
296	South Korea	10-1660557	AN IMPROVED PROCESS TO DEPOSIT DIAMOND LIKE CARBON AS PROTECTIVE COATING ON INNER SURFACE OF BOTTLES	KUMAR SUSHIL, DIXIT PRAKASH NARAIN, RAUTHAN CHANDRA MOHAN SINGH
297	United States Of America	9368734	LITHIUM METAL QUINOLATES AND PROCESS FOR PREPARATION THEREOF AS GOOD EMITTING, INTERFACE MATERIALS AS WELL AS N-TYPE DOPENT FOR ORGANIC ELECTRONIC DEVICES	Kamalasanan Modeeparampil Narayanan, Srivastava Ritu, Amit Kumar, Ishwar Singh, Dhawan Sandeep Kumar, Bawa Sukhwant Singh

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SNo	Country	Patent No	Title of Invention	Inventors
298	United States Of America	9487954	LACED COMPOSITE SYSTEM	NARAYANAN ANANDAVALLI, NARAYANAN LAKSHMANAN, NAGESH RANGANATHA IYER, JAYACHANDRAN RAJASANKAR, AMAR PRAKASH

ANNEXURE-III

Area-wise Research Publications (TOP 25 Papers) By CSIR Labs.				
BIOLOGICAL SCIENCES				
BASED ON IMPACT FACTOR OF THE JOURNALS				
S.NO.	**LAB**	**First Author**	**Journals**	**IF-2016**
1	IGIB, IITR	Wang, HD	LANCET, 2016, Vol. 388, Iss. 10053, pp. 1459-1544	47.831
2	IITR	Vos, T	LANCET, 2016, Vol. 388, Iss. 10053, pp. 1545-1602	47.831
3	IITR	Kassebaum, NJ	LANCET, 2016, Vol. 388, Iss. 10053, pp. 1603-1658	47.831
4	IGIB, IITR	Forouzanfar, MH	LANCET, 2016, Vol. 388, Iss. 10053, pp. 1659-1724	47.831
5	IGIB	Lim, SS	LANCET, 2016, Vol. 388, Iss. 10053, pp. 1813-1850	47.831
6	CDRI, NBRI	Shukla, AK	NATURE BIOTECHNOLOGY, 2016, Vol. 34, Iss. 10, pp. 1046-1051	41.667
7	CCMB, IGIB	Fuchsberger, C	NATURE, 2016, Vol. 536, Iss. 7614, pp. 41-+	40.137
8	CCMB	Mallick, S	NATURE, 2016, Vol. 538, Iss. 7624, pp. 201-+	40.137
9	IGIB	Singh, A	CHEMICAL SOCIETY REVIEWS, 2016, Vol. 45, Iss. 24, pp. 6666-6684	38.618
10	CCMB	Zou, WB	GASTROENTEROLOGY, 2016, Vol. 150, Iss. 7, pp. 1558-+	18.392
11	IICB	Ghosh, G	MOLECULAR CELL, 2016, Vol. 63, Iss. 4, pp. 544-546	14.714
12	CFTRI	Li, JL	JOURNAL OF THE AMERICAN CHEMICAL SOCIETY, 2016, Vol. 138, Iss. 25, pp. 7973-7981	13.858
13	CFTRI	Li, JL	JOURNAL OF THE AMERICAN CHEMICAL SOCIETY, 2016, Vol. 138, Iss. 35, pp. 11368-11377	13.858
14	IGIB	Pattnaik, B	JOURNAL OF ALLERGY AND CLINICAL IMMUNOLOGY, 2016, Vol. 138, Iss. 1, pp. 130-+	13.081
15	IMTECH	Trivedi, A	NATURE COMMUNICATIONS, 2016, Vol. 7, Iss. , pp. 11392-	12.124
16	IICB	Bose, M	Nature Communications, 2016, Vol. 7, Iss. , pp. 12200-	12.124
17	IICB	Mahata, T	ANGEWANDTE CHEMIE-INTERNATIONAL EDITION, 2016, Vol. 55, Iss. 27, pp. 7733-7736	11.994
18	CDRI	Gupta, A	ADVANCED DRUG DELIVERY REVIEWS, 2016, Vol. 102, Iss. , pp. 10-20	11.764
19	IMTECH	Chandra, V	BIOLOGICAL REVIEWS, 2016, Vol. 91, Iss. 2, pp. 429-451	11.615

20	CDRI	Thakur, R	PHARMACOLOGY & THERAPEUTICS, 2016, Vol. 168, Iss. , pp. 61-74	11.127
21	CIMAP	Tiwari, P	BIOTECHNOLOGY ADVANCES, 2016, Vol. 34, Iss. 5, pp. 714-739	10.597
22	IMTECH	Rajput, A	NUCLEIC ACIDS RESEARCH, 2016, Vol. 44, Iss. D1, pp. D634-D639	10.162
23	IGIB	Narang, P	NUCLEIC ACIDS RESEARCH, 2016, Vol. 44, Iss. D1, pp. D952-D958	10.162
24	IMTECH	Agrawal, P	NUCLEIC ACIDS RESEARCH, 2016, Vol. 44, Iss. D1, pp. D1098-D1103	10.162
25	IMTECH	Singh, S	NUCLEIC ACIDS RESEARCH, 2016, Vol. 44, Iss. D1, pp. D1119-D1126	10.162

Area-wise Research Publications (TOP 25 Papers) By CSIR Labs.				
CHEMICAL SCIENCES				
BASED ON IMPACT FACTOR OF THE JOURNALS				
S.NO.	**LAB**	**First Author**	**Journals**	**IF-2016**
1	IICT	Mahadevi, AS	CHEMICAL REVIEWS, 2016, Vol. 116, Iss. 5, pp. 2775-2825	47.928
2	IICT	Al Kobaisi, M	CHEMICAL REVIEWS, 2016, Vol. 116, Iss. 19, pp. 11685-11796	47.928
3	NCL	Sousa, LD	ENERGY & ENVIRONMENTAL SCIENCE, 2016, Vol. 9, Iss. 4, pp. 1215-1223	29.518
4	CECRI	Lee, J	ENERGY & ENVIRONMENTAL SCIENCE, 2016, Vol. 9, Iss. 11, pp. 3392-3398	29.518
5	NCL	Bhojgude, SS	ACCOUNTS OF CHEMICAL RESEARCH, 2016, Vol. 49, Iss. 9, pp. 1658-1670	20.268
6	NCL	Arulkashmir, A	ADVANCED ENERGY MATERIALS, 2016, Vol. 6, Iss. 9, pp. 1502334-	16.721
7	NCL	Mullangi, D	ADVANCED ENERGY MATERIALS, 2016, Vol. 6, Iss. 13, pp. 1600110-	16.721
8	NCL	Nandi, S	ADVANCED ENERGY MATERIALS, 2016, Vol. 6, Iss. 24, pp. 1601189-	16.721
9	NCL	Mitra, S	JOURNAL OF THE AMERICAN CHEMICAL SOCIETY, 2016, Vol. 138, Iss. 8, pp. 2823-2828	13.858
10	CSMCRI, NCL	Maity, A	JOURNAL OF THE AMERICAN CHEMICAL SOCIETY, 2016, Vol. 138, Iss. 35, pp. 11113-11116	13.858
11	NCL	Bertermann, R	JOURNAL OF THE AMERICAN CHEMICAL SOCIETY, 2016, Vol. 138, Iss. 49, pp. 16140-16147	13.858
12	NIIST	Ghosh, S	ANNUAL REVIEW OF MATERIALS RESEARCH, VOL 46, 2016, Vol. 46, Iss. , pp. 235-262	13.432
13	IICT	Gaddam, RR	NANO ENERGY, 2016, Vol. 26, Iss. , pp. 346-352	12.343
14	NIIST	Reddy, MLP	JOURNAL OF PHOTOCHEMISTRY AND PHOTOBIOLOGY C-PHOTOCHEMISTRY REVIEWS, 2016, Vol. 29, Iss. , pp. 29-47	12.317
15	NCL	Cardenas, PD	NATURE COMMUNICATIONS, 2016, Vol. 7, Iss. , pp. 10654-	12.124
16	NCL	Palaniselvam, T	ADVANCED FUNCTIONAL MATERIALS, 2016, Vol. 26, Iss. 13, pp. 2150-2162	12.124
17	NIIST	Charalambidis, G	NATURE COMMUNICATIONS, 2016, Vol. 7, Iss. , pp. 12657-	12.124
18	NCL	Yetra, SR	ANGEWANDTE CHEMIE-INTERNATIONAL EDITION, 2016, Vol. 55, Iss. 1, pp. 268-272	11.994
19	NCL	Halder, A	ANGEWANDTE CHEMIE-INTERNATIONAL EDITION, 2016, Vol. 55, Iss. 27, pp. 7806-7810	11.994
20	CSMCRI	Sahoo, J	ANGEWANDTE CHEMIE-INTERNATIONAL EDITION, 2016, Vol. 55, Iss. 33, pp. 9624-9628	11.994

21	NCL	Kaicharla, T	ANGEWANDTE CHEMIE-INTERNATIONAL EDITION, 2016, Vol. 55, Iss. 34, pp. 10061-10064	11.994
22	NIIST	Vedhanarayanan, B	ANGEWANDTE CHEMIE-INTERNATIONAL EDITION, 2016, Vol. 55, Iss. 35, pp. 10345-10349	11.994
23	NCL	Karmakar, A	ANGEWANDTE CHEMIE-INTERNATIONAL EDITION, 2016, Vol. 55, Iss. 36, pp. 10667-10671	11.994
24	IICT, NPL	Narayanaswamy, K	ANGEWANDTE CHEMIE-INTERNATIONAL EDITION, 2016, Vol. 55, Iss. 40, pp. 12334-12337	11.994
25	CSMCRI	Bhadra, S	ANGEWANDTE CHEMIE-INTERNATIONAL EDITION, 2016, Vol. 55, Iss. 42, pp. 13043-13046	11.994

Area-wise Research Publications (TOP 25 Papers) By CSIR Labs.				
ENGINEERING SCIENCES				
BASED ON IMPACT FACTOR OF THE JOURNALS				
S.NO.	**LAB**	**First Author**	**Journals**	**IF-2016**
1	CGCRI	Ghosh, SK	NANO ENERGY, 2016, Vol. 30, Iss. , pp. 621-629	12.343
2	CMERI	Prusty, G	ANGEWANDTE CHEMIE-INTERNATIONAL EDITION, 2016, Vol. 55, Iss. 8, pp. 2705-2708	11.994
3	CGCRI	Nandi, SK	BIOTECHNOLOGY ADVANCES, 2016, Vol. 34, Iss. 8, pp. 1305-1317	10.597
4	CMERI	Dutta, A	CHEMISTRY OF MATERIALS, 2016, Vol. 28, Iss. 6, pp. 1872-1878	9.466
5	IMMT	Dutta, A	JOURNAL OF PHYSICAL CHEMISTRY LETTERS, 2016, Vol. 7, Iss. 6, pp. 1077-1082	9.353
6	CMERI	Jana, M	JOURNAL OF MATERIALS CHEMISTRY A, 2016, Vol. 4, Iss. 6, pp. 2188-2197	8.867
7	AMPRI	Chowdhury, DR	JOURNAL OF MATERIALS CHEMISTRY A, 2016, Vol. 4, Iss. 10, pp. 3655-3660	8.867
8	IMMT	Mohapatra, L	JOURNAL OF MATERIALS CHEMISTRY A, 2016, Vol. 4, Iss. 28, pp. 10744-10766	8.867
9	CIMFR, CMERI	Nandy, A	RENEWABLE & SUSTAINABLE ENERGY REVIEWS, 2016, Vol. 59, Iss. , pp. 597-619	8.050
10	CMERI	Sengupta, D	RENEWABLE & SUSTAINABLE ENERGY REVIEWS, 2016, Vol. 60, Iss. , pp. 356-376	8.050
11	CMERI	Sah, RP	RENEWABLE & SUSTAINABLE ENERGY REVIEWS, 2016, Vol. 62, Iss. , pp. 109-120	8.050
12	NEERI	Pawar, S	RENEWABLE & SUSTAINABLE ENERGY REVIEWS, 2016, Vol. 62, Iss. , pp. 640-653	8.050
13	CGCRI	Mistry, S	JOURNAL OF CONTROLLED RELEASE, 2016, Vol. 239, Iss. , pp. 169-181	7.786
14	NEERI	Wankar, S	BIOSENSORS & BIOELECTRONICS, 2016, Vol. 82, Iss. , pp. 20-25	7.780
15	CGCRI	Ghosh, S	NANOSCALE, 2016, Vol. 8, Iss. 13, pp. 6921-6947	7.367
16	IMMT	Samal, A	CHEMSUSCHEM, 2016, Vol. 9, Iss. 22, pp. 3150-3160	7.226
17	CMERI	Jana, M	JOURNAL OF POWER SOURCES, 2016, Vol. 303, Iss. , pp. 222-233	6.395
18	CGCRI	Ghosh, KB	JOURNAL OF POWER SOURCES, 2016, Vol. 328, Iss. , pp. 15-27	6.395
19	CMERI	Maruyama, T	CARBON, 2016, Vol. 96, Iss. , pp. 6-13	6.337
20	NAL	Kumar, AA	CARBON, 2016, Vol. 96, Iss. , pp. 1043-1052	6.337
21	IMMT	Mishra, PM	CHEMICAL ENGINEERING JOURNAL, 2016, Vol. 299, Iss. , pp. 227-235	6.216

22	IMMT	Sim, S	CHEMICAL ENGINEERING JOURNAL, 2016, Vol. 303, Iss. , pp. 64-72	6.216
23	CMERI	Arun, RK	LAB ON A CHIP, 2016, Vol. 16, Iss. 18, pp. 3589-3596	6.045
24	AMPRI	Thakur, MK	ACS SUSTAINABLE CHEMISTRY & ENGINEERING, 2016, Vol. 4, Iss. 1, pp. 1-17	5.951
25	IMMT, NEERI	Manwar, NR	ACS SUSTAINABLE CHEMISTRY & ENGINEERING, 2016, Vol. 4, Iss. 4, pp. 2323-2332	5.951

Area-wise Research Publications (TOP 25 Papers) By CSIR Labs.				
INFORMATION SCIENCES				
BASED ON IMPACT FACTOR OF THE JOURNALS				
S.NO.	**LAB**	**First Author**	**Journals**	**IF-2016**
1	URDIP	Devarapalli, P	BIOFUELS BIOPRODUCTS & BIOREFINING-BIOFPR, 2016, Vol. 10, Iss. 5, pp. 534-541	3.694
2	URDIP	Ali, Y	NEW JOURNAL OF CHEMISTRY, 2016, Vol. 40, Iss. 1, pp. 711-723	3.269
3	URDIP, IGIB	Kharbanda, C	NEW JOURNAL OF CHEMISTRY, 2016, Vol. 40, Iss. 8, pp. 6777-6786	3.269
4	URDIP	Tantray, MA	NEW JOURNAL OF CHEMISTRY, 2016, Vol. 40, Iss. 7, pp. 6109-6119	3.269
5	URDIP	Khan, I	BIOORGANIC CHEMISTRY, 2016, Vol. 68, Iss. , pp. 41-55	3.231
6	URDIP	Tantray, MA	RSC ADVANCES, 2016, Vol. 6, Iss. 49, pp. 43345-43355	3.108
7	URDIP	Mandhare, A	EXPERT OPINION ON THERAPEUTIC PATENTS, 2016, Vol. 26, Iss. 8, pp. 891-905	3.041
8	URDIP	Mandhare, A	EXPERT OPINION ON THERAPEUTIC PATENTS, 2016, Vol. 26, Iss. 10, pp. 1157-1174	3.041
9	URDIP	Khan, I	BIOORGANIC & MEDICINAL CHEMISTRY LETTERS, 2016, Vol. 26, Iss. 16, pp. 4020-4024	2.454
10	URDIP, IGIB	Kharbanda, C	CHEMICAL BIOLOGY & DRUG DESIGN, 2016, Vol. 88, Iss. 3, pp. 354-362	2.396
11	CSIR-4PI	Shekhar, S	APPLIED MATHEMATICAL MODELLING, 2016, Vol. 40, Iss. 2, pp. 1300-1314	2.350
12	CSIR-4PI	Shekhar, S	TRANSPORT IN POROUS MEDIA, 2016, Vol. 113, Iss. 2, pp. 405-430	2.205
13	NISTADS	Basu, A	SCIENTOMETRICS, 2016, Vol. 107, Iss. 3, pp. 1171-1193	2.147
14	NISTADS	Basu, A	SCIENTOMETRICS, 2016, Vol. 108, Iss. 3, pp. 1689-1691	2.147
15	CSIR-4PI, NAL	Tiwari, M	GRANULAR MATTER, 2016, Vol. 18, Iss. 3, pp. 45-	1.762
16	CSIR-4PI	Goswami, P	PURE AND APPLIED GEOPHYSICS, 2016, Vol. 173, Iss. 4, pp. 1359-1377	1.591
17	NISTADS	Manisha, M	JOURNAL OF PUBLIC HEALTH POLICY, 2016, Vol. 37, Iss. 1, pp. 121-122	1.556
18	CSIR-4PI	Shekhar, S	SOIL DYNAMICS AND EARTHQUAKE ENGINEERING, 2016, Vol. 80, Iss. , pp. 56-64	1.545
19	CSIR-4PI, NISTADS	Rakesh, V	METEOROLOGICAL APPLICATIONS, 2016, Vol. 23, Iss. 3, pp. 529-540	1.411
20	CSIR-4PI	Ningombam, SS	JOURNAL OF ATMOSPHERIC AND SOLAR-TERRESTRIAL PHYSICS, 2016, Vol. 137, Iss. , pp. 76-85	1.326
21	CSIR-4PI, NISTADS	Gouda, KC	METEOROLOGY AND ATMOSPHERIC PHYSICS, 2016, Vol. 128, Iss. 5, pp. 565-577	1.159
22	CSIR-4PI	Ashish	JOURNAL OF SEISMOLOGY, 2016, Vol. 20, Iss. 2, pp. 629-653	1.089
23	NISCAIR	Kumar, N	CURRENT SCIENCE, 2016, Vol. 110, Iss. 7, pp. 1135-1137	0.843
24	NISCAIR	Tripathi, A	CURRENT SCIENCE, 2016, Vol. 110, Iss. 7, pp. 1307-1314	0.843
25	NISTADS	Bhattacharya, S	CURRENT SCIENCE, 2016, Vol. 110, Iss. 8, pp. 1419-1425	0.843

Area-wise Research Publications (TOP 25 Papers) By CSIR Labs.				
PHYSICAL SCIENCES				
BASED ON IMPACT FACTOR OF THE JOURNALS				
S.NO.	**LAB**	**First Author**	**Journals**	**IF-2016**
1	NPL	Ramanujam, J	PROGRESS IN MATERIALS SCIENCE, 2016, Vol. 82, Iss. , pp. 294-404	31.14
2	NPL	Vats, G	ENERGY & ENVIRONMENTAL SCIENCE, 2016, Vol. 9, Iss. 4, pp. 1335-1345	29.518
3	NPL	Vats, G	ENERGY & ENVIRONMENTAL SCIENCE, 2016, Vol. 9, Iss. 7, pp. 2383-2391	29.518
4	CSIO	Mehta, J	COORDINATION CHEMISTRY REVIEWS, 2016, Vol. 322, Iss. , pp. 30-40	13.324
5	NPL	Holmes, NP	NANO ENERGY, 2016, Vol. 19, Iss. , pp. 495-510	12.343
6	CSIO	Mehta, J	BIOTECHNOLOGY ADVANCES, 2016, Vol. 34, Iss. 1, pp. 47-60	10.597
7	NIO	Rudraswami, NG	ASTROPHYSICAL JOURNAL SUPPLEMENT SERIES, 2016, Vol. 227, Iss. 2, pp. 15-	8.955
8	CSIO	Kaur, R	JOURNAL OF MATERIALS CHEMISTRY A, 2016, Vol. 4, Iss. 11, pp. 3991-4002	8.867
9	NPL	Ranaweera, CK	JOURNAL OF MATERIALS CHEMISTRY A, 2016, Vol. 4, Iss. 23, pp. 9014-9018	8.867
10	NPL	Thirupathaiah, S	PHYSICAL REVIEW LETTERS, 2016, Vol. 117, Iss. 17, pp. 177001-	8.462
11	NGRI	Balaram, V	TRAC-TRENDS IN ANALYTICAL CHEMISTRY, 2016, Vol. 80, Iss. , pp. 83-95	8.442
12	CSIO	Kim, KH	TRAC-TRENDS IN ANALYTICAL CHEMISTRY, 2016, Vol. 85, Iss. , pp. 65-74	8.442
13	CSIO, IGIB	Bhatnagar, D	BIOSENSORS & BIOELECTRONICS, 2016, Vol. 79, Iss. , pp. 495-499	7.780
14	CSIO	Baliyan, A	BIOSENSORS & BIOELECTRONICS, 2016, Vol. 79, Iss. , pp. 693-700	7.780
15	NPL	Ghrera, AS	BIOSENSORS & BIOELECTRONICS, 2016, Vol. 80, Iss. , pp. 477-482	7.780
16	CSIO	Mehta, J	BIOSENSORS & BIOELECTRONICS, 2016, Vol. 83, Iss. , pp. 339-346	7.780
17	CSIO, IMTECH	Tuteja, SK	BIOSENSORS & BIOELECTRONICS, 2016, Vol. 86, Iss. , pp. 548-556	7.780
18	CSIO	Bhardwaj, N	BIOSENSORS & BIOELECTRONICS, 2016, Vol. 86, Iss. , pp. 799-804	7.780
19	NPL	Ali, MA	ACS APPLIED MATERIALS & INTERFACES, 2016, Vol. 8, Iss. 12, pp. 7646-7656	7.504
20	NPL	Griffith, MJ	ACS APPLIED MATERIALS & INTERFACES, 2016, Vol. 8, Iss. 12, pp. 7928-7937	7.504
21	NPL	Chaudhary, A	ACS APPLIED MATERIALS & INTERFACES, 2016, Vol. 8, Iss. 16, pp. 10600-10608	7.504

22	CSIO	Kukkar, M	ACS APPLIED MATERIALS & INTERFACES, 2016, Vol. 8, Iss. 26, pp. 16555-16563	7.504
23	NPL	Gao, ZL	ACS APPLIED MATERIALS & INTERFACES, 2016, Vol. 8, Iss. 41, pp. 27546-27552	7.504
24	NPL	Kumar, PN	ACS APPLIED MATERIALS & INTERFACES, 2016, Vol. 8, Iss. 41, pp. 27688-27700	7.504
25	CSIO	Vellingiri, K	ACS APPLIED MATERIALS & INTERFACES, 2016, Vol. 8, Iss. 44, pp. 29835-29857	7.504

Annexure-IV

Summary of important audit observations

Report no. 12 of 2016

Department of Scientific and Industrial Research

Unfruitful expenditure on procurement of BSL-3 facility

Centre for Cellular and Molecular Biology, Hyderabad procured a Bio-Safety Level-3 facility by making 100 *per cent* advance payment without ensuring proper installation of the same. There were problems in the facility that could not be rectified, which resulted in unfruitful expenditure of ₹ 1.90 crore incurred in its procurement.

(Parapragh 4.1)

Annexure-V

Members of CSIR Governing Body

(From 06th January 2017 to 05th January 2020)

1.	Director-General (Dr. Girish Sahni) Council of Scientific & Industrial Research Anusandhan Bhawan 2, Rafi Marg New Delhi - 110 001	Chairman
2.	The Secretary , (Expenditure) (Shri Ashok Lavasa) Ministry of Finance North Block New Delhi - 110 001	Member-Finance (ex-officio)
3.	Dr.(Mrs.) Madhu Dikshit, Director CSIR-Central Drug Research Institute Sector-10, Jankipuram Extension, Sitapur Road, Lucknow-226 031	Member
4.	Dr. Rakeh K. Mishra Director CSIR-Centre for Cellular and Molecular Biology, Uppal Road, Hyderabad- 500 007	Member
5.	Shri Dilip Shanghvi Managing Director Sun Pharmaceutical Industrial Ltd., SUN House, CTS No. 201-B/1 Western Express Highway, Goregaon€ Mumbai-400 063	Member
6.	Shri Dinesh K. Saraf Chairman and Managing Direcror Oil and Natural Gas Corporation Ltd. 5, Nelson Mandela Marg, Vasant Kunj New Delhi- 110 070	Member
7.	Prof. M.R. Satyanarayana Rao Professor Chromatin Biology Laboratory Molecular Biology and Genetics Unit (MBGU) Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), Jakkur Bengaluru- 560 064	Member

8.	Prof. Srikumar Banerjee Homi Bhabha Chair Professor Bhabha Atomic Research Centre,(BARC) and (Chancellor, Central Univeristy of Kashmir, Srinagar, J&K) Anusaktinagar, Mumbai- 400 094	Member
9.	Dr Arun Kumar Grover Vice Chancellor Punjab University Chandigarh-160 014	Member
10.	The Secretary (Prof. Ashutosh Sharma) Department of Science & Technology Technology Bhawan, New Mehrauli Road New Delhi -110 016	Member
11.	The Secretary (Dr. S. Christopher) Department ofDefence Research and Development (DDRD) and Chairman, Defence Research and Development Organisation (DRDO) Ministry of Defence New Delhi - 110 001	Member

ANNEXURE- VI

List of Plan Projects Under 12th Five Year Plan completed in 2016-17

Nodal Lab	Project Name
Cluster Area: Biological Sciences	
CSIR-CDRI	1. Factors Governing competent gamete production and reproductive dysfunction (PROGRAM)
CSIR-CDRI	2. Towards holistic understanding of Complex Diseases: Unraveling the Threads of Complex Diseases (THUNDER)
CSIR-CDRI	3. New Approaches Towards Understanding of Disease Dynamics and to Accelerate Drug Discovery (UNDO)
CSIR-CDRI	4. Emerging and re-emerging challenges in infectious diseases: Systems based drug design for infectious diseases (SPIenDID)
CSIR-CFTRI	5. New initiatives to boost agriculture productivity through maximizing pre- and post-harvest yields (AGROPATHY)
CSIR-NBRI	6. Bioprospection of plant resources and other natural products (BioprosPR)
CSIR-NBRI	7. Genomics of Medicinal Plants and Agronomically Important Traits (PlaGen)
CSIR-IIIM	8. Medicinal Chemistry for stem cell biology and regenerative medicine (MEDCHEM)
CSIR-IHBT	9. Plant Diversity: Studying adaptation biology and understanding/exploiting medicinally important plants for useful bioactives (SIMPLE)
CSIR-IHBT	10. Introduction, domestication, improvement and cultivation of economically important plants (AGTEC)
CSIR-IITR	11. Integrated NextGen approaches in health disease and environmental toxicity (INDEPTH)
CSIR-IITR	12. Nanomaterials: Applications and Impact on Safety, Health and Environment (NanoSHE)
CSIR-IICB	13. Understanding supra molecular ensembles and machines (UNSEEN)
CSIR-IICB	14. Host Interactome analysis: Understanding the Role of Host molecules in Parasitic Infection (HOPE)
CSIR-IICB	15. Neurodegenerative diseases: Causes and Corrections (miND)
CSIR-IICB	16. Therapeutics of Chronic Obstructive Pulmonary Disease (COPD) and Related Respiratory Disorders (TREAT)
CSIR-CCMB	17. Plant-Microbe and Soil Interactions (PMSI)
CSIR-CCMB	18. Epigenetics in Health and Disease (EpiHeD)
CSIR-IMTECH	19. Man as a Superorganism: Understanding the Human Microbiome (HUM)
CSIR-IMTECH	20. Centre for BIOtherapeutic Molecule DISCOVERY (BIODISCOVERY)
CSIR-IMTECH	21. Genomics and Informatics Solutions for Integrating Biology (GENESIS)
CSIR-IGIB	22. Centre for Cardiovascular and Metabolic Disease Research (CARDIOMED)
CSIR-IGIB	23. Genome Dynamics in cellular organization, differentiation and enantiostasis (GenCODE)

Nodal Lab	Project Name
CSIR-IGIB	24. CSIR-NCL-IGIB Joint Research Initiative: Interfacing Chemistry and Biology CSIR (NCL-IGIB-)
CSIR-HQ	25. S&T interventions to combat malnutrition in women and children (HCP07)
CSIR-CDRI	26. Anabolic Skeletal Targets in Health and Illness (ASTHI)
CSIR-CFTRI	27. Wellness through Foods and Nutraceuticals (WELFO)
CSIR-CIMAP	28. Chemical Biology of Ocimum and other Aromatic Plants (ChemBio)
CSIR-NBRI	29. Root Biology and its correlation to sustainable plant development and soil fertility (RootSF)
CSIR-IIIM	30. Nurturing a new Pan-CSIR drug pipe line: high intensity preclinical, clinical studies on lead candidates (DPL)
CSIR-IICB	31. Bio-energetic Disorders: A multi-model approach to monitoring and management (BenD)
CSIR-CCMB	32. Conservation of endangered animals of India: Molecular Genetics and Reproduction Approaches (ConservE)
CSIR-CCMB	33. Biology of Ageing and Human Health (BioAGE)
CSIR-IHBT	34. Estblishment of Centre for High Altitude Biology (CeHAB)
CSIR-IMTECH	35. Multidirectional approaches for molecular and systems level understanding of regulatory networks in pathogenic microbes (INFECT)
CSIR-IMTECH	36. Drug Discovery: Bugs to Drugs Programme (BUGS TO)
CSIR-IGIB	37. Wellness Genomics Project - Understanding genomic signatures of healthy living in Indian population (WG 100)
CSIR-IHBT	38. Process and Products from Himalayan Region and their toxicological evaluation (PROMOTE)
CSIR-CCMB	39. Plant Breeding, Genomics and Biotechnology (PLOMICS)
CSIR-IGIB	40. Towards Understanding skin Cell Homeostasis (TOUCH)
CSIR-IGIB	41. Efffective Application of Community Health Efforts through New Age, IT Based Modes (EACH-IT)
CSIR-CFTRI	42. Lipidomics Center (LIPIC)
CSIR-IMTECH	43. Expansion and Modernization of the Microbial Type Culture Collection and Gene Bank (MTCC)
CSIR-IGIB	44. Visualisation of Organisms in Action (VISION)
CSIR-CFTRI	45. Creation of Advanced Research Facility in Molecular Nutrition (Nutri-ARM)
CSIR-IICB	46. CSIR-Mayo Clinic Collaboration for Innovation and Translational Research (CKF)
Cluster Area: Chemical Sciences	
CSIR-CECRI	47. Multifunctional electrodes and Electrolytes for Future Technologies (MUTLIFUN)
CSIR-CIMFR	48. Clean Coal Technology (TapCoal)
CSIR-CLRI	49. Zero Emission Research Initiative for Solid Wastes from Leather (ZERIS)

Nodal Lab	Project Name
CSIR-CSMCRI	50. Membrane & Adsorbent Technology Platform for Effective Separation of Gases and Liquids (MATES)
CSIR-CSMCRI	51. Potassic (K) fertilizer Technology to Empower the Nation (K-TEN)
CSIR-IICT	52. Biocatalysts for Industrial Applications & Greener Organic Synthesis (BIAGOS)
CSIR-IICT	53. Inherently Safer Practices for Industrial Risk Reduction (INSPIRE)
CSIR-IICT	54. Organic reactions in generating innovative and natural scaffolds (ORIGIN)
CSIR-IICT	55. Non-Infringing chemistry and engineering for pharmaceuticals (NICE-P)
CSIR-IICT	56. Metabolic profiling of human body fluids by MS and NMR (CMET)
CSIR-IICT	57. Screening molecules in lead exploration (SMiLE)
CSIR-IICT	58. Development of Sustainable Processes for Edible Oils with Health Benefits from Traditional and New Resources (PEOPLE HOPE)
CSIR-IICT	59. Development of Sustainable Waste Managmnent Technologies for Chemical and Allied Industries (SETCA)
CSIR-IICT	60. Intelligent Coatings (IntelCoat)
CSIR-IIP	61. Energy Efficient Technologies (E2++)
CSIR-IIP	62. Biomass to Energy (BioEn)
CSIR-IIP	63. Catalysts for Sustainable Energy (ECat)
CSIR-IIP	64. New generation lubricants and additives (GenLube)
CSIR-IIP	65. Research Initiative for Low Emissions (RILE)
CSIR-IIP	66. Waste to Wealth - Waste plastics (W2W)
CSIR-IIP	67. Advanced Carbon Materials (AdCarbMate)
CSIR-IIP	68. Centre of Excellence for HRD in Hydrocarbon (AllTrain)
CSIR-NCL	69. Hydrogen Energy: Overcoming materials challenges in PEMFC towards generation, separation, storage and conversion of hydrogen (HYDEN)
CSIR-NCL	70. Innovate, develop and up-scale modular, agile, intensified and continuous processes and plants (Indus MAGIC)
CSIR-NCL	71. Catalysts for Speciality Chemicals (CSC)
CSIR-NCL	72. Encapsulated Microorganisms for Environmental Protection (EMEP)
CSIR-NCL	73. Creating intellectual property and capablitties for the development of improved security features and substrates for the Indian currency note (FUTURE)
CSIR-NCL	74. A Multi-Scale Simulation and Modeling Approach to Designing Smart Functional Materials for use in Energy, Electrochemistry and Bio-mimetics (MSM)
CSIR-NEIST	75. Natural Products as Affordable Healthcare Agents (NaPAHA)
CSIR-NEIST	76. Environmental Research Initiative for Paper and Process Industry (ERIPP)
CSIR-NIIST	77. Sustainable Technologies for the Utilization of Rare Earths (SURE)

Nodal Lab	Project Name
CSIR-NIIST	78. Development of functional foods and their formulations for potential health benefits of common man (FUNHEALTH)
CSIR-NIIST	79. Molecules to Materials to Devices (M2D)
CSIR-NIIST	80. Speciality Materials based on Engineered Clays (SPECS)
CSIR-CLRI	81. Science and Technology Revolution in Leather with a Green Touch (STRAIT)
CSIR-CLRI	82. Research Initiative for Waterless Tanning (RIWT)
CSIR-CSMCRI	83. High Purity Salt & Recovery of Valuable Metal Ions from Marine Resources (HPSMC)
CSIR-IICT	84. Development of Innovative Technologies for Strategic Flurochemicals (DITSF)
CSIR-IICT	85. Development of Novel Vaccine Adjuvants (DENOVA)
CSIR-NEIST	86. Advanced Polyolefins (SPIRIT)
CSIR-NEIST	87. North East Exploration for Pharmaceutical (NEEP)
CSIR-IICT	88. Affordable Cancer Therapeutics (ACT)
CSIR-IICT	89. Advance Drug Delivery System (ADD)
CSIR-CLRI	90. Design Innovation for Smart Material Transformation Yeaning Leather Life Style Products (D'STYLE)
CSIR-IICT	91. Augmentation of Analytical Research Facilities (AARF)
CSIR-NCL	92. Centre for Surface and Interface Science Research (CSISR)
CSIR-NCL	93. Nuclear Magnetic Resonance Centre for Advanced Research (NMRCAR)
CSIR-NCL	94. National Repository of Molecules (NORMS)
CSIR-NCL	95. Up gradation of Facilities/National Repository of Molecules and National Collection of Industrial Micro Organisms Resource Centre (NCIMRC)
CSIR-NEIST	96. CSIR Advanced Analytical Facility for North East (CAAF-NE)
Cluster Area: Engineering Sciences	
CSIR-AMPRI	97. Novel Energy Effective Metallic Materials for Automotive and General Engineering Application (LWM)
CSIR-CBRI	98. Engineering of Disaster Mitigation and Health Monitoring for Safe and Smart Built Environment (EDMISSIBLE)
CSIR-CGCRI	99. Development of Novel CSIR Technologies for Manufacturing Tailored and Patient-Specific Bioceramic Implants and Biomedical Devices at Affordable Cost (BIOCERAM)
CSIR-CGCRI	100. Advanced ceramics materials and components for energy and structural application (CERMESA)
CSIR-CIMFR	101. Development of a technology for optimal extraction of locked-up coal from underground mines using artificial pillars (DeCoalArt)
CSIR-CRRI	102. Development and Application of Technologies for Sustainable Transportation (SUSTRANS)
CSIR-NAL	103. Technology Solutions for Micro Air Vehicle Development (MAT)
CSIR-NEERI	104. Centre of Excellence: Waste Utilization and Management (WUM)

Nodal Lab	Project Name
CSIR-NML	105. Development of Zero Waste Technology for Processing and Utilization of Thermal Coal (ZWT-CUP)
CSIR-SERC	106. Innovative Technologies for Health Assessment and Damage Mitigation of Structures (I-HEAL)
CSIR-CMERI	107. Robotics and Micro Machines (ROuM)
CSIR-CMERI	108. Autonomous Underwater Robotics (UnWaR)
CSIR-AMPRI	109. Design and Development of Thermo Responsive & Magnetic Shape Memory Materials and Devices for Engineering Applications (TR&MSMM)
CSIR-CGCRI	110. Leadership in Specialty Glass and Optical Fiber Technologies (GLASSFIB)
CSIR-CMERI	111. Intelligent devices and smart actuators (InDeSa)
CSIR-CRRI	112. Evaluation of Economic Loss Due to Idling of Vehicles at Signalized and Mitigation Measures (ELSIM)
CSIR-IMMT	113. Minerals to Metals for Sustainable Planet (MINMET)
CSIR-IMMT	114. Processing of natural gemstones for aesthetic improvement and value addition (PNG)
CSIR-SERC	115. Engineering Sustainable Materials and Structures Action Plan I: Sustainability Through Eco-Balancing (SUSMAS)
CSIR-SERC	116. Engineering Sustainable Materials and Structures Action Plan II: Sustainability Through Nano-Technology and Bio-Mimetics (eNano-Tics)
CSIR-NAL	117. Avionics and Flight Controls Civil Aerospace Technologies (AFCCAT)
CSIR-NAL	118. Advanced Structural Technologies for Aircraft (ASTA)
CSIR-NAL	119. Aerodynamics and Propulsion Technologies for Next Generation Civil Aircraft (ADPR)
CSIR-CBRI	120. Innovative Materials and Technologies for Next Generation Green buildings (INMATE-NGGB)
CSIR-CIMFR	121. Development of underground coal gasification technology in India (CoalGasUrja)
CSIR-CIMFR	122. Development of suitable design methodology for extraction of coal at greater depths (>300 m) for Indian geomining conditions (DeepCoal)
CSIR-CRRI	123. Development of Indian Highway Capacity Manual (Indo-HCM)
CSIR-NEERI	124. National Clean Air Mission (NCAM)
CSIR-NEERI	125. Clean Water: Sustainable Options (Clean Water)
CSIR-IMMT	126. Centre for Special Materials (CSM)
CSIR-NAL	127. Transport Aircraft Design Bureau (TADB)
CSIR-NAL	128. Augmentation and Refurbishment of National Trisonic Aerodynamic Facilities (NTAF)
CSIR-NML	129. Development of Magnesium Metal Production Technology (MPT)
Cluster Area: Information Sciences	
CSIR-TKDL	130. Analysis and Monitoring of patent applications in International Patent Office for preventing misappropriation of Indias Traditional Knowledge (HCP006)

Nodal Lab	Project Name
CSIR-NISCAIR	131. CSIR Knowledge Gateway and Open Source Private Cloud Infrastructure (KNOWGATE)
CSIR-NISTADS	132. Indian S&T and Innovation Policy (ISTIP)
CSIR-URDIP	133. Patinformatics (Patinformatics)
CSIR-URDIP	134. Chembioinformatics for Drug Discovery (ISC0203)
CSIR-URDIP	135. Open Science and Open Innovation Infrastructure (OSOII)
CSIR-TKDL	136. Traditional Knowledge Digital Library 2020 (Enhanced TKDL-)
CSIR-CMMACS	137. Advanced Research in Engineering & Earth Sciences: Data intensive modelling and crowd sourcing approach (ARiEES)
CSIR-NISCAIR	138. CSIR--Wide Consortium Access to Online Information Resources (NKRC)
CSIR-NISCAIR	139. Vulnerability assessment and development of adaption strategies for climate change impact with special reference to coasts and island ecosystems of India (VACCINE)
Cluster Area: Physical Sciences	
CSIR-CEERI	140. Very High Power Microwave Tubes : Design and Development Capabilities (MTDDC)
CSIR-CEERI	141. Research Initiative on Nano Devices and Nano-Sensors (R-Nano)
CSIR-CSIO	142. Advanced Instrumentation Solutions for Health Care and Agro-based Applications (ASHA)
CSIR-NGRI	143. Geodynamic and Earthquake generating processes in NE India and Andaman Subduction Zone (GENIAS)
CSIR-NIO	144. Ocean Science Towards Forecasting Indian Marine Living Resource Potential (Ocean Finder)
CSIR-NIO	145. Geological processes in the Indian Ocean - Understanding the input fluxes, sinks and Paleoceanography (GEOSINKS)
CSIR-NIO	146. Geo-scientific investigations for deciphering the Earth's internal processes and exploration of energy resources (GEOSCAPE)
CSIR-NIO	147. Indian Aquatic Ecosystems: Impact of Deoxygenation, Eutrophication and Acidification (INDIAS IDEA)
CSIR-NPL	148. Development of Advanced Materials for Next-Generation Energy-Efficient Devices (D-NEED)
CSIR-NPL	149. Advanced Quantum Research and Innovation with Ultra Small Systems (AQuaRIUS)
CSIR-NPL	150. Measurement for Innovation in Science & Technology (MIST)
CSIR-NPL	151. Probing the Changing Atmosphere and its Impacts in Indo-Gangetic Plains (IGP) and Himalayan Regions (AIM-IGPHim)
CSIR-CEERI	152. Advanced Microsensors and Microsystems : Design, Development and Applications (MicroSensys)
CSIR-CSIO	153. Opto-Mechatronics Technologies for Next Generation Sensors and Applications (OMEGA)
CSIR-NGRI	154. Hazard due to Earthquakes and Tsunami in the Indian region (HEART)

Nodal Lab	Project Name
CSIR-NGRI	155. India Deep Earth Exploration Programme (INDEX)
CSIR-NGRI	156. Shallow subsurface imaging of India for resource exploration (SHORE)
CSIR-NIO	157. Analyses and Harnessing of Marine Biodiversity for Bioremediation of Aquaculture and Industrial Effluents (MARINEBIOTE)
CSIR-NPL	158. Research and Development on Single Trapped Ion based Frequency Standard (STIOS)
CSIR-CEERI	159. Advanced Facility for Nano Electronics (AFNE)

CSIR Establishments

BIOLOGICAL SCIENCES

CSIR-CCMB	Centre for Cellular and Molecular Biology, Hyderabad
CSIR-CDRI	Central Drug Research Institute, Lucknow
CSIR-CFTRI	Central Food Technological Research Institute, Mysore
CSIR-CIMAP	Central Institute of Medicinal & Aromatic Plants, Lucknow
CSIR-IGIB	Institute of Genomics & Integrative Biology, Delhi
CSIR-IHBT	Institute of Himalayan Bioresource Technology, Palampur
CSIR-IICB	Indian Institute of Chemical Biology, Kolkata
CSIR-IIIM	Indian Institute of Integrative Medicine, Jammu
CSIR-IMTECH	Institute of Microbial Technology, Chandigarh
CSIR-IITR	Indian Institute of Toxicology Research, Lucknow
CSIR-NBRI	National Botanical Research Institute, Lucknow

CHEMICAL SCIENCES

CSIR-CLRI	Central Leather Research Institute, Chennai
CSIR-CECRI	Central Electrochemical Research Institute, Karaikudi
CSIR-CSMCRI	Central Salt & Marine Chemicals Research Institute, Bhavnagar
CSIR-CIMFR	Central Institute of Mining & Fuel Research, Dhanbad
CSIR-IICT	Indian Institute of Chemical Technology, Hyderabad
CSIR-IIP	Indian Institute of Petroleum, Dehradun
CSIR-NCL	National Chemical Laboratory, Pune
CSIR-NEIST	North-East Institute of Science and Technology, Jorhat
CSIR-NIIST	National Institute for Interdisciplinary Science and Technology, Thiruvananthapuram

ENGINEERING SCIENCES

CSIR-AMPRI	Advanced Materials and Processes Research Institute, Bhopal
CSIR-CBRI	Central Building Research Institute, Roorkee
CSIR-CGCRI	Central Glass and Ceramic Research Institute, Kolkata
CSIR-CMERI	Central Mechanical Engineering Research Institute, Durgapur
CSIR-CRRI	Central Road Research Institute, New Delhi
CSIR-IMMT	Institute of Minerals and Materials Technology, Bhubaneshwar
CSIR-NAL	National Aerospace Laboratories, Bengaluru
CSIR-NEERI	National Environmental Engineering Research Institute, Nagpur
CSIR-NML	National Metallurgical Laboratory, Jamshedpur
CSIR-SERC	Structural Engineering Research Centre, Chennai

INFORMATION SCIENCES

CSIR-NISCAIR	National Institute of Science Communication and Information Resources , New Delhi
CSIR-NISTADS	National Institute of Science Technology and Development Studies, New Delhi
CSIR-4PI	Fourth Paradigm Institute, Bengaluru

PHYSICAL SCIENCES

CSIR-CEERI	Central Electronics Engineering Research Institute, Pilani
CSIR-CSIO	Central Scientific Instruments Organisation, Chandigarh
CSIR-NGRI	National Geophysical Research Institute, Hyderabad
CSIR-NIO	National Institute of Oceanography, Goa
CSIR-NPL	National Physical Laboratory, New Delhi

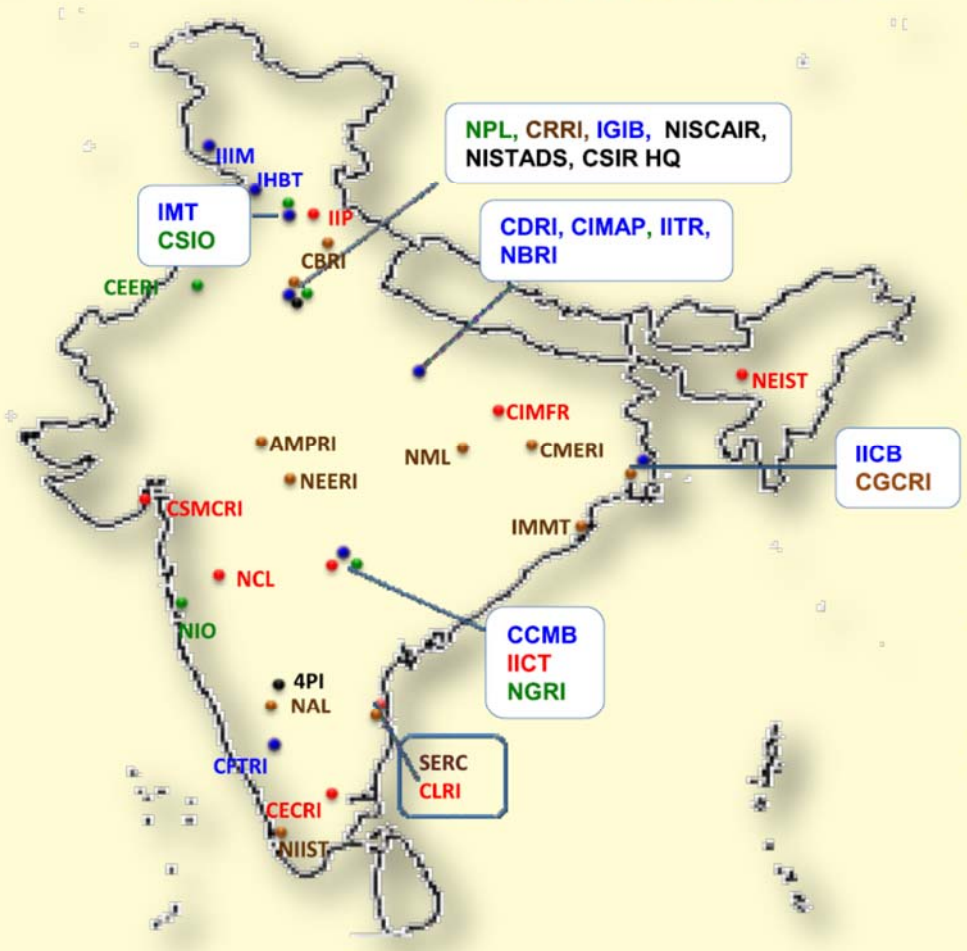
Units

CSIR-HRDC	Human Resource Development Centre, Ghaziabad
CSIR-TKDL	Traditional Knowledge Digital Library, Ghaziabad
CSIR-URDIP	Unit for Research and Development of Information Products, Pune
CSIR-OSDD	Open Source Drug Discovery, New Delhi
CSIR-TRISUTRA	Translational Research and Innovative Science through Ayurgenomics

Innovation Complexes:

Innovation Complex Chennai
Innovation Complex, Kolkata
Innovation Complex, Mumbai

CSIR Pan India



Themes :

- Aerospace, Electronics, Instrumentation & Strategic Sectors
- Civil, Infrastructure & Engineering
- Ecology, Environment, Earth & Ocean Sciences and Water
- Mining, Minerals, Metals and Materials
- Chemicals (including leather) and Petrochemicals
- Energy (Conventional & Non-Conventional) and Energy Devices
- Agri., Nutrition & Biotech
- Healthcare

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