Council of Scientific and Industrial Research

Annual Report 2018-2019

ANNUAL REPORT

2018-2019

Council of Scientific and Industrial Research
New Delhi

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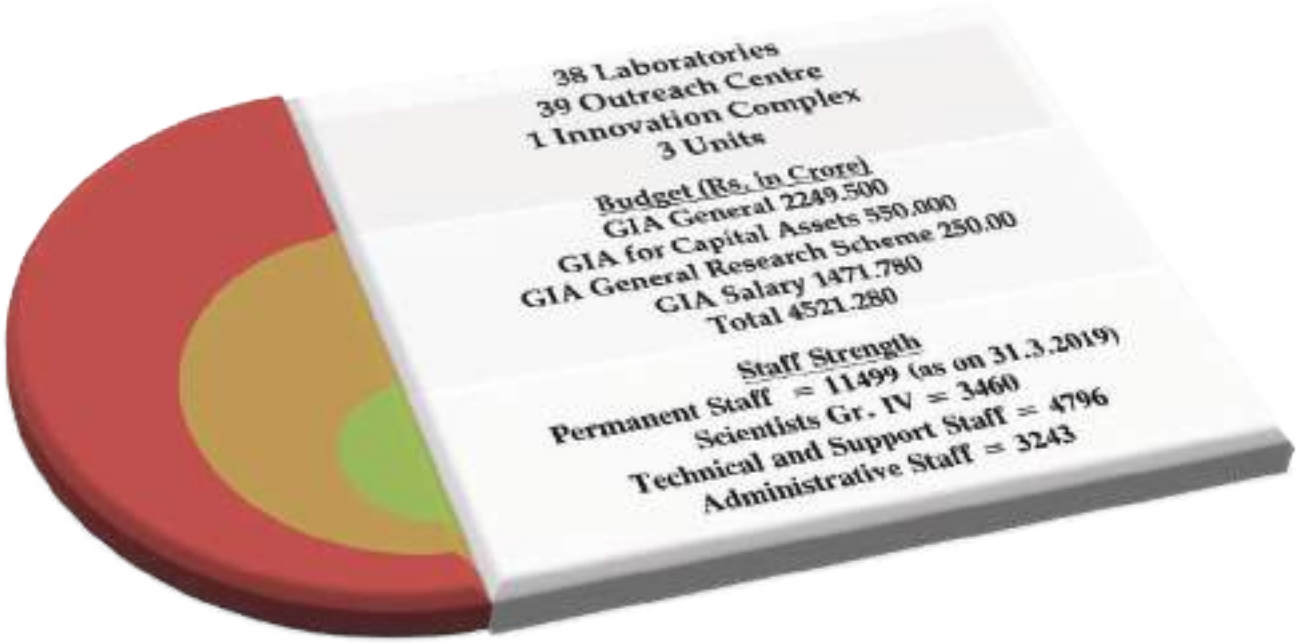
PREAMBLE

Resource Base 2018-19



Performance Indicators

PREAMBLE

1.0 PREAMBLE

- The Council of Scientific & Industrial Research (CSIR), established in the year 1942, is a premier R&D organization in the country. The organization has emerged as a multidisciplinary, multi-locational 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, one Innovation Complex and three units. CSIR's R&D expertise and experience is embodied in about 3502 active scientists supported by about 4648 scientific and technical personnel.
- CSIR's focus is on pursuing science which strives for global impact, technology that enables innovation driven industry and nurture trans-disciplinary leadership thereby catalysing inclusive economic development for the people of India. It thus provides: Science & Technology interventions to benefit society; cutting edge technologies to industry so as to enhance national competitiveness; and technological support to the strategic sector to strengthen and deepen the capability and capacity base. It catalyses S&T based entrepreneurship as well and has been building a sustainable ecosystem for S&T based Human resource development including skill development.
- CSIR has been providing significant technological interventions in many areas which include environment, health, drinking water, food, housing, energy, specialty chemicals & petrochemicals, glass & ceramics, medicinal plants & plants of economic value, leather, mining, metals & minerals, machinery & instrumentation, strategic sectors including aerospace etc. In doing so, CSIR partners with Industry in a significant manner.
- 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 5191 papers in SCI Journals during 2018 with average impact factor of 3.446.
- CSIR has a strong connect with different stakeholders like industries, line ministries etc. and strong relation with international S&T institutions. Focus is also upon creating incubation facilities for spin off and start-ups through its various constituent laboratories and CSIR hand holds these companies so as to create a new segment of knowledge enterprises.

- CSIR has been focusing on the development of S&T Human Resource and has been providing various fellowships for several decades now. It has been imparting skills in diverse S&T areas so as to empower youth for better career and employment opportunities. CSIR has forged linkage with Ministry of Skill Development and Entrepreneurship to enhance and widen its contributions for Skill Development in the country.

SIGNIFICANT EVENTS

SIGNIFICANT EVENTS

2.0 SIGNIFICANT EVENTS

CSIR Facilitates India's First Ever Biofuel-Powered Flight- Paves the way for sustainable and alternative fuels

India's first historic biofuel-powered flight was flagged off on its maiden voyage on 27 August 2018 from Dehradun airport by Uttarakhand Chief Minister Shri Trivendra Singh Rawat. The bio-aviation fuel was produced indigenously by CSIR-IIP from Jatropha oil and was based on the patented technology of the institute.

With this development, India has turned out to be one of the few nations in the world to utilise biofuel for planes. SpiceJet's latest generation Q400 aircraft featured in India's first biofuel-fueled flight from Dehradun to Delhi airport, which lasted for almost 45 minutes.

On the occasion, Dr. Harsh Vardhan, Hon'ble Minister, S&T, Earth Sciences and Environment, Forest & Climate Change and Vice President, CSIR, said that it is a historic day and that the biofuel technology is going to be a game changer as the Biojet fuel is greenhouse gas neutral, carbon neutral, reduces air pollution and would also bring down the import bill on crude oil. "Commercialisation of biofuel promises large-scale employment avenues both in the formal and informal sector," added Dr. Vardhan.

Fig. 2.I: Union Ministers Shri Jayant Sinha, Shri Suresh Prabhu, Dr. Harsh Vardhan, Shri Nitin Gadkari, Shri Dharmendra Pradhan, and Director CSIR-IIP Dr. Anjan Ray (Image Credit: DD News)

Fig. 2.2: India's first biofuel-fueled flight
(Image Credit: www.team-bhp.com)

Besides reducing the greenhouse gas emission by nearly 15% and Sulphur Oxide emissions by over 99%, the use of Bio-aviation fuel is expected to provide indigenous jet fuel supply security, conceivable cost savings as availability at the farm level scales up, superior engine performance and lesser maintenance cost for the airline operators.

International Science Literature and Film Festival- as a part of India International Science Festival 2018

Dr. Harsh Vardhan, Hon'ble Minister of Science & Technology, Earth Sciences and Environment, Forest & Climate Change expressed that science films and science literature play a very important role in science communication. He also added that he dreamt of the day when science films would be the first choice of entertainment of the people.

The International Science Literature and Film Festival was coordinated by CSIR-NISCAIR and Vigyan Prasar as a part of the 4th India International Science Festival.

The three-day event had an interesting mix of sessions that included panel discussions on science literature and science films; workshops on filmmaking, communicating science to the public, and visualising and designing science cartoons; interactions with authors and filmmakers; screening of science films, and an International Science Book Fair.

Elaborating the vision and mission of CSIR, Dr. Shekhar C. Mande, DG, CSIR explained that the organisation works on everything in terms of science and technology. Every CSIR lab has a niche and a strong base of excellent scientists who are contributing their excellence for the society, in the domain of their knowledge base.

Fig. 2.3: Dr. Harsh Vardhan, Hon'ble Minister of Science & Technology, Earth Sciences and Environment, Forest & Climate Change addressing the gathering at the concluding function of the ISLFF at Lucknow

Fig. 2.4: Dr Shekhar C. Mande said that every CSIR lab has a niche and a strong base of excellent scientists who are contributing their excellence for the society

National Science Day Celebration and Shanti Swarup Bhatnagar Prize distribution

National Science Day celebration was held on 28th February 2019, at Vigyan Bhawan, New Delhi. The occasion was graced by the Hon'ble

Fig. 2.5: Hon'ble Prime Minister and President, CSIR Shri Narendra Modi at Shanti Swarup Bhatnagar Awards Function

Prime Minister of India, Shri Narendra Modi as the Chief Guest.

Hon'ble Prime Minister and President, CSIR Shri Narendra Modi conferred Shanti Swarup Bhatnagar Prizes for the years 2016, 2017 and 2018 for Science and Technology. While congratulating the awardees, he said that science, technology and innovation should be connected with the aspirations and requirements of the society.

In order to make India a global hub for manufacturing, knowledge and technology-based industries, Shri Narendra Modi asked the scientific community to take advantage of the Fourth Industrial Revolution and develop technologies.

Hon'ble Minister of Science & Technology Minister, Dr. Harsh Vardhan said that the efforts of the scientific community have taken CSIR to the ninth position in international ranking out of 1207 institutions of the world. Further, he mentioned about the various Government initiatives to foster innovation and strengthen the Science and Technology space in India.

Fig. 2.6: Hon'ble PM Shri Narendra Modi called on scientists and researchers to adopt an interdisciplinary approach

Fig. 2.7: Dr. Harsh Vardhan, Union Science & Technology Minister

Fig. 2.8: The Shanti Swarup Bhatnagar prize winners with the Hon'ble PM, Minister and DG

International Conference and Exhibition on Energy and Environment: Challenges and Opportunities (ENCO-2019)

CSIR-CIMFR organised an International Conference and Exhibition on Energy and Environment: Challenges and Opportunities (ENCO-2019), during 20-22 February 2019 at Vigyan Bhawan, New Delhi. The conference was inaugurated by the Hon'ble President of India, Shri Ram Nath Kovind.

Fig. 2.9: Hon'ble President delivering his address

The three-day conference was aimed at identifying research and development requirements to develop new methods, technologies and applications for clean, safe, cooperative sustenance of society, environment, energy and industries in the post-2020 era.

Speaking on the occasion, the Hon'ble President appreciated CSIR for its globally acclaimed work in the field of science & technology and specifically CSIR-CIMFR for its contributions in coal-based, energy-oriented research and for developing safe, productive and sustainable mining methods.

The president further drew the attention of the audience towards current concerns about energy and environment not only for developing countries but also for developed ones. "Global trends show that coal will remain the predominant energy source for most countries, including India, while renewable sources will also grow," said Hon'ble President and urged the gathering to come up with actionable ideas on environmental issues related to using of fossil fuels and viable alternatives.

He also recalled India's commitments in the Paris Agreement and said that India had many commitments at the Paris Climate Conference expressing the strong desire to control carbon emission by Nationally Determined Contribution targets. Further, he advised the audience to deliberate on the development of eco-friendly technologies for green mining to ensure environment-friendly use of natural resources.

During the Conference, Dr. Harsh Vardhan, Union Science & Technology Minister, inaugurated an industrial exhibition in the Vigyan Bhawan Lawn. During his address, he mentioned that the world today recognises India's achievements, initiatives and visionary approach in the field of clean energy. He talked about the world's largest and innovative energy-efficient lighting programme of India with 330 million LED lights which reduced the emission of carbon dioxide by 32 million tonnes per year.

Dr. Harsh Vardhan said that energy use needs to be optimal to make its supply sustainable. Though, worldwide coal is the predominant source of energy, hydroelectric, nuclear, solar and other renewable sources of energy are being considered as low carbon alternatives.

Addressing the gathering, DG-CSIR and Secretary-DSIR, Dr. Shekhar C. Mande, said, "In the Paris Agreement, a target has been set for achieving less than two degrees of temperature change. India is one of the very few countries which is on target to meet the targets defined in the Paris Climate Change Agreement." Further, he also briefed about the achievements of CSIR.

Member, NITI Aayog, Dr. V.K. Saraswat, in his keynote address said, "The theme of the conference Energy & Environment is most timely because all of us know that energy is the lifeline and this lifeline is coming under stress due to increasing demand." Energy use is an indication of the growth of the nation. Per capita energy consumption directly indicates the GDP of the nation, he added.

During the event, a Souvenir was also released and Dr. Vardhan presented the first copy of the Souvenir to the Hon'ble President. Earlier, he was also presented with a "Coal-ball".

Around a thousand delegates from India and abroad participated in the conference, including policymakers, regulators, thought leaders, managers, entrepreneurs, administrators,

Fig. 2.10: Release of Souvenir

practising engineers, environmentalists, geo-environmentalists, researchers, academicians and technocrats. The conference was marked by keynote papers, oral presentations and poster presentations.

CSIR-NPL Collaborates with Government Mint to Develop India's Own Gold Standard

India, despite being one of the largest markets for gold, most of the gold reference material is imported to check the purity of gold. Currently, goldsmiths use certified reference material from the National Institute of Standards and Technology (NIST) of the US.

The new standard bar of gold – BND 4201 is the reference material for gold of 9999 fineness and can be used to verify the purity of gold sold in shops. Bharatiya Nirdeshak Dravya (BND 4201) is India's first home grown high purity gold reference standard developed through a collaboration among the India Government Mint (IGM), Bhabha Atomic Research Centre (BARC), CSIR-NPL and National Centre for Compositional Characterisation of Materials.

The measurement of the high purity BND-4201 is traceable to SI units; therefore, the possibilities of exporting to other economies are very high.

Development of this reference material indigenously would help jewellers to move towards more conductive methods rather than conventional fire assay methods for testing purity of gold, which is time consuming and environment destructive as poisonous gases are released.

Fig. 2.II: India Government Mint (IGM) has signed an agreement with BARC and CSIR-NPL to develop the first Indian gold standard, the Bharatiya Nirdeshak Dravya (BND 4201) (Image Courtesy: pibmumbai.gov.in)

Indigenous Lithium Ion Battery Production to Decrease Foreign Imports

CSIR-CECRI and RAASI Solar Power Pvt Ltd have signed a Memorandum of Agreement for transfer of technology for India's first Lithium Ion (Li-ion) Battery project. The Agreement was signed in Bengaluru on 9 June 2018 Director, CSIR-CECRI and Chairman-cum-Managing Director of RAASI Group in the presence of Union Minister for Science & Technology Dr. Harsh Vardhan.

Fig. 2.12: The Memorandum of Agreement signed between CSIR-CECRI and RAASI Group

Currently, Indian manufacturers source Lithium Ion Battery from China, Japan and South Korea among other countries. But now, CSIR-CECRI has developed an indigenous technology of Lithium-ion cells and set up a demo facility in Chennai to manufacture prototype Lithium-Ion cells. It has secured global IPs with potential to enable cost reduction, coupled with appropriate supply chain and manufacturing technology for mass production.

"Today's development is a validation of the capabilities of CSIR and its laboratories to meet technology in critical areas to support our industry, besides other sectors," said Dr. Harsh Vardhan after the signing ceremony. "It will give tremendous boost to two flagship programmes of Hon'ble Prime Minister Shri Narendra Modi – increasing the share of Clean Energy in the energy basket by generating 175 Giga Watts by 2022, of which 100 Giga Watts will be Solar and the second, National Electric Mobility Mission, to switch completely to electric vehicles by 2030."

Establishment of a National Calibration Facility for PM_1, $PM_{2.5}$ and PM_{10} Sampling Inlets

A particulate matter (PM) wind-tunnel has been established at CSIR-NPL. This is a first and unique facility in the country to test and calibrate PM_1, $PM_{2.5}$ and PM_{10} samplers. With this facility, now all the PM samplers manufactured in the country can be calibrated and certified. Also, all the imported PM samplers can be tested for their suitability under Indian conditions. Parameters such as cut-off size, sharpness of cut-off etc. can be tested and calibrated by using this facility.

A high-volume $PM_{2.5}$ sampler, has been developed and patented by CSIR-NPL. The technology has been transferred to M/s Environmental Solutions.

Hon'ble Minister of S&T and Earth Sciences Dr. Harsh Vardhan inaugurated the indigenously developed and commercialized high-volume sampler by the M/s Environmental Solutions under the licensed technology (know-how) of CSIR-NPL patented technology.

Fig. 2.13: Indigenously developed wind-tunnel facility to test and calibrate PM_1, $PM_{2.5}$ and PM_{10} samplers

Fig. 2.14: Inauguration of indigenously developed high-volume sampler

Participation of Hansa – NG Aircraft in Aero India Exhibition

Significant efforts were made towards the development of Hansa- New Generation (NG) aircraft with the improvements such as, glass cockpit, advanced fuel efficient ROTAX engine with better performance (increased range & endurance), optimized airframe, glass ockpit, steerable nose wheel, electrically operated flaps, IFR compliance, improved ingress-egress, better interiors/ergonomics and external finish. The technology for light weight composite material has been developed for producing the Hansa parts. For the first time in history of Hansa aircraft programme, DG, CSIR had on-board flying experience in the Hansa. Hansa has been upgraded to Glass cockpit and certified by DGCA. The aircraft took part in Aero India 2019.

Fig. 2.15: Hansa-NG with DG CSIR on-board the aircraft at Aero India

Dr. Shekhar C. Mande, DG-CSIR, Felicitated with Bharat Asmita Tantra-Vidnyan Shrestha Award

Dr. Shekhar C. Mande, DG, CSIR has been awarded the 'Bharat Asmita Tantra-Vidnyan Shrestha Award'. The Award ceremony was held on 3 February 2019 jointly organised by MIT World Peace University, MIT School of Government and Bharat Asmita Foundation.

CSIR bags Exhibitor of the Year Award

CSIR was adjudged as "Exhibitor of the Year" at the 106th Indian Science Congress — Pride of India (PoI) Mega Science Expo on the focal theme "Future India: Science & Technology" organised during 3-7 January 2019 at the Lovely Professional University (LPU), Phagwara, Punjab.

The five-day Mega Science Exhibition showcased cutting-edge technologies, leading scientific products and services, path-breaking R&D initiatives, schemes and achievements of India's foremost and leading public and private sectors, central and state government departments, research labs, educational institutions, corporate, defence, etc.

Latest technological advancements made in various sectors by CSIR, DRDO, ICMR, DST, MoES, GSI, DAE, ISRO, DBT, ICAR, etc. and other institutions, academic bodies, universities and other stakeholders associated with the education sector were exhibited at the PoI Expo.

Fig. 2.16: 'Exhibition of the Year' Award to CSIR at 106th Indian Science Congress

SIGNIFICANT S&T ACHIEVEMENTS

SIGNIFICANT S&T ACHIEVEMENTS

3.0 SIGNIFICANT S&T ACHIEVEMENTS

Red mud based lead free material for X-ray and CT scanner rooms

CSIR-AMPRI has designed joint free red mud based radiation shielding tiles. The material is tested by as per AERB norms and semi pilot plant level studies were carried out to further improve density and reduce the thickness of tiles . Results revealed that 0.6 mm thickness of the tiles possess attenuation characteristics (100 kVp) equivalent to 0.9 mm lead. Shield thickness at 100 KVp in terms of half-value thickness (HVT) is 1.6 mm which is equivalent to 15 mm of concrete. The technology transferred to M/s Assurays, Noida.

Upscaling and installation of developed tiles in X-Ray, CT scanner rooms and Cath-Lab has been done at M/S Saideep Healthcare Pvt Ltd Ahmednagar, Maharashtra by M/s Assurays, Noida. Radiation levels are below permissible limit and radiation shielding provided is as per AERB norms of permissible radiation levels.

Vitamin D_2 Enriched: Shiitake mushroom

Shiitake *(Lentinula edodes)* is an edible mushroom which has high medicinal value. Vitamin D is essential for bone health and to boost immune system. A technology for enhanced production of ergocalciferols (Vitamin D_2) in Shiitake mushroom has been developed by CSIR-IHBT for captive cultivation for Vitamin D2 enriched mushroom in 2 months with yield of 0.5-0.6 kg fresh fruiting body per kg of dried substrate. Encapsulated 500 mg shiitake powder meets 50% recommended dietary allowances (RDA) of Vitamin D_2.

Technology has been transferred to M/s Innotech AgroPostikum Pvt. Ltd., Guwahati Biotech Park, IIT Guwahati, Assam and M/s Pravin Masalewale, 44, Hadapsar Industrial Estate, Hadapsar, Pune.

Fig. 3.I: Installation of titles in M/S Saideep Healthcare Pvt. Ltd. Ahmednagar, Maharashtra

Fire Retardant Water Based Clear/ Transparent Coating for Wood & Wood Based Interiors

CSIR-CBRI developed fire retardant water based clear/transparent coating that could be used on all types of wood and wood-based interiors (i.e. the materials / products used inside the building, either existing or new). The application of coating may be done by brush, roller or spray gun. The raw materials include amides, phosphoric acid (specified % available commercially), and water, Boron compounds, catalyst and preservative in specified quantities and the reaction was carried out in stages using specified quantities of ingredients at specified temperatures for specified time. The resultant product is "Fire Retardant Water Based Clear/Transparent Coating". The technology has been transferred to M/s Paramount Intercontinental Pvt. Ltd, Sonepat.

Stone dust-precipitator systems for stone carving artisans

It has been observed that a large workmanship in Sirohi and surrounding areas artisans are working on stone carving, which is the key source of income for them. Most of these are illiterate and tribal. Some of them work from home and also those who are working in factories do not use protective means. Due to their working without protection, silica dust enters into the lungs by inhalation of breath. It is marked by inflammation and scaring of the lungs resulting in nodular lesions in the upper lobes of the lungs and after few years of working a large number of them dies due to silicosis.

CSIR-CEERI has developed stone dust-precipitator system for stone carving artisans, provides dust free environment to the workers and is ready for deployment in smaller factories. This system collects the tiny dust particles with its high suction power, which is near about 10 times more than that of the inhaling power of human beings. System is based on vacuum technology and in this system there is a main chamber, which works as a junction of dust collecting branches.

To create a vacuum in this chamber, a high speed exhaust kit is placed at the top, which sucks air from the chamber continuously and throws it outwards. There are four filters fitted around the chamber, which separates the stone dust from air. These filters consist of continuous water spray, so that the stone dust gets removed from filters and collected in the dust collector in the form of sludge along with water. A standalone system for single artisan has also been developed.

Converting Paddy Biomass into Green 'Biocoal'

CSIR-NPL has devised a solution to deal with the problem of stubble burning. The scientists have called for conversion of paddy biomass into green 'biocoal' to be used in thermal power plants.

According to a study published in *Current Science,* this conversion of paddy stubble into green product biocoal through torrefaction process would also help farmers to earn money using the agriculture residue. Besides, by optimizing the processing parameters of torrefaction process, desired calorific value of torrefied product has been archived, as per the study conducted in Haryana. It also pointed out that 10 per cent use of torrefied product with coal can consume 140 million tonnes of rice straw, thus considerably reducing the consumption of fossil fuels and also cutting down environmental pollution and greenhouse gas (GHG) emission.

Similarly, residue of other crops like wheat, sugarcane, oilseed, maize and cotton which is estimated to be around 500 million tonnes in the country, can be used as biocoal in thermal plants after torrefaction.

CSIR Launches Aroma Mission in Leh

CSIR-IIIM launched the CSIR-Aroma Mission at Leh, Ladakh. The CSIR Aroma Mission seeks to bring about transformative change in the aroma sector through interventions in agriculture, processing and product development for fuelling the growth of the aroma industry and boosting rural employment.

With its widely varying agro-climatic conditions, Jammu and Kashmir is suitable for production of a variety of aromatic crops like Rose, Lavender, Rosemary, Wild Marigold, Monarda, Scented Geranium, Mints and different aromatic grasses. The CSIR Aroma Mission launched at the High Mountain Arid Agriculture Research Institute in Leh seeks to provide all support and guidance in promoting cultivation of these crops in Ladakh leading to not only augmenting the aroma industry but also considerably enhancing farmers' incomes.

An awareness programme "Catalyzing Rural Employment through Cultivation, Processing, Value Addition & Marketing of Aromatic Plants" was conducted at the Shenam Hall, Leh, Ladakh where a team of scientists from CSIR-IIIM interacted with more than 100 farmers, students, women self help groups and other participants from different parts of Ladakh.

First of its Kind "Waste Management Park" Built

CSIR-NEERI has established first of its kind Waste Management Park to Nagpur. The main focus of the park is to make people aware of effective waste management by reducing, reusing, recycling and segregating the waste; the park is itself a desirable model for depicting how well waste can be converted into useful products.

The Waste Management Park exhibits how waste can be managed, reduced and beautified. The park has two huts that serve as a learning centre about how different kinds of wastes like hazardous waste, Construction and Demolition (C&D) waste, biomedical/reject waste, etc. can be treated and recycled and simultaneously highlight what a citizen can do to minimise waste generation.

Technology that Converts Distillery Waste to Fertiliser developed

Distilleries generate 10-15 litres of wastewater effluent or "spent-wash" while producing one litre of alcohol from fermentation of sugarcane molasses. There are almost 300-odd molasses-based distilleries in India churning out 2.5-2.6 billion litres of alcohol annually, and in doing so also discharging 30-35 billion litres of spent wash that can contaminate surface and ground water.

CSIR-CSMCRI has developed a process to separate the main source of pollution — potash and biodegradable organic matter — from distillery spent-wash. While helping distilleries comply with the Central Pollution Control Board's mandated zero liquid discharge (ZLD) action plans, this technology will also meet up to a tenth of India's potassium-based fertiliser requirements, now entirely met through imports. It will encourage more distilleries to come up and produce ethanol for blending with petrol, cutting the country's oil import bill and bringing sugarcane growers better returns.

The technology employs a coagulation process to separate complex organic compounds from spent-wash. According to CSIR-CSMCRI, the process yields 10 tonnes of complex organics, 2.5 tonnes of Potassium Nitrate and 75,000-80,000 litres of recycled water from every one lakh litres of spent-wash.

CSIR-CSMCRI has already filed a patent and has converted the process into a commercial-scale technology in collaboration with Chem Process Systems Private Ltd, an Ahmedabad-based firm. The first full-fledged commercial plant using the technology is expected to be commissioned by Aurangabad Distillery Ltd (ADL) at Walchandnagar, Maharashtra soon.

SCIENTIFIC EXCELLENCE

SCIENTIFIC EXCELLENCE

4.0 SCIENTIFIC EXCELLENCE

CSIR has published 5191 research papers during 2018 in SCI journals of repute.

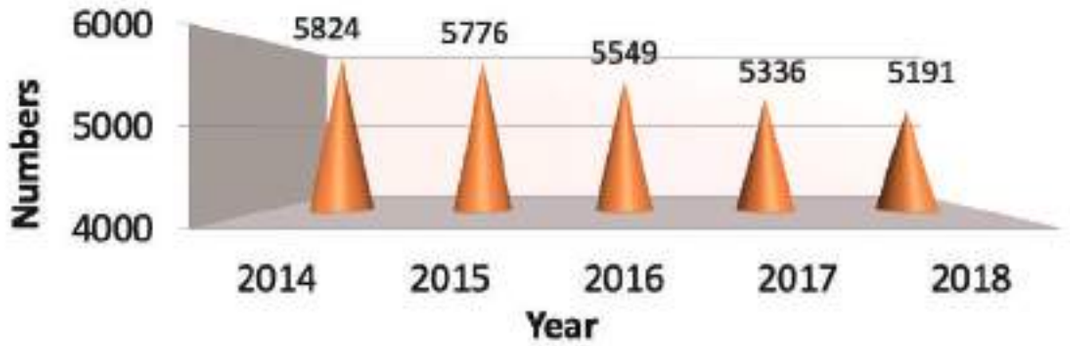


Fig. 4.1: Research papers during 2014 to 2018

The new knowledge generated from CSIR laboratories is reflected in terms of high average Impact Factor (3.446). Following graphs shows the trend of research over the last five years.

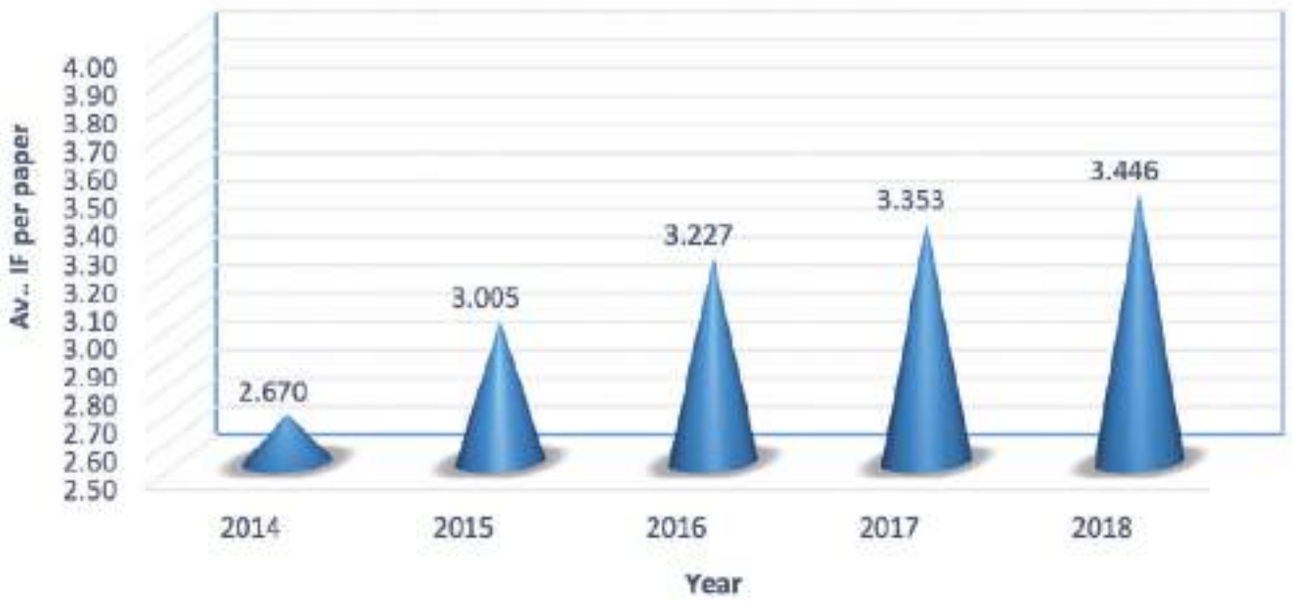


Fig. 4.2: Average impact factor per paper, during 2014-18

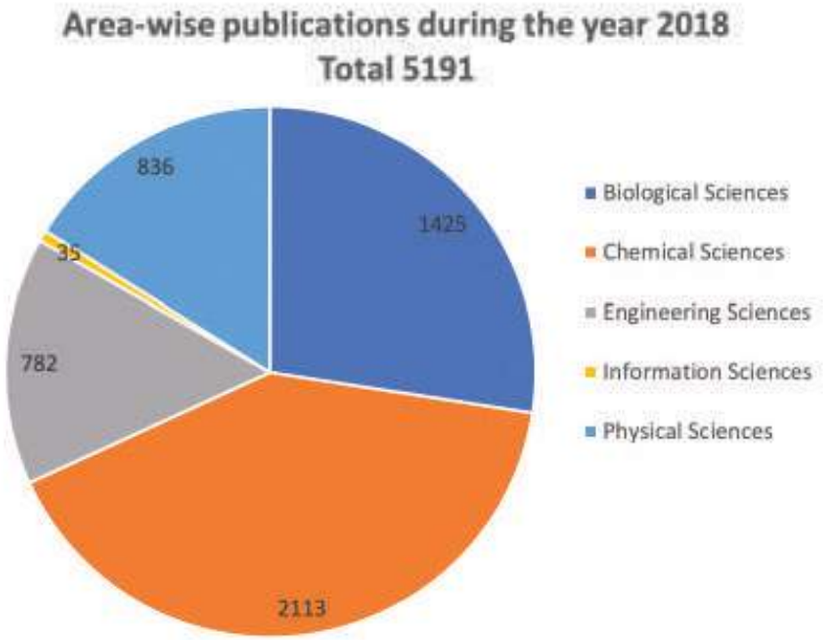


Fig. 4.3: Clusterwise publication in 2018

Excellence in Intellectual Property

CSIR has filed 174 patents abroad and 209 patents in India during 2018-19, and it has been granted 285 patents in abroad and 167 patents in India. Following graphs provide data on patents filed and patents granted over the last five years:

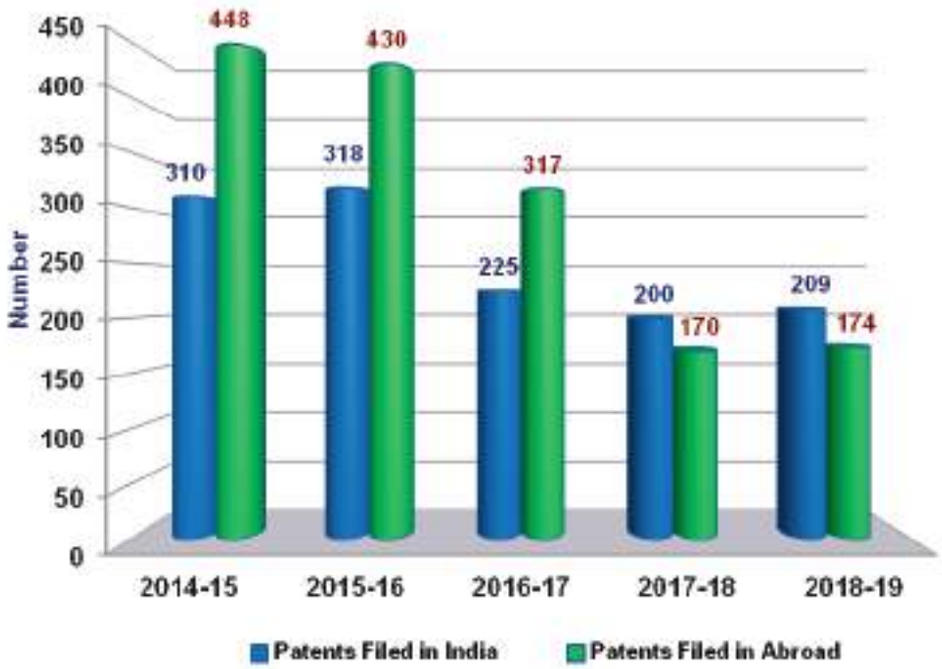


Fig.4.4: Patents filed in numbers from FY2014-15 to FY2018-19

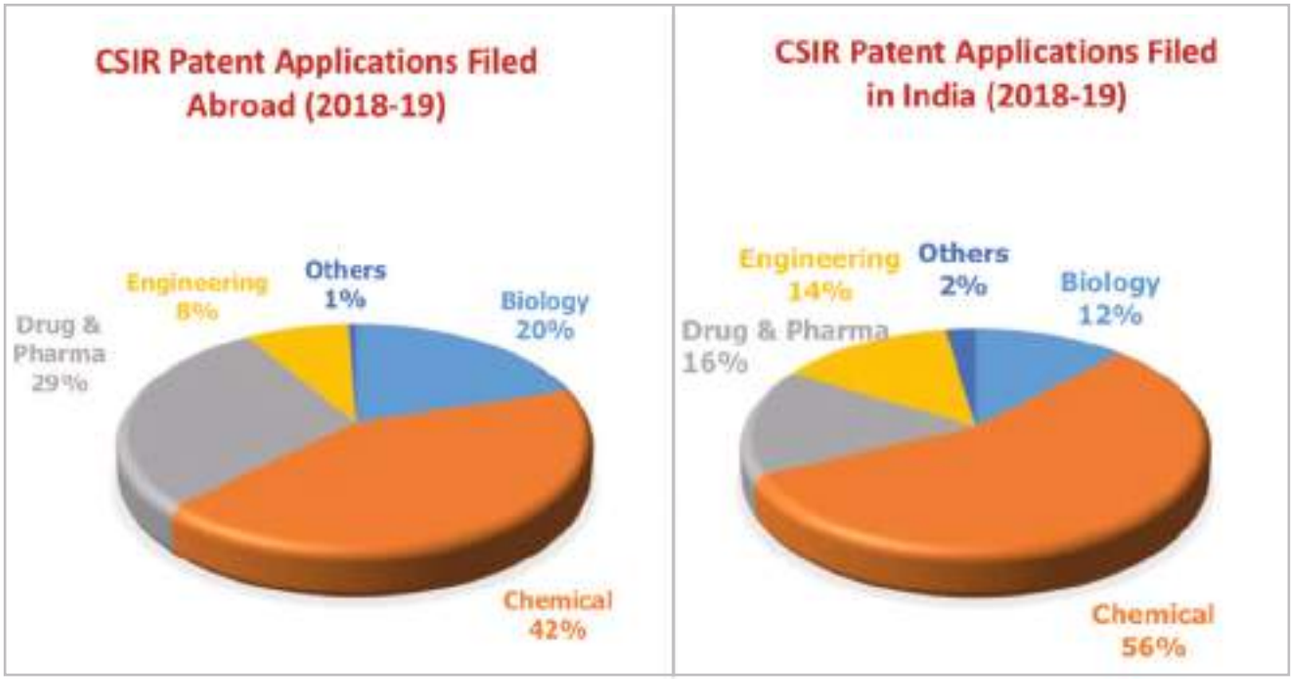


Fig. 4.5: Cluster-wise patents filed in Indian and abroad during 2018-19

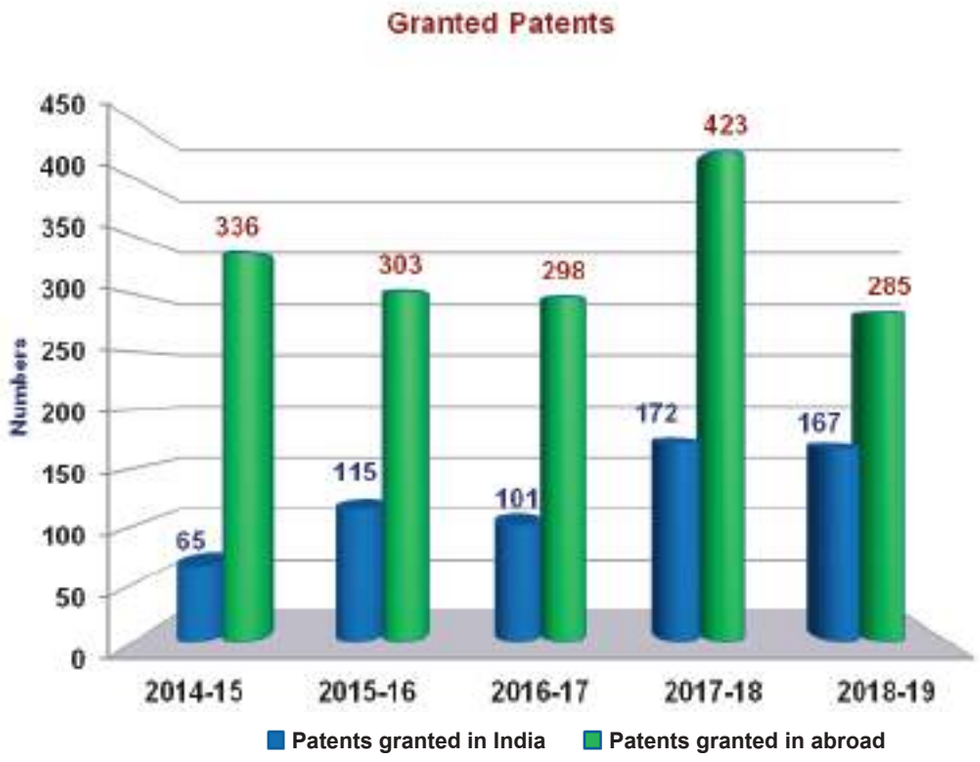


Fig. 4.6: Patents granted in numbers from FY2014-15 to FY2018-19

CSIR's Copyright Filing

CSIR has filed 35 Copyright applications during 2018-19. The Copyright applications filed by CSIR subsist in different categories such as literary work, software and artistic work.

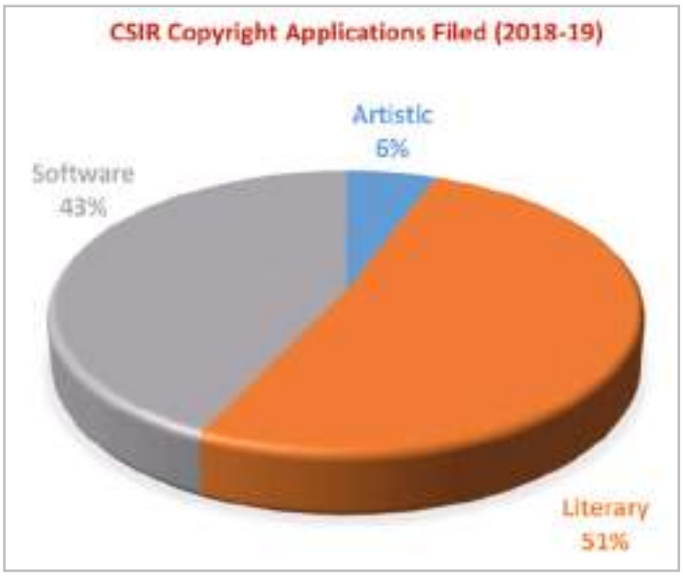


Fig. 4.7: Copyright applications filed during 2018-19

Value GenerWation through External Cash Flow (ECF)

CSIR has generated External Cash Flow of Rs. 1308.44 crore during 2018-19, through working with various Govt./ Non-Govt. Indian and foreign organizations. Following graphs provide data on ECF generated over the last five years:

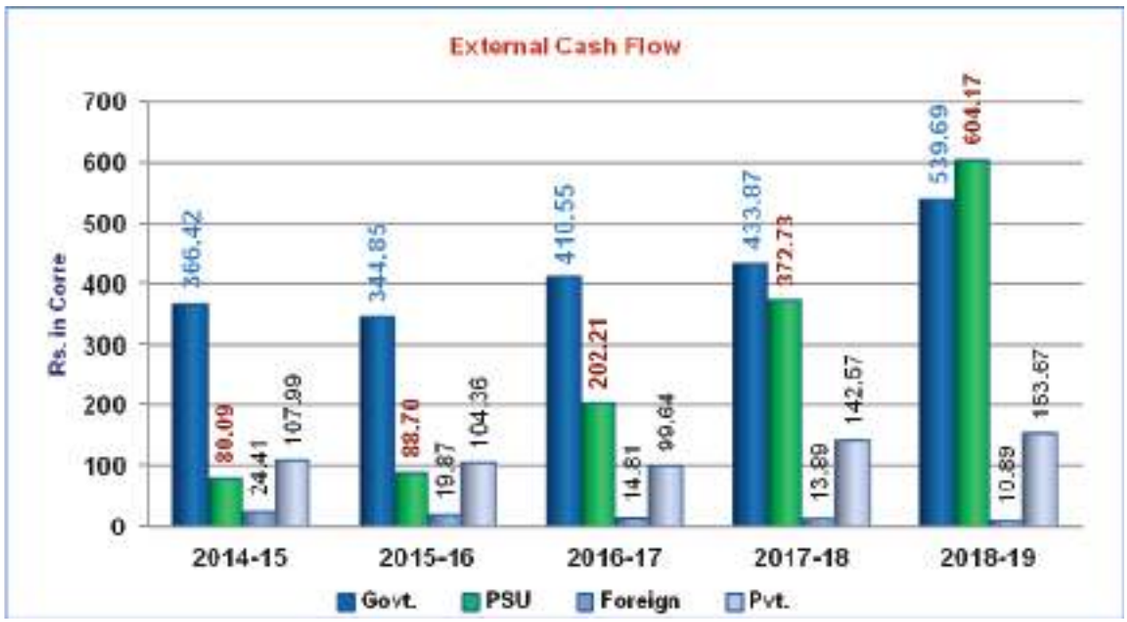
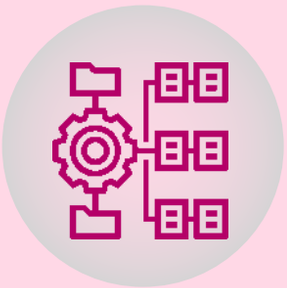


Fig.4.8: External Cash Flow from FY2014-15 to FY2018-19



AREA-WISE SIGNIFICANT S&T CONTRIBUTIONS

AREA-WISE SIGNIFICANT S&T CONTRIBUTIONS

5.1 BIOLOGICAL SCIENCES

CSIR-IGIB Licenses out Diagnostic Tests for Rare Genetic Diseases

CSIR-IGIB has entered into an agreement with Dr Lal PathLabs to commercialise a set of 27 genetics tests. Dr Lal PathLabs has a large network of diagnostic centres across the country. To be launched in phases over the year, these tests could make diagnosis of genetic diseases much easier.

CSIR-IGIB has a rich expertise in the area of genomics and the institute has carried out over 14,000 genetic tests, benefiting about 4,000 patients. These tests cover a variety of diseases/disorders including movement disorders, motor neuron disease, mitochondrial disorders, developmental and inborn errors of metabolism, and leukodystrophies.

New Clues to Parkinson's Disease Found

A protein called alpha-synuclein plays a very crucial role in the development of Parkinson's disease. CSIR-IICB has shown that the protein (native form), oligomers (early), as well as amyloid fibrils, affect each other in the aggregation pathway.

Out of 20 amino acids they used only two amino acids to direct their study in live neuroblastoma cells (a type of cancerous cells). The first amino acid was Glutamate which was responsible for the formation of amyloid fibrils by facilitating early oligomer generation; the other was Arginine responsible for amyloid fibril inhibition by inducing a change in the actual (native) structure of the protein.

The study also revealed that Glutamate acts as a facilitator and Arginine as an inhibitor of the late stage of alpha-synuclein aggregation pathway. However, it is not clear whether the observed effects are due to cellular changes or due to direct interaction of these molecules with alpha-synuclein. The nature of the interaction of these molecules with alpha-synuclein as well as the mechanism of internalisation is yet to be better understood.

Anti-TB Cocrystal 4-Fixed Drug Combination (FDC) Drug with Improved Stability

CSIR-NCL has developed an Anti-TB cocrystal drug with improved stability. The cause for the instability of the 4-FDC drug chemical structures was studied and discovered pharmaceutically stable cocrystal by applying Crystal Engineering principles to improve the stability, so that the drug inhibits the cross-reaction between Isoniazid and Rifampicin, and thereby overcomes the formation of inactive by-products.

The pharmaceutical cocrystals of INH (INH-Caffeic acid and INH-Vanillic acid) were used to improve the stability of 4-drug FDC. The pharmaceutically stable cocrystal of INH is able to improve the stability greater than 5-fold compared to the current 4-FDC drugs. The coformer additives which stabilise the formulation are pharmaceutically accepted excipients. Stability studies were carried

out under accelerated conditions of 40°C temperature and 75% relative humidity. The first time improvement of stability of anti-TB 4-FDC drugs using cocrystals of INH in a fixed dose formulation was reported.

Fig. 5.I.I: Anti-TB drug with improved stability

Novel Way to Inhibit Bacterial Growth

CSIR-CCMB have discovered a new mechanism to inhibit bacterial growth, paving the way for novel antibiotics to fight against infections resistant to drugs.

The scientists isolated an Antimicrobial Protein (AMP) from the milk of a unique egg-laying mammal, namely, Echidna, also known as spiny anteaters found in Australia and New Guinea. The extracted protein may serve as an alternative to antibiotics used on livestock. The Antimicrobial Protein (AMP) in the milk of the mammal can puncture the cell membranes of multiple bacterial species thereby destroying the infection.

The study has been published in the journal *Biochimica et Biophysica Acta–Biomembranes*.

Early Diagnosis of Prediabetes Using Novel Markers

CSIR-NCL, in collaboration with the Chellaram Diabetes Institute, Pune, has identified some novel markers for efficient prediction of prediabetes. The glycated peptides of a protein, namely Albumin were studied and differentiated to evaluate their ability to predict the prediabetic condition.

Prediabetes is a condition wherein the blood glucose or blood sugar levels in the body are higher than the normal. At a certain level of sugar in the body, it becomes type 2 diabetes which is the advanced stage. Prediabetes can be controlled with simple changes in lifestyle and eating habits. In this research work, blood samples were collected from prediabetic but healthy patients for a series of diagnostic tests such as levels of glucose bound haemoglobin (HbA1c), fasting blood glucose, and lipid profiles were also performed. After the inspection, only four peptides were taken out of fourteen as per the selection criteria.

A study was carried out to quantify these four glycation sensitive peptides in the selected patients. All these peptides were observed with a higher fold difference in prediabetes than the corresponding unmodified peptides like FBG, PPG and HbA1c. The study suggested that these peptides may determine prediabetes more efficiently, and therefore they could form a potential panel of biomarkers for diagnosis of prediabetes.

Therefore, quantifying these 4 glycated peptides of glucose-sensitive lysine (a building block of protein) residues of albumin will help in diagnosis of prediabetes.

Inflammasome activation in Kupffer cells confers a protective response in nonalcoholic steatohepatitis

Inflammasome activation in liver macrophage related to nonalcoholic steatohepatitis has been explored by CSIR-IICB. Hepatocellular death or ballooning distinguishes the transition of simple steatosis to irreversible nonalcoholic steatohepatitis (NASH). However, the molecular mechanism of hepatocellular apoptosis in NASH is largely unclear, and discovery of endogenous mediators that could prevent or inhibit cell

death is thereby critical in intercepting NASH progression. CSIR-IICB has identified pigment epithelium-derived factor (PEDF), a secreted, moonlighting hepatokine as 1 hepatoprotective agent in mice with diet-induced NASH. Hepatic PEDF expression is induced by IL-1β, which is derived from inflammasome activation in liver-resident Kupffer cells. This study highlights PEDF as a functionally important hepatokine in NASH progression by linking inflammasome activation and hepatocellular death.

Discovery of a major-groove-specific nuclear-localizing, cell-penetrating tetrapeptide.

Identification of key amino acids is required for development of efficient cell-penetrating peptides (CPPs) that have tremendous implications in medicine. CSIR-IICB has studied the importance of two amino acids, Arginine and Tryptophan, in cell penetration and developed short, non-toxic tetrapeptides with excellent potential for cell penetration and nuclear localization. Among them, Glu-Thr-Trp-Trp (ETWW) emerges as the most promising. Results suggest that it enters into cancer cells following an endocytic pathway and binds at the major groove of nuclear DNA, where successive tryptophan plays major role. CSIR-IICB subsequently showed that it is not a P-glycoprotein substrate and is non-toxic to PC12-derived neurons, suggesting its excellent potential as a CPP. This study provides major fundamental insights about the positional importance of tryptophan and opens new avenues toward the development of next-generation CPPs and major-groove-specific anticancer drugs.

Picomolar detection of retinol binding protein - 4 for early management of type II diabetes

Type II diabetes is one of the major threats to mankind as it causes insulin resistance in human body. Retinol Binding Protein 4 (RBP4) is considered as a potential biomarker for early management of this disease and its low-level detection is an important task. A novel RBP4 biosensor has been developed by CSIR-CSMCRI using homemade plastic chip electrodes (PCEs) as a platform for self-assembled monolayer (SAM) of 4-ATP and further functionalization with glutaraldehyde. Anti-RBP4 is used as biorecognition species and electrochemical impedance spectroscopy was used for analysis. A wide concentration range from 100 fg/mL to 1 ng/mL has been tested and a low limit of detection (LOD) of 100 fg/mL has been achieved. This is the first report for fabrication of electrochemical biosensor of RBP4 using Ag-Ab interaction having such low LOD. Excellent reproducibility and quick measurement makes this biosensor extremely useful for the biomedical industry.

Mitigation of climate change using seaweed based biostimulant: A case study with sugarcane cultivation in India

Strategies for sustainably increasing sugarcane productivity without any negative implications to the environment are challenging. CSIR-CSMCRI demonstrated successfully the potential of an agro-technique involving foliar applications of *Kappaphycus alvarezii* seaweed based biostimulant in combination with recommended rate of synthetic fertilizers (RRF) for sustainably enhancing sugarcane production and mitigating environmental impacts. Kappaphycus seaweed extract (KSWE) applied at 5% concentration enhanced cane productivity by 12.5 and 8%, respectively, in plant and ratoon crops. The present study advocates a paradigm shift in policy to encourage use of biostimulants in the context of mitigating adverse effects of global climate change and expecting better returns from sugarcane cultivation.

Differential transcriptome modulation leads to variation in Arsenic stress response in *Arabidopsis thaliana* accessions

Arsenic (As) is a ubiquitous metalloid and a health hazard to millions of people worldwide. The presence of As in groundwater poses a threat as it not only affects crop productivity but also contaminates food chain. In recent past, natural variation in *Arabidopsis thaliana* has been utilized to understand molecular and genetic adaptation under different stresses. Responses of Arabidopsis accessions were analyzed at biochemical and molecular levels towards arsenate [As (V)] stress at CSIR-NBRI. On the basis of reduction in root length, accessions were categorized into tolerant and sensitive ones towards As (V). A number of genes associated with defense and stress-response, transport system, regulatory mechanisms and biochemical processes showed differential expression in contrasting accessions.

Identification of lead compound with promising therapeutic potential against experimental visceral leishmaniasis.

In an endeavor to search for affordable and safer therapeutics against debilitating visceral leishmaniasis, CSIR-CDRI examined antileishmanial potential of ammonium trichloro [1,2-ethanediolato-O,O']-tellurate (AS101); a tellurium based non-toxic immunomodulator. AS101 showed significant *in vitro* efficacy against both *Leishmania donovani* promastigotes and amastigotes at sub-micromolar concentrations. AS101 could also completely eliminate organ parasite load from *L. donovani* infected Balb/c mice along with significant efficacy against infected hamsters (>93% inhibition). Analyzing mechanistic details revealed that the double edged AS101 could directly induce apoptosis in promastigotes along with indirectly activating host increased ROS generation and anti-leishmanial IgG production. AS101 could inhibit IL-10/STAT3 pathway in *L. donovani* infected macrophages. These findings provide the first evidence for the mechanism of action of AS101 with excellent safety profile and suggest its promising therapeutic potential against experimental visceral leishmaniasis.

Biofilm: a resource of anti-biofilm agents and their potential implications in targeting antibiotic drug resistance

Biofilms play an important role in the antibiotic drug resistance, which is threatening public health globally. Almost, all microbes mimic multicellular lifestyle to form biofilm by undergoing phenotypic changes to adapt adverse environmental conditions. Many anti-biofilm agents have been experimentally validated to disrupt the biofilms during last three decades. To organize this data, CSIR-IMTECH developed the 'a Biofilm' resource (http://bioinfo.imtech.res.in/manojk/ abiofilm/) that harbors a database, a predictor, and the data visualization modules. The database contains biological, chemical, and structural details of 5027 anti-biofilm agents (1720 unique) reported from 1988-2017. These agents target over 140 organisms including Gram-negative, Gram-positive bacteria, and fungus. They are mainly chemicals, peptides, phages, secondary metabolites, antibodies, nanoparticles and extracts. They show the diverse mode of actions by attacking mainly signaling molecules, biofilm matrix, genes, extracellular polymeric substances, and many more. The QSAR based predictor identifies the anti-biofilm potential of an unknown chemical with an accuracy of ~80.00%. This comprehensive platform would help the researchers to understand the multilevel communication in the microbial consortium. It may aid in developing anti-biofilm therapeutics to deal with antibiotic drug resistance menace.

Drug and nanoparticle-mediated rapid naked eye water test for pathogens detection

Inspired by the interaction of colistin with lipopolysaccharides (LPS) of the bacterial outer membrane, CSIR-IMTECH described a simple, cost effective and rapid assay for the detection of bacterial contamination in water samples. Colistin, a bactericidal drug, has been used in a receptor configuration for detection of

pathogenic microorganisms without involving any tedious sample preparation step. The approach employs the cationic antibiotic drug for dual purpose, firstly, as a primary binder for pathogens and secondly, as an aggregator for negatively charged Gold nanoparticles (GNPs). The former consists of colistin binding to bacteria in water that renders GNPs free in solution thus depicting red color and the latter shows colistin driven aggregation of GNPs producing blue colored solution. The assay works in a two-step procedure that involves addition of colistin and GNPs to the water sample before results can be visualized based on color change. The assay is sensitive at a concentration up to 10 bacterial cells·mL−1 in a time frame of 5 min without requiring any expensive reagents and instruments.

Alternative route for improving photosynthesis is crop plants

CSIR-IHBT identified a unique pathway for re-assimilation of photorespired CO_2 and NH_3 in C3 plants at high altitude. Pathway was transplanted with success in Arabidopsis, a C3 plant species; the transgenics showed improved photosynthesis and yield, and reduced photorespiratory losses. The work which shows an alternative route for improving photosynthesis in crop plants through introduction of C4-like traits into C3 plants, was well appreciated by the F1000 prime group (a faculty of more than 8,000 international leading experts in biology and medicine).

Purification, identification and characterization of two novel antioxidant peptides from finger millet (Eleusine coracana) protein hydrolysate

CSIR-IHBT successfully identified antioxidant peptides from a finger millet protein hydrolysate. Two potential antioxidant peptides were identified as TSSSLNMAVRGGLTR and STTVGLGISMRSASVR. Synthetic peptides with the same sequence were synthesized and characterized for their antioxidant activity. Molecular docking studies revealed that potential antioxidant activity from both peptides resulted from the interaction of serine and threonine residues with free radicals. The current study suggested that natural peptides identified from finger millet have potent antioxidant activity and regarded as a promising source for a functional food ingredient.

Plant virology studies

In the area of virology, wildly growing *Ficus palmata* was identified by CSIR-IHBT as a natural host of apple stem grooving virus, a very important virus of apple. In another study, *Rumex nepalensis* was identified as an off-season host of Tomato leaf curl virus. Interestingly, *P. kurroa*, an ethno-pharmacologically important endangered medicinal herb, traditionally used in several preparations of Indian Ayurvedic medicine, was found to be naturally infected by a complex of alternanthera yellow vein virus and cotton leaf curl *Multan betasatellite* when grown at mid hill altitude in Palampur. Alternate hosts are important for survival of the viral pathogens during unfavourable conditions.

Improved polycyclic aromatic hydrocarbon degradation in a crude oil by individual and a consortium of bacteria.

In this study, CSIR-IITR reported the ability of *Stenotrophomonas maltophilia, Ochrobactrum anthropi, Pseudomonas mendocina, Microbacterium esteraromaticum and Pseudomonas aeruginosa* to degrade multiple polycyclic aromatic hydrocarbons (PAHs) present in crude oil. The PAHs in the crude oil sample obtained from Digboi oil refinery, India were estimated to be naphthalene (10.0 mg L^{-1}), fluorene (1.9 mg L^{-1}), phenanthrene (3.5 mg L^{-1}) and benzo(b)

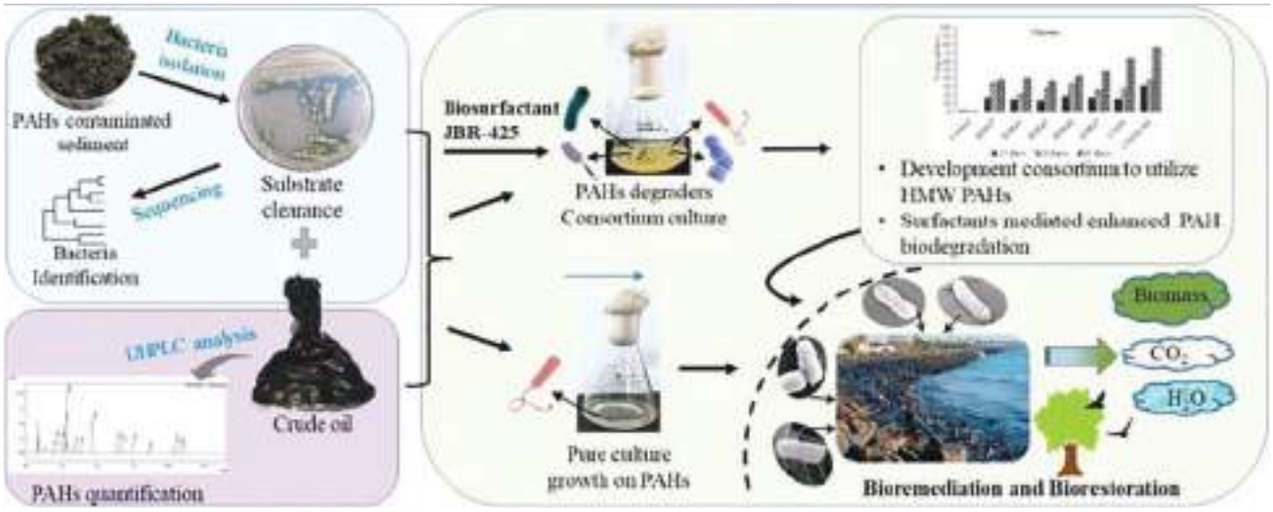


Fig. 5.1.2: PAH remediation by bacteria

fluoranthene (6.5 mg L^{-1}). Consortium of these bacteria showed enhanced biodegradation of 89.1%-naphthalene, 63.8%-fluorene, 81% of phenanthrene and 72.8% benzo(b) fluoranthene in the crude oil. The degradation was further improved up to 10% by consortium on addition of 40 μg mL^{-1} rhamnolipid JBR-425 biosurfactant. These results suggest that the developed bacterial consortium has significant potential in PAH remediation.

Preclinical development of *Crocus sativus* based botanical lead IIIM-141 for Alzheimer's disease

CSIR-IIIM has shown that *Crocus sativus* extract (IIIM-141) display promising efficacy in a genetic mice (5XFAD) model of Alzheimer's disease (AD). The acute oral toxicity study has shown that IIIM-141 is safe up to the dose of 2000 mg/kg, with no effect on the body weight, and biochemical/ haematological parameters of the rats. The repeated oral administration of IIIM-141 for 28-days at 100 mg/kg dose, does not caused any pre-terminal deaths and abnormalities in Wistar rats. The pharmacokinetic analysis indicated that after oral administration of IIIM-141, the majority of crocin gets hydrolyzed to its aglycone crocetin. The sustained release capsule formulation was developed, which showed improved *in vitro* dissolution profile and significantly enhanced plasma exposure in the pharmacokinetic study. The data serves as the benchmark for the further research on this botanical candidate.

AKT Inhibition Modulates H3K4 Demethylase Levels in PTEN-Null Prostate Cancer

Hyperactivated AKT kinase due to loss of its negative regulator PTEN influences many aspects of cancer biology, including chromatin. AKT primarily regulates Acetyl-CoA production and phosphorylates many histone-modulating enzymes, resulting in their activation or inhibition. Therefore, understanding the therapeutic impact of AKT inhibition on chromatin-related events is essential. Here, CSIR-IIIM reported that AKT inhibition in prostate-specific PTEN knockout mice significantly induces di- and trimethylation of H3K4 with concomitant reduction in H3K9 acetylation. It was observed that miR-137. The mechanism by which AKT kinase modulates the prostate cancer epigenome through regulating H3K4 methylation has been identified. Additional studies on AKT inhibition-mediated induction of H3K4 methylation will help in designing strategies to enhance the therapeutic efficacy of PI3K/AKT inhibitors.

A lipid-based cell penetrating nano-assembly for RNAi-mediated anti-angiogenic cancer therapy

Limited tumor tissue penetration is one of the key impeding factors retarding successful in vivo exploitations of anti-angiogenic cancer therapy. CSIR-IICT reported the design of a cell penetrating peptide decorated lipid nano-assembly which, upon systemic administration, induces significant mouse tumor growth inhibition via enhanced tumor infiltration of encapsulated anti-angiogenic siRNA.

Leishmania species and stage-specific adaptive mechanisms explored

The hurdles in drug and vaccine development pipelines for leishmaniasis, a complex, multifaceted disease, are largely due to the digenetic lifecycle, differential clinical manifestations of the parasite, and the incomplete understanding of its adaptations within its hosts. For the first time, CSIR-NCL reviewed the distinct computational and experimental techniques employed to identify the species and stage-specific adaptive mechanisms at different levels of biological organization, the progress made so far, and limitations in comprehending leishmaniasis as a systems biology disease. Based on the available perspectives, suggestions were made to tackle the growing challenges for bridging the genotype with the phenotype. A systems perspective can be instrumental in understanding the complexities of the disease and can provide insights for targeted control.

Nanobeads for detection of bilirubin in human blood serum

Amphiphilic polystyrene having pendant glucuronic acid was synthesized by CSIR-NCL covalently incorporating oligo (p-phenylenevinylene) (OPV) based fluorophore. The OPV fluorophore functioned as signal transducer and glucuronic acid on surface of PS nanobeads acted as interaction site for free bilirubin to facilitate non-covalent interaction via hydrogen bonding. Visual color change from blue to bluish green was observed under UV lamp after addition of bilirubin into polymer. The limit of detection was found to be as low as 20 nM which is far less than the clinical range for causing jaundice (< 25 to > 50 μmol/L). The developed sensor showed its effectiveness towards real time monitoring of free bilirubin in human serum.

Aggregation of Respiratory Complex Subunits Marks the Onset of Proteotoxicity in Proteasome Inhibited Cells

Living cells have a robust protein quality control mechanisms to ensure their correct folding, functioning and degrading the proteins that are not required or damaged. With age, these control mechanisms are known to weaken, and cause proteins to misfold, aggregate and possibly cause toxicity in cells. This study by CSIR-CCMB investigates the players and mechanisms of early stages of protein aggregation. It shows that by inhibiting proteasomal machinery in cells, which helps in degrading proteins, Respiratory Chain Complex (RCC) proteins are one of the first ones to aggregate. It also shows that specific signatures in the protein sequence, called the Low Complexity Regions partially contribute to this aggregation. Aggregation of the RCC proteins could deregulate formation of functional protein complexes in mitochondria and lead to mitochondrial dysfunction.

5.2 CHEMICAL SCIENCES

Biodiesel from Tung Oil

CSIR-CMERI, Ludhiana Centre, has come up with a promising alternative to reduce the dependency on fossil fuels by designing and developing a biodiesel plant to convert vegetable into biodiesel. Tung oil has been

used in different industrial applications such as ceramic, paint, paper and cloth production. More recently, Tung oil (*Aleurites fordii*) has been regarded as a promising non-edible source of biodiesel production.

A semi-continuous type biodiesel plant has been designed, developed and tested at CSIR-CMERI. The plant with the capacity of 600 litres/day is able to produce biodiesel from any edible and non-edible vegetable oil irrespective of its FFA (Free Fatty Acids) content. This plant was utilised for making biodiesel based on optimised parameters to produce biodiesel from Tung seed oil.

In the North-Eastern part of India, a sufficient quantity of non-edible oil seeds like Tung is available having oil content ranging from 30% to 40%. The seeds can be extracted in an oil expeller. The extracted oil can be used to make biodiesel through transesterification. The biodiesel produced (calorific value of 9500–10500 kCal/kg) can be used to run engines and diesel gensets locally.

The leftover cake can be fed into the biogas plant. The biogas produced (calorific value of 5700 kCal/kg) can be used for cooking purpose or lighting purpose (directly or through generating electricity).

Dyes Sensitised Solar Cells

CSIR-NCL and IIT Roorkee have developed organic dyes that can increase the efficiency of Dye Sensitised Solar Cells (DSSC). A process has been established to produce functional porphyrins without the use of Platinum and Palladium catalysts and have developed simple, efficient, cost-effective sensitizers which involve fewer synthetic steps resulting in five porphyrin Zn(II) complexes with power conversion efficiency 5.3% to 7.1%.

Synthesis of Quantum dots from 2D Materials

Transition metal dichalcogenides quantum dots (TMDQDs) with few layers based on 2D layered materials are in the forefront of recent research owing to their unique band structure. Such quantum dots (QDs) can be employed for components in optoelectronic devices.

CSIR-CECRI have developed a novel single step electrochemical route for the synthesis of tungsten-di-sulfide quantum dots (WS_2) from their bulk counterpart. The average size of the WS2 QDs is 3 nm ± 1 nm (N=102) with few layers.

Fig. 5.2.I: Biodiesel from Tung Oil

Time dependent TEM investigations revealed that time has played a vital role in this electrochemical transformation. This electrochemical transformation provides a facile method to obtain WS_2 QDs from their bulk counterpart which is expected to have greater impact on the design and development of nanostructures derived from 2D materials. Further, the QDs thus obtained exhibited higher photoluminescence (PL) quantum efficiency (5%) and exhibit an excitation-wavelength dependent photoluminescence.

Electrosynthesis of Nitrogen-Doped Blue Luminescent Phosphorene Quantum Dots (NPQDs)

CSIR-CEERI has reported a facile one-step route for the electrosynthesis of Nitrogen-Doped Blue Luminescent Phosphorene Quantum Dots (NPQDs) from Black Phosphorous (BP) at room temperature. This is the first report on the electrosynthesis of NPQDs.

The nitrogen percentage in NPQDs can be varied by the appropriate choice of solvent and supporting electrolyte. NPQDs synthesised in this work have an average size of 6 ± 1.5nm (N=50) and exhibit ca. 88.7% quantum efficiency 1.

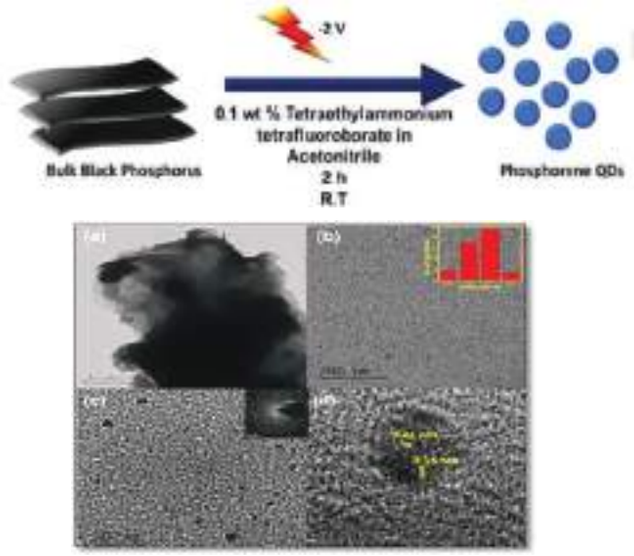


Fig. 5.2.2: Scheme representation of Electrosynthesis of NPQDs from bulk black phosphorous

Structural Stability Determination of Phosphorene Quantum Dots (PQDs)

CSIR-CECRI have investigated the role of structural distortion in determining the stability of electrochemically synthesised blue luminescent Phosphorene Quantum Dots (PQDs) from bulk black phosphorus.

The team has found that there occurs a structural distortion during the electrosynthesis of PQDs [Average size=8 ± 1.5 nm (N = 60)] from black phosphorus leaving unsaturated edge sites which will be easily passivated by oxygen functionalities to maintain the structure. These functional groups exert a +I effect (electron donating effect) and increase the electron density on the PQD skeleton causing in-plane P−P bonds to elongate.

The researchers further investigated the role of oxygen content in maintaining the structural integrity of oxygenated and non-oxygenated PQDs by Density Functional Theory calculations which emphasised the experimental evidence that an increasing oxygen content results in structural distortion of PQDs while an optimum oxygen content balances the stability of PQDs.

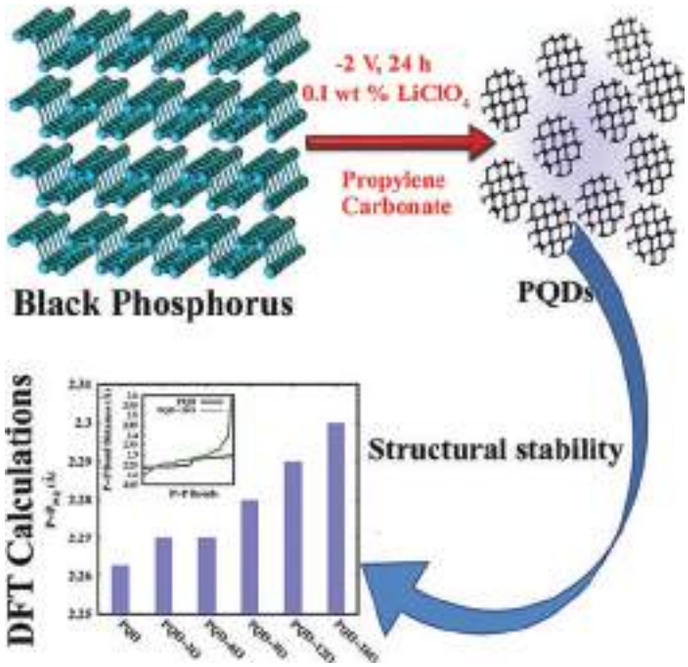


Fig. 5.2.3: Schematic representation of the synthesis of PQDs from black phosphorous

Eco-Friendly Disintegration and Disinfection of Plaster of Paris (POP) from Biomedical Waste

Plaster of Paris (POP) is being used in Healthcare (Orthopaedics and Dentistry) sector for various uses. The plaster casts are made out of POP for the immobilization of broken bones while it heals and for surgical bandages. In dentistry, POP is used for mounting casts or models of oral tissues. Generally, around 7–8kg/day POP plaster waste is generated by Dental and Orthopaedic hospitals. Such hazardous waste containing various microbial loads is collected by local Municipal bodies which is burnt in open space or incinerated at high temperature or left as it is for decomposition.

The burning of this waste emits the toxic gases and heavy metals into the environment. It bears some cost in addition. The POP waste from such biomedical origin if not disposed appropriately might enter into natural bodies such as rivers, lakes, wells, and ponds causing water pollution, introducing various health issues (like antimicrobial resistance, disturbance of natural flora) and ultimately a threat to aquatic flora and fauna. Therefore, the disposal of biomedical wastes has become a major problem and warrants greener alternatives for management.

CSIR-NCL, has come up with a greener process to address this issue. The eco-friendly and rapid disintegration of biomedical-related POP waste is achieved by treating it with ammonium bicarbonate solution (20%w/v ABC) that forms non-hazardous products but value added chemicals like ammonium sulphate and calcium carbonate in the form of sludge. The ammonium sulphate [$(NH_4)_2SO_4$] is generally used in agriculture as a chemical fertilizer and calcium carbonate ($CaCO_3$) can be used as a raw material for making chalks or as an

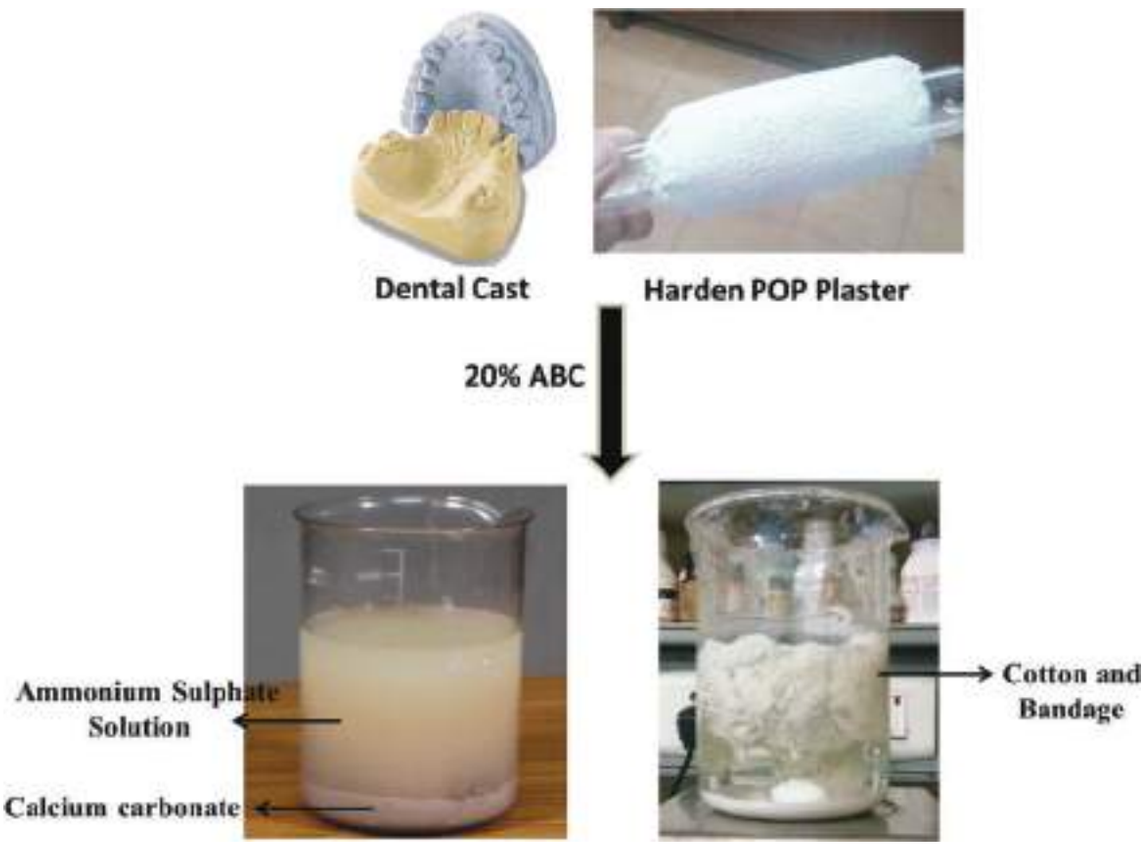


Fig. 5.2.4: Disintegration of POP waste by ammonium bicarbonate

additive in the cement industry for making bricks and sheets proving this as a greener, cost-effective and a value addition process. The antimicrobial and antibiofilm activity of ammonium bicarbonate has been documented in disinfection microbiology, which also revealed that it can also disinfect the POP waste generated from patient samples like burns, accident, fractures and dental problems of medical waste. Moreover, it is a good alternative for POP incineration, which can also minimise the air pollution and keeps environment safe.

Multifunctional Amines Enable the Formation of Polyamide Nanofilm Composite Ultrafiltration and Nanofiltration Membranes with Modulated Charge and Performance

Conventional thin film composite (TFC) nanofiltration (NF) membranes are positively or negatively charged with an active layer thickness of several nanometers depending on the preparation conditions. Low molecular weight cut-off (MWCO) ultrafiltration (UF) membranes obtained by the phase inversion process show low permeate flux due to the formation of a several micrometre thick skin layer. CSIR-CSMCRI has developed an extremely simple route to produce novel TFC NF (MCO~180 Da) and UF (MWCO~1 and 10 kDa) types of membranes with an active layer thickness in the range of 12–36 nm via supported interfacial polymerization using polyethyleneimine (PEI) as a monomer. TFC NF membranes exhibited a permeate water flux of 19–24 L $m^2h^{-1}bar^{-1}$ which is about 4–5 times higher than those of PEI-based membranes and 1.3–4 times higher than few commercial NF membranes of similar MWCOs. The process is scalable, and the membranes are useful for the separation of charge and neutral solutes with high efficiency.

Rhamnolipid from a *Lysinibacillus sphaericus* strain IITR51 and its Potential Application for Dissolution of Hydrophobic Pesticides.

Rhamnolipid produced from a *Lysinibacillus sphaericus* IITR51 was characterized and its ability for dissolution of hydrophobic pesticides were evaluated by CSIR-IITR. *L. sphaericus* produced 1.6 g/L of an anionic biosurfactant that reduced surface tension from 72 N/m to 52 N/m with 48% emulsification index. The biosurfactant was found stable over a wide range

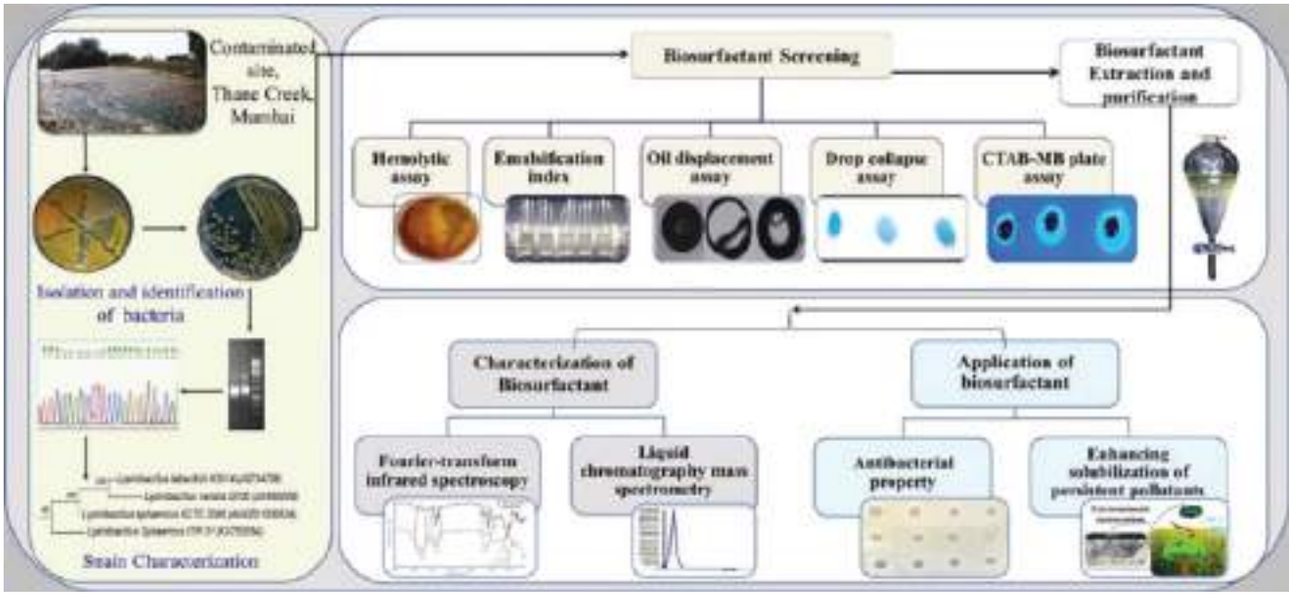


Fig. 5.2.5: Anoinic biosurfactant by bacteria

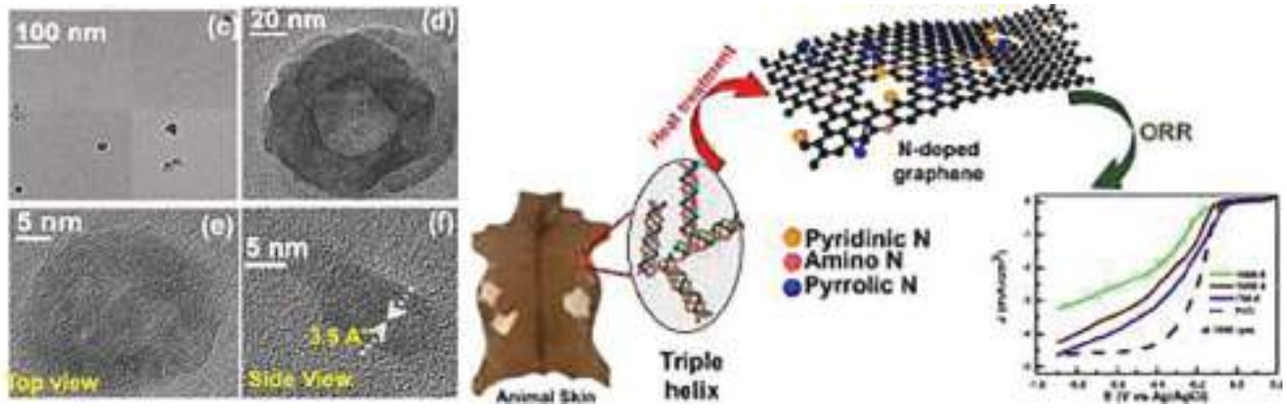


Fig. 5.2.6: Nano-onions with ORR electrocatalytic activity

of pH (4.0-10.0), temperature (4-100 °C), salt concentration (2-14%) and was identified as rhamnolipid. The bacterium utilized benzoic acid, chlorobenzene, 3- and 4-chlorobenzoic acid as sole source of carbon and was found resistant to arsenic, lead and cadmium. Furthermore, the isolated biosurfactant showed antimicrobial activities against different pathogenic bacteria. The results obtained indicate the usefulness of rhamnolipid for enhanced dissolution and thereby increasing the bioavailability.

Nitromethane as a Carbanion Source for Domino Benzoannulation with Ynones: One-Pot Synthesis of Polyfunctional Naphthalenes and a Total Synthesis of Macarpine

A one-pot, transition-metal-free, domino Michael/ SNAr protocol of general applicability has been devised by CSIR-IICT for the regioselective synthesis of polyfunctional naphthalenes by employing nitromethane and ortho-haloaryl ynones. Nitromethane has been utilized as a one carbon carbanion source that is incorporated into a variety of ynones to end up as an aromatic nitro substituent. The methodology has been further extended to alicyclic o-haloynones to increase functional diversity pattern and to deliver various benzocarbocyclic scaffolds. The efficacy of this methodology of domino process has been well demonstrated by total synthesis of quarternary benzophenanthridine plant alkaloid macarpine which displays cytotoxic activity against HeLa S_3 tumor cell lines with an IC50 of 0.192 mg/mL.

N-rich Carbon Nano-Onions from Collagen Biowastes for Oxygen Reduction Reaction

A facile strategy was developed by CSIR-CLRI to synthesize Nitrogen-rich Carbon nano- onion architectures from the renewable biological resource, collagen, for use as a metal-free ORR catalyst. The product contains an appreciably high percentage of nitrogen (7.5%) integrated into the carbon molecular skeleton. The materials exhibit outstanding ORR electrocatalytic activity with low onset potential, high current density, superior methanol crossover immunity and better durability than the benchmark Pt/C catalyst in alkaline medium. The findings ascertain that renewable biomasses can be easily transformed into novel carbon nanostructures with excellent catalytic activity.

Nanoparticles from collagen biowastes for energy and environmental applications

Bi-functional iron encapsulated carbon (Fe@C) nanoparticles were synthesized from collagen bio-waste for energy and environmental remediation applications. A simple high-temperature treatment transformed highly insulating and paramagnetic collagen- FeCl3

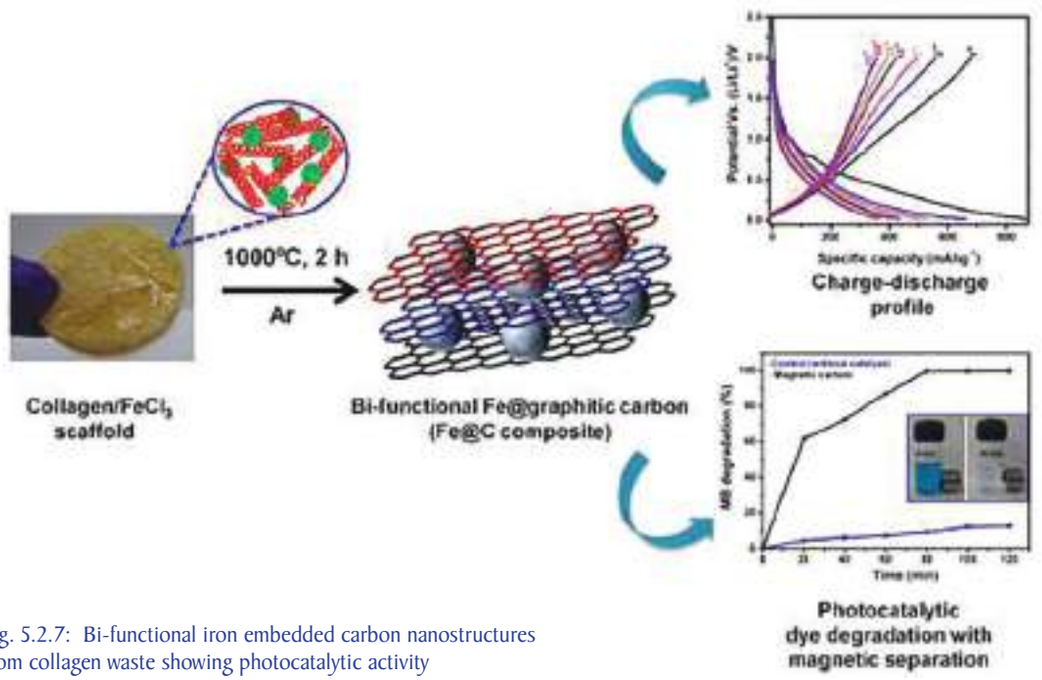


Fig. 5.2.7: Bi-functional iron embedded carbon nanostructures from collagen waste showing photocatalytic activity

scaffolds into perfectly conducting and ferromagnetic bi-functional Fe@C nanoparticles. The structural and morphological analysis reveals that different phases of Fe nanoparticles are embedded in the graphitized carbon matrix forming a core-shell type of nanostructures. The mesoporous nanoparticles showed an exceptional photocatalytic activity towards 100% degradation of methylene blue within 80 min of sunlight irradiation. CSIR-CLRI demonstrated that the presence of Fe nanoparticles in graphitic carbon lattice enabled an outstanding Li+ storage property with large reversible specific capacity (~384 mAh/g) after 75 cycles. CSIR-CLRI results provide a cost-effective, scalable and sustainable approach for the synthesis of functional nanomaterials from industrial bio-waste for applications in energy and environmental remediation.

MoS_2 Quantum Dots as Efficient Catalyst Materials for the Oxygen Evolution Reaction

The development of an active, earth-abundant, and inexpensive catalyst for the oxygen evolution reaction (OER) is highly desirable but remains a great challenge. By combining experiments and first-principles calculations CSIR-CECRI demonstrate that MoS_2 quantum dots (MSQDs) are efficient materials for the OER. Our theoretical and experimental findings provide important insights into the synthesis process of MSQDs and their catalytic properties and suggest promising routes to tailoring the performance of the catalysts for OER applications.

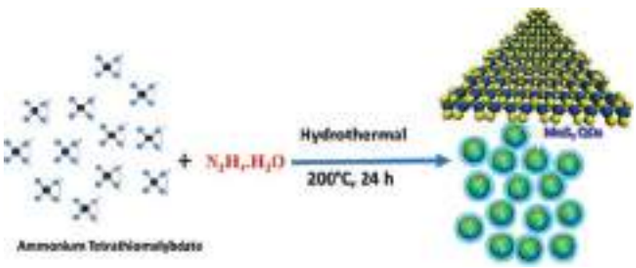


Fig. 5.2.8: Schematic representation of the MSQD synthesis. Ammonium tetrathiomolybdate was used as a single precursor for MoS_2 growth

Metal–organic framework@SiO_2 as permselective separator for lithium–sulfur batteries

The shuttling of polysulfides between the electrodes in a Lithium–Sulfur battery (Li–S)

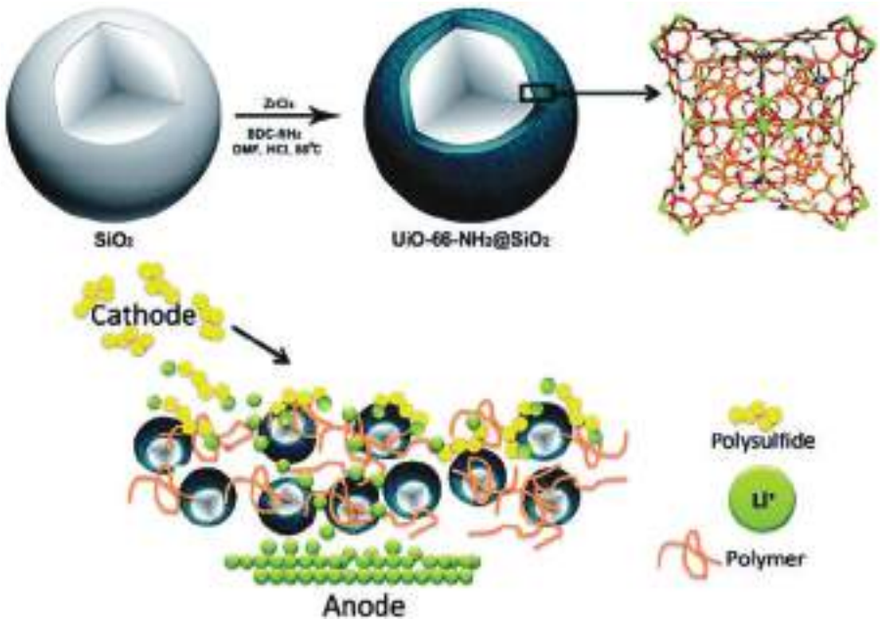


Fig. 5.2.9: Synthesis of the UiO-66-NH_2@SiO_2 (top) and the permselective membrane showing the proposed membrane action mechanism

system remains a challenge to be addressed in order to realize the full potential of this promising technology. In order to overcome this issue several strategies have been adopted by CSIR-CECRI. In this work, UiO-66-NH_2@SiO_2 was successfully synthesized and coated on a commercial Celgard 2320 membrane. The coating of UiO-66-NH_2@SiO_2 on a Celgard 2320 membrane has not only enhanced the thermal stability and wettability but also other electrochemical properties such as ionic conductivity, compatibility and charge–discharge behaviour. The enhanced discharge capacity was attributed to the electrostatic and/or H-bonding interactions between the polysulfide and UiO-66-NH_2@SiO_2 as evidenced by its positive zeta potential (+56.42 mV). More importantly, the permselective properties of the membrane significantly play against the self-discharge of Li–S cells in which 98.5% of its capacity was retained even after 40 h which is superior to earlier reports.

CO_2 fixation and production of biodiesel by *Chlorella vulgaris* NIOCCV under mixotrophic cultivation

In this study by CSIR-NIO, *Chlorella vulgaris* NIOCCV was cultivated in seafood processing industry wastewater with continuous supply of 5%, 10%, and 20% CO_2. The optimum CO_2 fixation efficiency (RCO_2), biomass productivity, specific growth rate (SGR), and lipid content were recorded on dry weight basis at CO_2 supply of 10%. The fatty acid methyl ester-derived biodiesel properties determined at same condition were in compliance with national and international fuel standards. The synergistic environmental benefit of nutrients removal from wastewater is shown as an additional advantage of microalgal cultivation. Thus, integration of algae-based CO_2 fixation with wastewater treatment and biodiesel production may realize microalgal CO_2 capture technology as environmentally sustainable and economically more attractive.

Artificial photosynthesis using sunlight to generate fuel

A quasi-artificial leaf (QuAL) device was developed by CSIR-NCL in a wireless configuration with TiO_2/Mn-CdS composite and NiCu as co-catalyst for solar hydrogen production in direct sunlight. The device works at no applied potential and generates 10.5mL/h of hydrogen, with power conversion efficiency of 4.8%. A good resemblance of NiCu alloy to

Pt in terms of electrochemical activity makes the device economical. High lifetime of electrons in Mn-CdS helps to greatly improve charge utilization for H_2 production in QuAL device. In addition, re-absorption of emitted light is successfully utilized to enhance hydrogen yield in the present work.

Flexible supercapacitor electrode materials

Perylenediimide (PDI) and benzodithiophene (BDT) based donor-acceptor random and alternate p conjugated polymers were developed and explored as composite electrode materials in Type III supercapacitor device by CSIR-NCL. Results show that the donor-acceptor alternate design involving P(PDI-alt-BDT) is an excellent supercapacitor electrode material with specific capacitance of 113 F g-1with excellent stability up to 4000 cycles and almost 100% retention of the initial capacitance in single electrode setup in PC-LiClO4 organic electrolyte. Flexible supercapacitor device were also fabricated which shows areal capacitance of 35 mF cm-2 at a current density of 0.5 mA cm-2, which is promising for commercial application.

Crop protection: Understanding regulation of protease gene expression in cotton bollworm (*Helicoverpa armigera*) and identification of peptides for growth inhibition

Insects cope up with plant defensive protease inhibitors (PIs) present in the ingested food by differentially regulating digestive proteases. Mechanisms regulating protease gene expression in insects are largely unknown. Multi-domain PI arrests growth and development of cotton bollworm. CSIR-NCL presented evidence supporting a dynamic transition in cotton bollworm protease expression upon PI-ingestion by identifying a distinct novel PI isoform of cotton bollworm in larvae feeding on PI. Based on present and earlier studies a potential mechanism of protease regulation in cotton bollworm and subsequent adaptation strategy to cope with anti-nutritional components of plants is proposed.

Photocatalytic synthesis of cyclic carbonates from CO_2 and epoxides using $CoPc/TiO_2$ hybrid under mild conditions

First report on the photocatalytic coupling of carbon dioxide with epoxides to give cyclic carbonates under extremely mild such as room temperature and atmospheric pressure conditions using a hybrid photocatalyst consisting of cobalt phthalocyanine grafted on titanium oxide ($CoPc/TiO_2$) under visible irradiation is described by CSIR-IIP. The developed protocol provided almost quantitative conversion of various epoxides to corresponding cyclic carbonates in excellent yields without any evidence for the formation of any by-product.

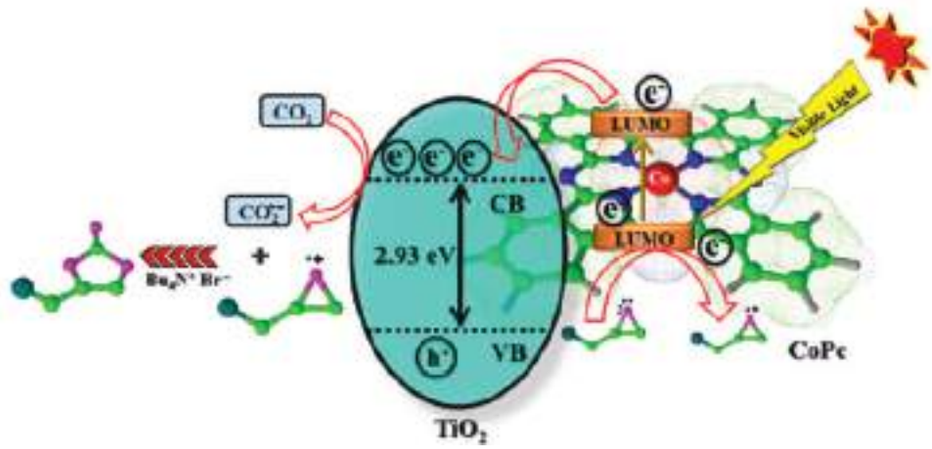


Fig. 5.2.10: Photocatalytic synthesis of cyclic carbonates from epoxides and CO_2

At the end of the reaction, the photocatalyst was separated by centrifugation and reused for several subsequent recycling runs without any significant loss in activity, and no leaching had observed during the photocatalytic reactions.

5.3 PHYSICAL SCIENCES

CSIR-NPL and M/s Global PT Provider (P) Ltd Sign Agreement of Production of Bharatiya Nirdeshak Dravya

CSIR-NPL and M/s Global PT Provider (P) Ltd signed an agreement for the production of Bharatiya Nirdeshak Dravya (BND). CSIR-NPL contributes metrological traceability to the reference material producers, which can be further exported in different countries under the brand name of Bharatiya Nirdeshak Dravya (BND). Global PT is the NABL authorised PT provider and also producer of reference materials which includes hardness blocks.

Tirupur Corporation Signs MoU with CSIR-CLRI regarding production of *Biogas from Degradable Waste*

The Tirupur Corporation has signed a Memorandum of Understanding with CSIR-CLRI to prepare a Detailed Project Report (DPR) and develop sustainable technology for a Bio-Compressed Natural Gas (Bio-CNG) bottling plant. The plant will help the environment by converting the degradable waste generated in the city into CNG which can then be used by automobiles with good mileage. Currently, nearly 100 tonnes of organic waste is generated every day in the city from approximately 520 tonnes of mixed municipal solid waste. The two plants will have a cumulative capacity to produce 300 Bio-CNG cylinders per day.

A Solution to *Parali* Burning

Delhi along with the National Capital Region (NCR) has been cited among the 20 most polluted cities in the world. Especially during the winter seasons, the air and smog pollution level reaches almost 30 times more than the World Health Organization's (WHO) safe limits.

A large portion of the harvested agro-residues (~140 MT), known as *parali* in the larger area of North India, is burned in the field primarily to clear the field for farming activities for the cultivation of the next crop.

Fig. 5.3.I: Parali burning (Source: www.Outlookindia.com)

To provide a solution to reduce Delhi's smog pollution and stop burning of agro-waste *parali* in Delhi and neighbouring States (Haryana, Punjab and Uttar Pradesh) and converting them into useful materials CSIR-AMPRI is working develop a technology for utilising paddy and wheat straw as raw materials for "manufacturing hybrid greenwood", which may be used as a substitute of wood or particle board.

There is a possibility of converting agro-waste residues, especially the paddy, wheat and maize straw into commercially viable materials equivalent or better than that of commercially available synthetic wood such as particle board, plywood, etc. This envisaged unique programme also aims to contribute to the Government of India initiatives on Make in India, Clean India and Skill Development.

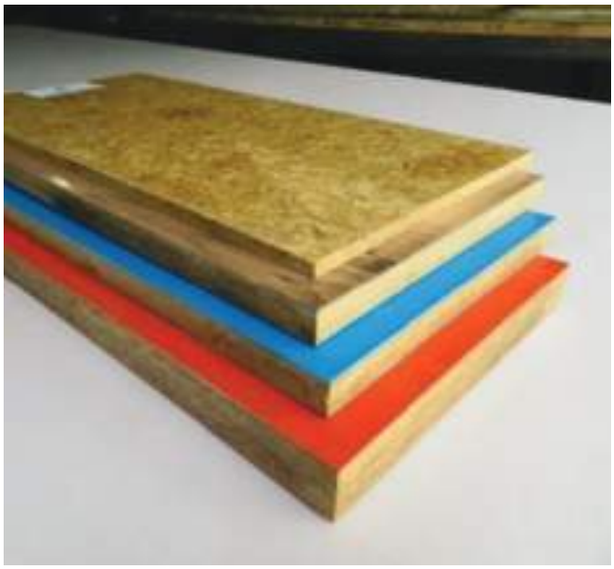


Fig. 5.3.2: Composite materials developed from wheat straw by CSIR-AMPRI Bhopal

Fig. 5.3.3: Wood substitute hybrid composite materials based on fly ash/red mud/marble wastes reinforced with natural fibres developed by CSIR-AMPRI

CSIR-NPL Develops Device for Single-layer Graphene

CSIR-NPL has designed a low-pressure chemical vapour deposition (LPCVD) device that allows high quality, single-layer graphene measuring 4 inches in length and 2 inches in width to be grown. The quality of the single-layer graphene is metrology-grade, and can be used in next-generation quantum devices.

The LPCVD device developed indigenously costs about ₹ 5,00,000, which is one-tenth of the imported ones. The quality of the single-layer graphene grown using this device is also superior.

Fig. 5.3.4: Single-layered graphene

Natural Composite for Stronger Bone Grafts

CSIR-NML has developed a novel nanocomposite that has shown potential to be used as a regenerative bone graft especially in regions that need high strength. The nanocomposite was synthesised through a simple and cost-effective route. The composite contains carboxymethyl cellulose, gelatin and hydroxyapatite, with the hydroxyapatite in nanoscale (25-10 nm size). Since bone grafts to be used in load-bearing applications must match the strength of the natural bone, the researchers evaluated the strength and elasticity of the nanocomposite and found it to be in the same range as human cancellous and cortical bone. The new polymer nanocomposite is thermally stable up to 200^0C, biodegradable and also accelerates the formation of new bone apatite under simulated body fluid.

Composite Membrane Synthesis for Application in Waste Water Treatment

Composite membranes and their application for water/wastewater treatment have been acknowledged as an important field that can lead to many significant niche areas. These membranes combine the merits of both ceramic

and polymeric materials where conventional membranes are either inapplicable or inefficient. Knowledgebase for preparation of composite membrane followed by its application in wastewater treatment using nanofiltration set up has been generated by CSIR-CGCRI. A ceramic-polymer composite membrane and a ceramic-ceramic membrane were developed in parallel and the preparation processes kept similar with an aim of comparison. The ceramic-ceramic membrane was prepared using different phases of alumina following sol-gel method and subsequent sintering.

Awareness Campaign at 100 Traffic Intersections of Delhi and related studies

When the vehicles are waiting for their turn to clear a signalized intersection, the drivers normally do not keep the engines off and this result in extra fuel consumption due to idling and increased vehicular emissions. This fuel consumption can be saved along with reduction in corresponding emissions by switching off the vehicle engine during idling at signals. A 40 days long awareness campaign was carried out by CSIR-CRRI at 100 signalized intersections in Delhi to create awareness amongst drivers regarding switching off their engines during idling. Impact of awareness campaign was estimated based on the number of vehicles switching-off their engines during idling which is further used to estimate idling fuel losses and corresponding emissions.

The study established that there was 9357 CO_2e (CO_2 equivalent) tonnes of emissions per day at selected 100 signalized intersections before the start of campaign, which reduced to 7976 t/day CO_2e after the study (~14%). Thus, the study helped in saving ~1381 CO_2e tonnes of emissions per day.

Impact of Road Condition on Fuel Consumption of Vehicles

Five roads in NCR were selected by CSIR-CRRI to quantify the fuel consumed per km for typical small car with petrol fuel, big car (SUV) with diesel fuel, and diesel truck in loaded and unloaded conditions. Fuel consumption tests were conducted on good, fair and bad condition of roads to find the fuel consumed by these vehicles for different road conditions at three steady speeds 20, 50 and 70 kmph for the test sample length of 1100 km with fuel sensor installed and road condition measured in term of IRI (International Roughness Index). Section is defined based on IRC guideline (good, fair and poor). Correlations between road condition and fuel consumption for petrol, diesel and truck were established.

This study by CSIR-CRRI showed that good roads with IRI<2.8 have lesser fuel consumption as compared to bad roads with IRI>4.00. Also, saving in fuel is observed at optimum speed of 50 kmph. Maintenance cost to maintain the roads from poor to good is estimated approximately ₹ 25.83 lakh per km /lane/year and for poor to fair is ₹ 12.04 lakh per km, whereas fuel cost for poor to good condition, poor to fair were found ₹ 14.45 lakh per km per lane/per year and ₹ 41.17 lakh/km/lane respectively. The fuel cost was estimated ₹ 41.6 lakh whereas maintenance cost was ₹ 85 lakh km/lane for poor to good for CC roads. To maintain fair to good condition, the fuel cost was estimated ₹ 15.33 lakh per lane per year verses maintenance cost of ₹ 0.5 lakh per km per lane per year. The result in this study will be guiding factor for road maintenance department for utilising the fuel loss comparison verses maintenance cost and decide priority in maintenance activity. A dissemination of the results was done by organizing a national level workshop in CSIR-CRRI on July 05, 2018.

5.4 ENGINEERING SCIENCES

Licensing of CSIR-NAL's Lead Zirconate Titanate (PZT) Powder Technology to M/s IPA Pvt. Ltd., Bengaluru

CSIR-NAL signed License Agreement with M/s IPA Pvt. Ltd., Bengaluru for "Production of

Fig. 5.4.I: PZT powder and fabricated PZT rings prepared at CSIR-NAL team, for accelerometer applications

PZT powders and the products manufactured thereof". PZT powders of high piezo properties (with piezoelectric charge constant (d_{33}) > 500 pC/N and maximum d_{33} of 700 pC/N) using the wet chemical route.

The agreement was signed for the production and commercialisation of Lead Zirconate Titanate (PZT) powder for sensor and actuation applications. PZT powder is used for fabrication of various types of components used for many engineering applications such as aerospace vibration control, precision fluid flow control, underwater sonar transducers, accelerometers, force transducers, vibration sensors, vibration energy harvesting, etc.

Performance of Confined Masonry Buildings under Quasi-Static Condition

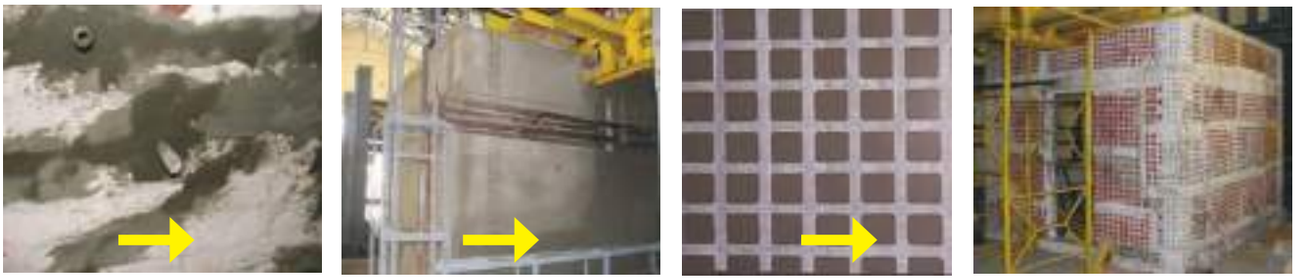
Since the dawn of civilization, masonry is the most commonly used material in building industries, especially for low to medium rise buildings due to several advantages such as resistance, acoustic and thermal insulation, simple and economic construction, etc.

However, Unreinforced Masonry (URM) buildings have proven vulnerable in seismic events, with significant building damage and numbers of fatalities, the world-over. To improve the seismic resistance of masonry buildings, different methods have been attempted over the years, leading to the concept of reinforced masonry (RM) and confined masonry (CM) systems.

Thus, to study the seismic performance of different masonry building typologies, an experimental study was performed by CSIR-CBRI 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. There is a need to explore the effective and efficient retrofitting measure for damaged CM building so as to improve its behaviour when subjected to lateral loading.

To explore the best suitable retrofitting technique, various alternate options viz. Welded Wire Mesh (WWM), Chicken Mesh (CM), Nylon Mesh (NM), Industrial Geo-grid (IG), Polypropylene Band (PB) and Plastic Cement Bag (PCB) were evaluated for retrofitting of masonry prisms and wallets. The results showed Plastic Cement bag mesh was the most effective strategy as retrofit measure. In addition, this



Preparation of plastic cement bag mesh | Cementitious grouting | Jacketing using plastic cement bag | Plastering and curing

Fig. 5.4.2: Strengthening of damaged CM building

Fig. 5.4.3: Full-scale retrofitted confined masonry building subjected to lateral cyclic load

Fig. 5.4.4: Damage pattern for retrofitted confined masonry building subjected to lateral cyclic load

material has advantages like low cost, high flexibility, minimum thickness, non-corrodible nature, adequate grip and reuse of waste material.

Figure presents the preparation of mesh from empty plastic cement bags and cementitious grouting for filling the cracks in masonry walls of CM. Subsequently, plastic mesh was fixed on both faces of masonry wall by means of epoxy and nails, which were later embedded in 15 mm thick cement: sand (1:4) mortar.

Durability Studies of Nano-Engineered Fly Ash Concrete

Mechanical and durability studies of nano-engineered fly ash concrete have been investigated by CSIR-CBRI using various concrete mixes containing 30–50% fly ash (FA), 3% silica nanoparticles (SNPs) and 6% silica fume (SF) at constant water/cement (w/c) ratio of 0.29. Durability parameters i.e. carbonation (2% CO_2, 20°C, 65% RH) and sulphate attack (5% magnesium sulphate) were used and the specimens were exposed up to 180 days. Long-term carbonation results revealed that SNPs incorporated mixes show a reduction of carbonation depth up to 73% with respect to control specimens containing 30% FA. Similarly, SNPs incorporated specimens show significant resistance towards the sulphate attack of about 39% as compared to control specimens. For the comparison purpose, SF containing specimens were also evaluated, however, higher resistance were observed for SNPs incorporated concrete specimens. Diffusion coefficient and service life of SNPs incorporated specimens were studied using Meta and Demis model, revealed exponential enhancement in the service life of SNPs incorporated concrete mixes.

Controlled electrodeposition of Iron Oxide/Nickel Oxide@Ni for the investigation of the effects of stoichiometry and particle size on energy storage and water splitting applications

CSIR-CMERI carried out controlled synthesis of nickel/iron multimetal oxides with different stoichiometry and particle sizes. Electrodeposited samples grown at different pH values showed a wide range of electrochemical properties such as dissimilar current response and potential window due to the formation of different stoichiometry and surface morphologies. Smaller particle size and higher content of NiO are advantageous due to the creation of a facile diffusion path. Moreover, electrical conductivity as well as series resistance increased for the samples with smaller particle size due to the quantum size effect. The quantum size effect was confirmed from the blue shift of the UV-vis absorbance spectrum. Finally, an asymmetric supercapacitor (ASC) cell was fabricated with electrodeposited samples, which showed a large potential window of ~1.6 V along with a high energy and power density of ~91 W h kg^{-1} and 7200 W kg^{-1}, respectively. Furthermore, the ASC exhibited very low relaxation time constant (~1.3 ms) and long stability of ~83% after 10 000 CD cycles, ensuring the effectiveness of electrodeposited multimetal oxides for energy storage as well as water splitting applications.

A novel non-enzymatic Zinc Oxide thin film based electrochemical recyclable strip with device interface for quantitative detection of catechol in water

Catechol, one of the major effluents released by various chemical and metal processing industries, causes severe pollution of groundwater. Monitoring of catechol in water using cost-effective, handheld sensor is demanding for the safety of the environment. In this work by CSIR-CMERI, non-enzymatic zinc oxide thin film based electrochemical strip sensor is developed on conducting glass substrate for detection of catechol. The preparation of strip without employing standard Pt or Ag/AgCl electrodes and simply depositing ZnO through wet chemical process represents a cost-effective innovative technique. The strip is integrated with readout meter and an algorithm is built based on the experimentally observed linear variation of amperometric current with catechol concentration. The quantitative detection performance is demonstrated by testing 0.1–12 ppm catechol solutions.

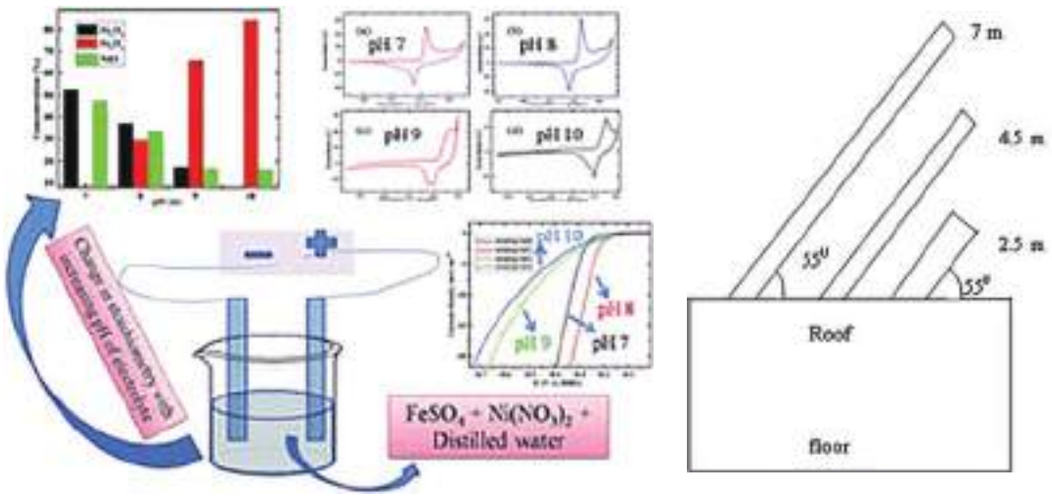


Fig. 5.4.5: Schematic representation of super capacitor cell with electrodeposited samples, showing large potential window for energy storage and water splitting applications

Design of notch to distress the goaf edge pillars to enable coal extraction under massive strata

The trial and errors method are generally practiced to determine geometry and pattern of the blast holes parameter to create a suitable sized notch in B&P method of coal mining.
A detailed designs of notch to weaken the overhanging roof strata at the goaf edge has been developed by CSIR-CIMFR to optimize the cost and safety. The developed designs and their results have been crosschecked with the experimental observations.

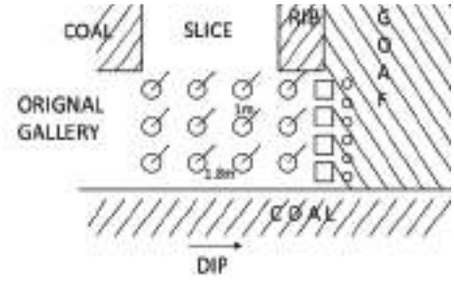


Fig. 5.4.6: Blasting patterns used for creating goaf edge notch

A Hybrid Structural Health Monitoring Technique for Detection of Subtle Structural Damage

There is greater significance in identifying the incipient damages in structures at the time of their initiation as timely rectification of these minor incipient cracks can save huge maintenance cost. However, the change in the global dynamic characteristics of a structure due to these subtle damages are insignificant enough to detect using the majority of the current damage diagnostic techniques. Also, the sensitivity of global dynamic characteristics like modal frequencies and mode shapes depends on the spatial location of these subtle damage. In view of this, a hybrid damage diagnostic technique for detection on minor incipient damages in the structures is developed by CSIR-SERC. In this hybrid technique, modal-effective-damage is identified rather than damage, by isolating the modes affected by the subtle damage in the structure.

5.5 INFORMATION SCIENCES

High Performance Computing and Cyber Security- Adaptive Traffic Signal Control in Vehicular Networks: Simulation model developed

Existing road intersection management is done through traffic lights. The inefficient traffic light control causes numerous problems, such as long delay of travellers, huge waste of energy and worsening air quality. It may also contribute to vehicular accidents. Artificial Intelligence provides the ability to continuously learn to augment its ability to make good judgment by recognizing its surrounding. Reinforcement learning (RL) is a part of machine learning paradigm where an agent aims to maximize the reward by choosing the right action, by interacting with the environment repeatedly to develop a suitable policy. The comparison in traffic condition with and without using the Reinforcement learning. Here, the number of vehicles on the road at a time is treated as the parameter to define the performance. It can be seen that, in the initial stage, there are not much improvement in the case, where the signal is controlled using RL. However, as the time progresses, the RL learns from the traffic pattern and improves the traffic condition. The results are an outcome of the simulations carried out using SUMO (Simulation of Urban Mobility) model by CSIR-4PI.

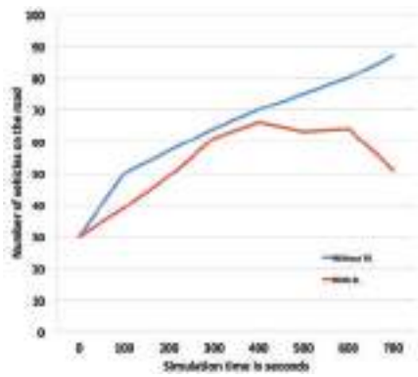


Fig. 5.5.I: Number of vehicles on the road for the two scenarios of traffic control (one with RL and one without RL). Decrease in the number of vehicles on the road is an indication of the increase in efficiency

CONTRIBUTION TO GoI MISSIONS

CONTRIBUTION TO GoI MISSIONS

6.1 CONTRIBUTIONS TOWARDS SWASTH BHARAT MISSION

CSIR laboratories have been making efforts towards drug discovery and development for disease areas of national interest and global relevance. The R&D is also being done in the areas of Diagnostic & Therapeutic devices, Rehabilitation & Assistive technologies, Imaging based medical devices and Advanced manufacturing based orthopaedic implants. Some of technology contributions towards Swasth Bharat Mission are as follows:

- **Diagnostics for Genetic Diseases**: CSIR-IGIB has developed low-cost genetic diagnostic assays for application in clinical settings which can help to understand the mutation spectrum of genetic diseases in the country for three major disease classes spanning Neurology, Cardiology and Genodermatoses. 27 Gene tests have been transferred to Dr Lal Path Lab Pvt. Ltd. CSIR-CCMB also provides genetic diagnostic services for close to 30 such monogenic disorders. The strategy is to identify the causal genetic defect, screen individuals in the family for carrier status, tracking inheritance of the genetic defect in the fetus by performing prenatal diagnosis on fetal samples (procured at appropriate stage of pregnancy through hospitals) and genetic counselling. The diseases being analysed include Hemoglobinopathies, Musculopathies, Bleeding and clotting disorders and Neurodegenerative diseases. Genetic testing has been conducted for over 1500 referred patients in the year 2018-19.
- **Saffron Based Nutraceutical for Brain Health:** CSIR-IIIM has developed saffron based nutraceutical lead IIIM-141 for brain health. This product has been out-licensed to the M/S Pharmanza Herbal Pvt. Ltd. (Gujarat) in July 2018, for launching it in the US and Indian Market as a nutraceutical product for brain health. This nutraceutical product will be specifically beneficial for people, who are at higher risk of developing Alzheimer's or dementia, including the patients with early onset of disease.
- **Food for Wellness**: Improved Samba Mahsuri Rice of low Glycemic Index: Improved Samba Mahsuri rice variety (ISM) developed by CSIR-CCMB has another unique feature of low glycemic index (i.e. a value of 50.99), which is amongst the lowest value for several rice varieties tested. Foods with glycemic index (GI) value below 55 (like ISM) are considered highly suitable for consumption by patients suffering from diabetes as consumption of foods with low GI results in slow release of glucose into the bloodstream, thus reducing the ill effects of the diabetes. Thus ISM, in addition to possessing desirable attributes like high yield, fine-grain type, bacterial blight resistance, premium market price etc., also has a unique advantage of low GI, thus enhancing its market potential and profit earned by the farmers.
- **Medical grade SS surgical needles:** CSIR-NAL in collaboration with M/s Sutures

Fig. 6.I.I: Medical grade SS surgical needles before and after electropolishing

India Pvt Ltd, has developed electrolyte formulation for the electropolishing of SS surgical needles. Images of the polished and unpolished biomedical grade SS surgical needles. The performance of developed process (NALEPSS) is comparable with the existing commercial process used by the firm. Bath replenishment and effluent treatment procedures have also been established and training has been given to M/s Sutures personnel on the entire process. These needles are extensively used in government hospitals.

- **Drug discovery and Development:** CSIR-IMTECH has contributed in the area of antimicrobial resistance and its remedial measures. CSIR-IMTECH has discovered a new antibiotic which works against colistin-resistant *Klebsiella pneumonia*. Pre-clinical development of this antibiotic is under progress. Similarly, CSIR-IMTECH has developed efflux pump inhibitors against different pumps exists in Gram positive and Gram negative bacteria and established the valuable data in combination of FDA approved antibiotics. At present, pre-clinical development work is undergoing in association with NIPER Mohali.
- **Full scale automated ghani plant** designed, developed, fabricated & installed under CSIR-NMITLI Programme for production of mustered oil by converting traditional ghani plant under NMITLI Project. The fully automated pilot plant would help oil industry in maintaining high hygiene standards, improving quality of the product, increasing productivity, reducing labour dependence and harsh working conditions.
- CSIR-CEERI has also developed a real-time remote milk supply chain monitoring network called 'PRADUMN' which comprises of an integrated milk quality monitoring system for real-time remote monitoring of milk supply chain starting from village level to dairy. Integrated milk quality monitoring system comprises of Ksheer Scanner Plus which provides milk adulteration check and measurement of milk quality parameters (fat, solid-non-fat, protein, lactose and percentage of added water) embedded with a wireless communicating device.
- **Devices for Halthcare:**
  - CSIR-CSIO has developed an affordable Postural Stability Assessment System for balance assessment relearning with the help of Biofeedback based therapy tools. Postural Assessment System is safe to use as a training tool for sit-to-stand, stand-to-sit, joint movements for stance and gait analysis. The developed foot pressure sensor is used for assessing balance stability of individuals:
  - CSIR- CSIO has developed a wheelchair (Intelligent Patient Vehicle) through finger gestures on the touch screen device for paraplegic people The technology is affordable and useful for weak upper limb persons with motor disability as no such technology

is available in India. Moreover, the imported non-graphic touch pad based solutions costs 20 times with no scope for customization / feature addition.

6.2 CONTRIBUTIONS TOWARDS SWACHH BHARAT MISSION

- **Utilization of industrial solid wastes in manufacturing of building bricks:** Reuse of waste in integrated steel plants is important with regard to environmental and economic consideration. CSIR-IMMT has developed an innovative process of effective utilization of various industrial and mining wastes in manufacture of cold setting building brick.
- **Bio-methanation of coal rejects/ low grade coal and biomass and Demonstrated model at village Gaurigram, Chandankiyari, Dhanbad, Jharkhand, India:** Gaurigram village is located in the Chandankiyari block, one side being guarded by Damodar and other sides with adjacent villages. Coal washery reject and abundant organic waste (poultry waste, agricultural waste, cow dung, kitchen waste) is available in Gaurigram village in plenty that can be effectively used for bio-methanation process. CSIR-CIMFR interacted with the villages and apprised them about the features and application of bio-methanation, developed CROW model coal reject/ low grade coal-biomass based rural bio-methane reactor; and Up-skilled the villagers about operation of the Bio-Reactor.
- **Application of Biomethanation technology for waste disposal:** Approximately 350 to 400 million tons of organic waste (food waste, livestock waste, agriculture waste etc.) is generated in India and the scientific disposal of the waste is highly essential. In this context, resources recovery through eco-friendly and economically viable processes are gaining significance under Swachha Bharath Mission (SBM) initiated by Government of India (GoI). Keeping this in view, CSIR-IICT has made intensive research efforts and developed a state of art patented high rate biomethanation technology called "Anaerobic Gas Lift Reactor (AGR)" for the generation of biogas and bio-manure from organic solid waste. AGR technology is superior as it incorporates novel features required for the biomethanation of organic solid waste as per its characteristics. Presently, seven plants are working at The Akshaya Patra Foundation (Bellary & Hubli in Karntaka; Rourkela in Odisha; Vrindavan in UP;

Fig. 6.2.1: CSIR-CIMFR CROW model Coal reject/low grade Coal-biomass based Rural Bio-methane Reactor

Fig. 6.2.2: CSIR-CIMFR Scientists up-skilling the villagers about the operation of the Bio-Reactor

Ahmadabad, Surat & Bhavnagar in Gujarat) for the treatment of food waste (one ton per day) based on AGR Technology where midday meal is cooked for about 7 lakh school children using the biogas generated from these plants. In addition to this, 8 more plants (capacities in the range of 250 k to 10 tons per day) are working across India for the treatment of food waste, market vegetable waste, landfill leachate, organic fraction of MSW, poultry litter, cattle manure etc. The following plants were installed in India for the FY 2018-19

Fig. 6.2.3: Waste to Biogas based power based at Jawaharanagar, Hyderabad

Fig. 6.2.4: Full scale biogas plant for the treatment of food waste at Kurnool, AP

Fig. 6.2.5: Full scale biogas plant for the treatment of food waste at Capgemini, Hyderabad

- **Wastewater Treatment Technology with emphasis on "Betterment of the Well Water Quality":** In modern age, effluent water from various industries is of deepest concern, which is highly responsible for aquatic pollution especially in India. The wastewater can be treated in wastewater treatment plants through physical, chemical and biological treatment processes. This method developed by CSIR-CMERI has some environmental benefits compared to other conventional methods (coagulation, electrodeposition, reverse osmosis etc.) for wastewater treatment.
- **Events and training programmes:** CSIR Laboratories beside undertaking R&D and technological developments, organized "Swatch Bharat Abhiyan Pakhwara" and organized activities like essay writing, quiz, tree plantation, cleanliness of premises, offices and laboratories, public awareness programmes, to contribute in the mission.
- CSIR-SERC has developed a Precast Ferrocement Toilet Core Unit (Prefer Toco) technology as a solution for quality and speedy construction of toilets which are required on a massive scale, especially to promote the Swachh Bharat Mission. The developed Toilet Units are modular and portable and requires minimum site work
- CSIR-CEERI has developed an Internet of things (IoT) enabled platform system for NH_3, CO and H_2S sensing, which enables to monitor the gas levels at desired location. Developed systems include indigenously developed metal oxide MEMS gas sensors, electronics and smart algorithms.

6.3 CONTRIBUTIONS TOWARDS SASHAKT BHARAT MISSION

- **Licensing of DHVANI & ABHIAS – An Electronic Target Systems for marksmanship training to BEL, Bangalore:** CSIR-NAL has developed Acoustic Based Hit Identification and Analysis System (ABHIAS) for marksmanship

Fig. 6.3.I: ABHIAS

Fig. 6.3.2: DHVANI

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 has been fully developed and the technology along with Detection and Hit Visualization using Acoustic N-wave Identification (DHVANI) has been transferred to BEL, Bengaluru for production, marketing and after sales service. Apart from low maintenance cost, this indigenous system is 60% of the cost of comparable imported system.

- **Vehicle Detection and Classification System:** Vehicle Detection and Classification System (VDCS) is a sensing module, which keeps on monitoring the perimeter and does a primary classification of moving targets such as vehicles, personnel using seismic, acoustic and thermal imaging sensor. On detection and classification of vehicle it generates command and prompts to take further appropriate action. During the year, the engineering unit of VDCS has been designed by CSIR-CSIO and integrated for field trials.

- **Extraction of tungsten values from Hutti gold mine tailings concentrate and scrap:** The strategic metal tungsten finds major applications in defence particularly for the ammunition used in anti-tank warfare and pre-fragments in missile warheads and rockets, which are based on heavy alloys containing about 90% of tungsten by weight. CSIR- IMMT has been working on development of a suitable technology for the extraction of tungsten from Hutti gold ore tailings and tungsten based heavy alloy scrap. Bench scale testing of the process flowsheet in lock cycle at 1 kg scrap processing has been achieved with confirmed recoveries and product quality. Similarly, bench scale testing of another process for recovery of tungsten from Hutti tailings at 1 kg scale was successfully tested.

- **CSIR Aroma Mission-Farmer centric S&T Interventions for Socio-economic Development:** Under CSIR Aroma Mission, CSIR-CIMAP has organized 139 awareness programs in the year 2018-19 and trained 7539 manpower all over India to boost the cultivation as well as value-addition of aromatic crops with the mission's aim of doubling the farmers' income and

helping the country to emerge as a global leader in the production and supply of essential oils. CSIR-CIMAP distributed 300 quintals of Mentha suckers on the occasion of Kisan Mela to the Mentha growers which was attended by about 7000 farmers and entrepreneurs from different parts of the country. The total yield of this planting material itself would generate gross return of about ₹ 15 crores in a span of 3 months.

- **Commercial deployment of salt and potash technologies to augment National capability:** CSIR-CIMFR has developed the basic process for preparation of slow release potassium fertilizer from combustion waste of biomass based power plants (Patent applied 0197INF2016). Potassium from the waste ashes was extracted in few inventive steps without using any harmful acids. Laboratory process developed has been demonstrated in a bench scale reactor (1 kg/batch), now the process is being studied in a 100 kg ash/ batch reactor. The fertilizer has been tested by CSIR-CSMCRI, ICAR- Indian Institute of Sugarcane Research, Lucknow and found encouraging results.
- **Traceability and calibration and testing services to use industries:** Many equipment is being imported by the Indian industries, strategic sectors etc. and requires measurement traceability on regular basis to yield quality products. CSIR-NPL, the NMI of India, has provided traceability and apex level calibration and testing services to user industries for various types of instrument for the measurement of time, mass, length, nano-metrology, temperature, optical radiation, resistance, DC & AC higher voltage, AC power meters, current, LF, HF impedance, DC metrology, force, pressure, vacuum, ultrasonic, acoustics, vibration, gas metrology, fluid flow metrology, and humidity. Overall, CSIR-NPL has generated approximately 2500 calibration and testing reports. It saves considerable foreign exchange and time to enable faster services if these services would have been hired from abroad. Beneficiaries include Strategic sector (ISRO, DRDO, Defence), Public sector (STQC, ERTL, ETDC, NTPC, NHPC, CPRI, BHEL, BEL) etc.
- **CSIR-NAL support to ADA's LCA-Tejas Programme:** CSIR-NAL continued its

Fig. 6.3.3: Control laws successfully flight-tested for air-to-air refueling

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. For Series Production programme of LCA-Tejas, nine sets of Fin and Rudder assemblies from SP 11 to SP 19 aircraft were delivered (with production partner TAML). All seven types of Centre Fuselage parts were supplied as per the commitment to HAL. Four sets of MLG Aft doors with fairings were also delivered for SP16 to SP20. Further, the National Control Law team, with its work centre at CSIR-NAL, successfully completed the Air-to-Air Refueling activity on LCA Airforce Mark-1 aircraft.

- **Trainings/ support to farmers and students:** CSIR-CCMB distributed a non-transgenic Improved Samba Mahsuri (ISM) rice variety seeds in Andhra Pradesh, Telangana, Tamil Nadu & Uttar Pradesh to aid farmers grow improved rice and keep seed for next season without depending on seed companies.

6.4 CONTRIBUTIONS TOWARDS MAKE IN INDIA MISSION

To support the mission, CSIR Laboratories across various domains, have significantly contributed by developing processes, technologies and establishing facilities. CSIR has and supported the Indian industry by transferring the know-how, providing incubation facilities and requisite trainings. A brief about the tools/technologies:

- **Design and Development of Mob Control Vehicle (MCV):** CSIR-CMERI has initiated the design and development of Mob Control Vehicle (MCV) with the aim of better control of ingress and dispersion of aggressive mob in riotous situations. The design and development team comprising members from various R&D research Groups of CSIR-CMERI has been working in close coordination with Ministry of Home Affairs (MHA), Govt. of India, Ministry of Defence and various stakeholders like CRPF-RAF, BSF and Ordinance Factory Board (OFB) for getting their valuable inputs in deriving the system specifications.

  The first prototype MCV has been built on a bus augmented with advanced electronics and control system and suitable for CRPF/RAF for mob control. The vehicle is augmented with dash board integrated display of GPS tracker and Navigator, stitched image display from front cameras, Rear View Camera, Joystick operated Pan Tilt MBL (Multi Barrel Launcher), Multi-channel video transmission system to command and control centre along with Multi-copter surveillance system and irritant spraying system to disperse mob surrounding the

  The second prototype MCV has been built on a tractor fitted with hydraulically

Fig. 6.4.1: MCV-Bus Type

Fig. 6.4.2: MCV-Tractor Type

operated retractable shields and suitable for Police and BSF. Other significant features include hydraulically operated platform; IR Bullet front view, rear view and side view cameras; PTZ camera with 360-degree view mounted on a hydraulic operated platform with controller

The 2nd phase of the project deals with detail design and development of the vehicle with features integrated in Phase-I and users' feedback received through demonstration of "Proof of the Concept" prototype. Design and testing of various modules in the second phase has already been commenced.

- **Project on catalysis for sustainable development:** CSIR-NCL has developed and patented clean burning dimethyl ether (DME) production technology from methanol dehydration. the technology is ready for pilot scale demonstration. DME can be blended with LPG (max. 20%) and diesel (max. 40%) as it has several fuel properties including high cetane number. Commercial production of DME is expected to save large Forex. Clean burning increases the fuel efficiency and minimizes pollution. Smaller production units can be accommodated in ships and DME can be used for entire energy requirement of ship, and would contribute to Sagarmala scheme
- **Colour shift protein film for use as a security feature in anti-counterfeiting:** CSIR-IMTECH identified a novel route for entrapment of colour shift bacteriorhodopsin protein on porous paper. The Blue and yellow filter were masked at the top of the porous paper and deposited protein film at the bottom of porous paper. The Blue will not allow the normal light to pass through the filter so there is no change in the protein film colour. Whereas yellow filter will allow the light to pass through and there is a change in the colour from purple to yellow. Within a few seconds the yellow will revert back to the original purple colour under non-illumination conditions using Torch light. This novel colour shift protein film using blue and yellow filters can be used as a security feature in anti-counterfeiting and color shift applications.
- **CSIR-CIMAP field distillation units of various capacities:** Designing, fabrication, installation, commissioning and providing training to farmers for directly fired type,

Fig. 6.4.3: 24 Units installed in 2018 in 13 states throughout the country

cohobation & boiler operated improved field distillation units of varying capacities & designs under CSIR-Aroma mission project and consultancy projects in farmers field in several states of India have been taken up for distillation of aromatic oils. The units have been technically modified with improvements in the design of calandria and condenser to increase the efficiency.

- **Crucial Qualification test of LCA Fuel Drop Tank of Tejas:** CSIR-SERC, Chennai was entrusted with the challenging task by Aeronautical Development Agency (ADA), Bengaluru. The 1200 Lt fuel drop tank of Tejas (5 m long and 640 mm diameter) to be qualified for slosh and vibration loadings simultaneously as a mandatory requirement. The Aeronautical Development Agency (ADA), Bengaluru has designed and developed the Light Combat Aircraft (LCA) - Tejas, for the Indian Air Force, with Hindustan Aeronautics Limited (HAL) as the Principal Partner and with other agencies including CSIR.

  The crucial qualification test on the fuel drop tank with 2/3 water filled has been carried out at the Fatigue & Fracture Laboratory along with the Advanced Seismic Testing and Research Laboratory of CSIR-SERC. CSIR-SERC has developed the test methodology to carry out this crucial and complicated qualification test for the first time in the country along with ADA and HAL. The simulation test was carried out using a specially fabricated test fixture developed by CSIR-SERC. The fuel drop tank withstood 25 hours of sloshing and vibration and 15 hours of only sloshing as per MIL Standards and complied. These very important and crucial tests are a FOC (Final Operation Clearance) requirement for enhancing the drop tank life to 3000 flying hours and to obtain the full certification.

Fig. 6.4.4: Crucial Qualification test on the fuel drop tank

- **A certified agency for Air Pollution Monitoring Equipment:** CSIR-NPL established of a National Calibration Facility for PM1, PM2.5 and PM10 sampling inlets and commercialization of indigenously developed high-volume PM2.5 sampler by the M/s Environmental Solutions from the know-how of CSIR-NPL patented technology. CSIR-NPL has been designated as 'Certifying Agency for Air Pollution Monitoring Equipments' by the Ministry of Environment, Forest & Climate Change. Facility ones established will provide a complete and cost effective solution for test, calibration and certification of `Online Continuous Emission Monitoring System (OCEMS)', `Continuous Ambient Air Quality Monitoring System (CAAQMS)' and PM2.5/PM10 samplers to the Indian as well as foreign manufacturers.
- **Reformulation of LPG Sweetening catalyst and its international commercialization:** CSIR-Indian Institute of Petroleum (CSIR-IIP) in collaboration with Bharat Petroleum Corporation Ltd (BPCL) developed a catalyst Thoxcat ES useful for sweetening of LPG. The rights of production have been licensed to LONA Industries, Mumbai. This catalyst has been commercialized in 2007. This catalyst is covered by 9 Indian and International patents and running successfully in 10 refineries including one abroad. This is an important Make an India Initiative. To increase our market share, CSIR-IIP and BPCL (R&D) are jointly working to implement the catalyst in refineries outside India also (starting with the relatively easily accessible Middle East (M.E.).

Fig. 6.4.5: The first bio-jet fuelled plane makes a successful touchdown at the Delhi Airport

- **Bio-Jet Fuel from non-edible oil sources:** CSIR-IIP developed a process which is a single-step process for the production of bio-jet fuel from non-edible oil sources. The process is a novel single-step catalytic process based on non-edible, waste, low cost oils to produce drop-in biofuel for air-transport purposes. The product yield is 35-55% and with properties and compositions meeting the specification required for aviation fuel (ASTM D1655 and ASTM D4054). It also meets ASTM D7566 after aromatics removal.
- **Paper-based microfluidic kit for early detection of pregnancy in cattle and buffaloes:** CSIR-CCMB with the aim to help the dairy/animal husbandry industry has developed a paper-based microfluidic kit for early detection of pregnancy in cattle and buffaloes. Once pregnant, the animal needs to be fed with a highly nutritious diet. When the breeders start feeding them this diet when they are unsure if the animal has conceived, it adds to the breeders' expense. Currently pregnancy detection in cattle employs methods like rectal palpation, ultrasound sonogram and estimation of hormones in milk and blood – all of which requires skilled labour. On the contrary this paper-based microfluidic kit can be used by unskilled labour. It does not require a cold chain for transporting it. The kit is sensitive enough to check for a month old pregnancy. The simplicity of the kit also makes it highly affordable at a potential cost of ₹ 30 per test.
- **Indigenous technology capability in glass and ceramics:** Five component borosilicate glass beads have been developed by CSIR-CGCRI in partnership with industry. High-density glass cullet for radiation shielding applications with provision for scaling up the size of glass slabs are also being produced in partnership with industry. One of the major focus is capacity strengthening for the manufacturing process whereby a high-volume refractory pot has been developed through slip casting technique. The aforesaid activities have accelerated indigenous technology capability development and consolidation in a key domain where technology might not be available from outside.

6.5 CONTRIBUTION TOWARDS NAMAMI GANGE MISSION

- **Contributions to reduce/prevent the pollution load from tanneries in Ganga River basin:** Leather manufacturing units in the central region are located predominantly in Ganga river basin in Jajmau, Banthar and Unnao. The leather industry is associated with significant wastewater discharge and environmental impacts. CSIR-CLRI has made the following significant contributions to reduce/prevent the pollution load from tanneries.

  Waterless Chrome tanning technology of CSIR-CLRI has been implemented in about 12 tanneries in Kanpur and Zero wastewater discharge technology has been implemented in about 3 tanneries in Kanpur towards clean ganga.

- **Development of Algorithms for the River water quality monitoring using Hyperspectral Imaging and Machine Learning techniques:** Water pollution is a major environmental issue in India. Most rivers, lakes and surface water in India are polluted. The largest source of water pollution in India is untreated sewage. Other sources of pollution include agricultural runoff and unregulated small scale industry. Ganga, the most sacred river and lifeline to millions is also getting polluted due to anthropogenic activities. CSIR-CSIO developed algorithms to map the river quality using Hyperspectral Imaging and spectro-radiometer data so as to effectively map and manage the sources of pollution. The water samples were collected from Ganga river at Prayagraj after the Kumbhmela and are being analysed for the development of prediction models for chlorophyll-a, total suspended solids, color dissolved organic matter, total phosphorous and turbidity in the water.

- **Water and Soil quality testing:** CSIR-IITR team collected soil sample along the entire stretch of Gomti River, Lucknow for the determination of different pollutants. A total of 39 samples were collected and evaluated for the range of metals Zinc, Manganese, Iron, Copper, Arsenic, Lead, Cadmium, Chromium and Nickel. The concentration of iron in the studied samples was found to be highest among the essential metals in landfill sites near Gulalaghat. 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.

- CSIR-NAL has developed indigenous advanced polymer composite processing equipment, such as Microwave autoclave, desktop autoclave and multi zone hot bonder to strengthen the eco-system related to aerospace sector in the country. The developed products are low cost and energy efficient for addressing composite process and repair requirements which would strengthen the eco-system related to aerospace sector.

- CSIR-NAL has designed and developed & certification of FPGA based IP core 818 as a part of the international standard RTCA DO-254 for avionics video and data widely used in Civil and Defence advanced display systems was obtained CEMILAC certification. The technology reduces the number of voluminous bundles of wires used for communication reducing all them into couple of fibre channel interfaces;

- CSIR-CSIO developed a technology of Military Head Up Display Test Platform incorporated as part of Aviation Cockpit Display Validation Platform – ACDVP. It is used to evaluate the electronic, optical and mechanical interface functionality of the cockpit displays and optronic systems which includes verification of performance and design parameters. This platform makes the process of automated testing & debugging less time consuming for ground staff and Maintenance Personnel.

- CSIR-CSIO developed NVG compatible LED lights for Helo Deck Visual Landing Aid System (HVLAS) on Indian Navy Ships

- CSIR-CFTRI has developed a technology for developing carbonated fruit juice beverages containing natural fruit juice/pulp in concordance with FSSA regulations for fruit juice beverages.

6.6 CONTRIBUTION TOWARDS STARTUP INDIA MISSION

CSIR constituent laboratories are continuously providing support and nurturing start-up companies entrepreneurs through technology incubation centres, technology transfers, skill enablement etc. Few notable contribution towards the "Start-up India" mission during the year 2018-19 are as follows:

- CSIR-CIMAP is supporting 'Startup India' program through its Technology Business Incubation Centre (TBIC) in Lucknow campus. The institute supported production work of about 20 start-ups/entrepreneurs to promote its technologies of CSIR-CIMAP.
- CSIR-CSMCRI's knowhow related to preparation of Liquid Seaweed Plant Bio-stimulant (LSPB) from brown algae – Sargassum, Shri Tejas Mevada has formed a start-up company by the name of Purvraj Agro Industries Pvt Ltd, at Ahmedabad and has taken licence for the this knowhow.
- Development of Solid-state cooling refrigerator for storage of food stuff for common usage and vaccine for medical sector usage. This technology by CSIR-NPL has been selected as a winner for the top 11 technologies by Tata Trusts under social alpha energy challenge. The technology has also been selected for the incubation at their International energy incubation centre.
- CSIR-IITR established a Centre for Innovation and Transnational Research (CITAR) to support incubation for start-ups, joint R&D programmes with industries and use of advanced R&D facilities. Two companies' viz. M/s SS

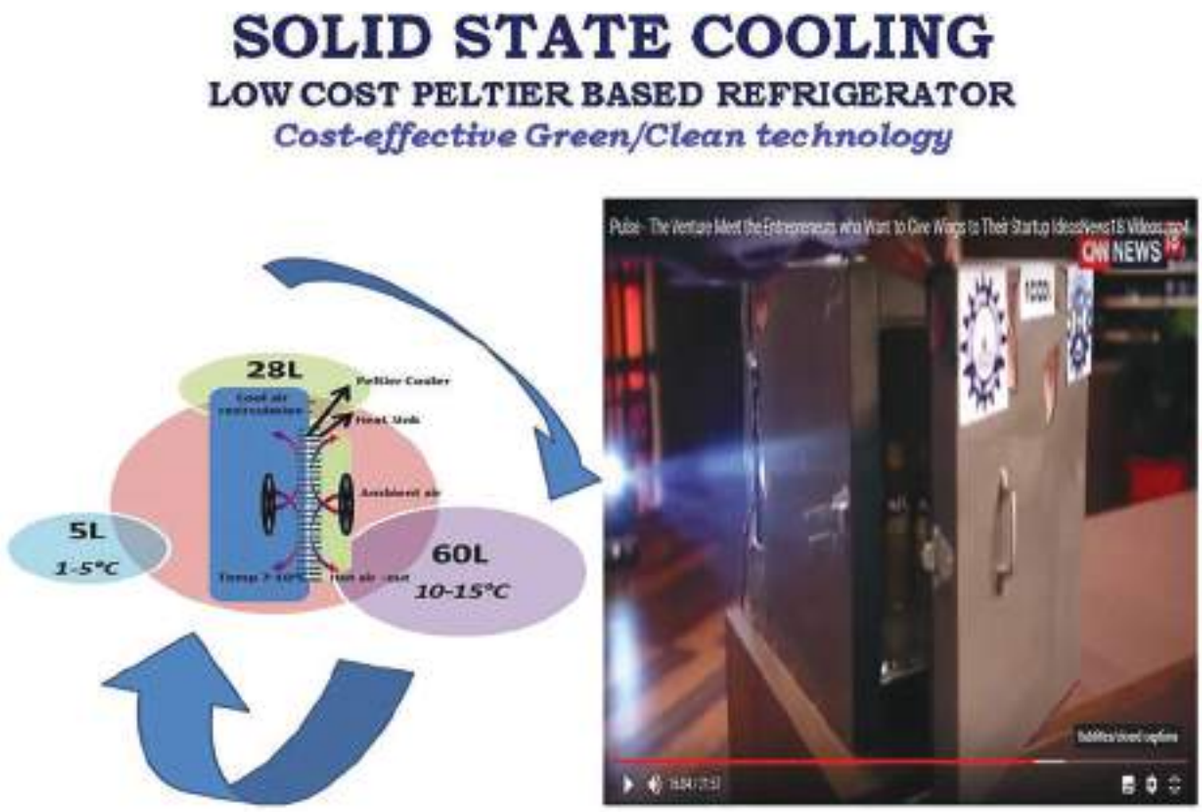


Fig. 6.6.I: Solid-State Peltier-based low-cost refrigerator

Fig. 6.6.2: Solid-State Peltier-based low-cost refrigerator technology has been selected for the incubation at Tata Trusts International energy incubation centre

Medical systems (I) Pvt Ltd, Uttarakhand and M/s Bacti Barrier India Company, New Delhi worked at CITAR, CSIR-IITR in the area of microbial disinfection and sterilization during the year 2018-19. The joint ventures lead to the development of mature technologies for which the patents are filed and both the companies successfully graduated in March 2019. It is important to mention that the M/s SS Medical systems (I) Pvt Ltd, Uttarakhand also taken the technology of "ONEER" developed by CSIR-IITR for commercial venture.

- CSIR-IICT has played an instrumental role in nurturing about 10 Start-ups during 2018-19.
- Atal Incubation Centre at CSIR-CCMB (AIC-CCMB) under the Atal Innovation Mission of NITI Aayog has incubated 19 early stage life science start-ups in 2018-19. The areas of interest of these start-ups range from diagnostics and vaccines development, biosimilar production, drug discovery in human and animal healthcare. One of the

incubated companies, Magellan Life Sciences has successfully graduated from AIC-CCMB. Magellan Life Sciences focuses on producing Brazzein, a natural sweetener on a large scale, and are now based out of UK. Their work is expected to positively impact the food industry in a huge way. To encourage young life scientists and handhold budding life science entrepreneurs in the city of Hyderabad, AIC-CCMB conducts regular networking sessions and training workshops.

- **Seaweed Technology:** CSIR-CSMCRI has licensed technologies viz., - "Process for preparation of Liquid Seaweed Plant Bio-Stimulant (LSPE) from brown algae – Sargassum" and Process for liquid seaweed bio-stimulant from red algae – Kappaphycus to five start-up/small scale manufacturing companies in India. The fresh seaweed as harvested from both wild (in the case of Sargassum) and cultivated (in the case of Kappaphycus) are liquefied to produce a sap that proved to be a promising low cost bio-stimulant (foliar spray) from field trials on various crops with improved productivity.

6.7 CONTRIBUTION TOWARDS SKILL INDIA MISSION

- **CSIR Jigyasa: Student scientist connect programme:** CSIR and Kendriya Vidyalaya Sangathan (KVS) signed an MoU on Scientist – Student Connect programme 'Jigyasa' on 6th July, 2017 in the august presence of Minister for S&T and Minister for Human Resource Development. Jigyasa program aims to inculcate scientific temperament among school kids, inspire young minds about scientific research, and to ignite the spirit of scientific thinking at an early age. The program is a unique platform for bringing in teachers and scientists for nurturing young minds. The program envisages opening up the national scientific facilities to school children, enabling CSIR scientific

Fig. 6.7.I: Glimpse of activities with Jigyasa programme

knowledgebase and facility to be utilized by schoolchildren. Some major highlights of Jigyasa program are as follows:

- More than 74,604 students and 6155 teachers from various schools visited CSIR laboratories
- 2-3 days Teachers' Workshop was conducted by many CSIR laboratories providing 'Hands-on' training.
- Young Scientist Competition and Budding Innovator Camp (EPIC 2018) was organized at CSIR-IITR and various hands-on sessions on microscopy, molecular biology techniques, food toxicology, neurotoxicology, computational biology, nanotechnology, drug design, etc. and porotypes development of their proposed idea was discussed.
- CSIR-NEERI conducted hands-on science experiments, Science with fun, Project work, Quiz to KV and Government schools
- CSIR-NEIST conducted Teachers workshop on learning Science & Dissemination.

6.8 CONTRIBUTION TOWARDS DIGITAL INDIA MISSION

- **AnalytiCSIR:** An online web portal, has been developed by CSIR, which provides access to its state-of-the-art analytical facilities and services of CSIR laboratories across the country. The CSIR's constructive move, will be a great asset to students and researchers of all facets of science and engineering in the country, who do not have access to sophisticated scientific equipment to carry out research of global impact.

  AnalytiCSIR v1.0 (first version), has been featured with the details of the available scientific equipment and research facilities at various research laboratories under the umbrella of CSIR and provides access to book the services of these facilities. The AnalytiCSIR e-portal was pre launched by DG, CSIR on 9th February 2019, during the Director's Conference in Dhanbad, which initially limited for the intra and inter-lab usage. This internal exercise will enable to assess and streamline the performance of the portal, before it is extended to all the institutions Accordingly, soon the process is streamlined and found robust, it will be extended to all students/ academia/ industries/other public sector laboratories within the country. CSIR-IICT, Hyderabad has carried out the design, development and execution of the AnalytiCSIR Web portal.

  Presently the facility includes 1281 equipment at 35 CSIR labs across India offering 1828 tests. The portal contains dashboards covering sample & test management, payment confirmation and test reporting, monitoring of lab-wise test bookings and earnings.

- **Mobile App for Smart Directory:** Computer Networking & e-Management Department of CSIR-IMMT implemented and updated a Mobile App for Smart Directory. It also provides quick links for Announcements, News and other repositories.

- **CSIR-AROMA Mission Web Portal:**

  In order to connect various activities under the CSIR Aroma Mission to various stakeholders, CSIR-CIMAP developed a web portal (http:// aromamission.cimap.res.in), which was successfully launched on 4th August 2018 in Bengaluru. The web portal is a dynamic website which publishes various activities and progress under the mission. The website offers the facility of registration to the beneficiaries, buyers and fabricators under the Aroma Mission. It allows sharing of ideas, thoughts and suggestions with the Mission Director and other participating lab directors in addition to the feedback mechanism. The system has an in-built email and SMS facility as well.

  Three short video films were developed on Mentha, Vetiver and Lemon Grass under Aroma Mission program.

Fig. 6.8.1: Mentha, Vetiver and Lemon Grass

- **E-portal for Central Facility**
  - Help Desk for various complaints and its online tracking.
  - Central facility sample and instrument requisition and tracking for the users registered in the portal.
  - The National Mission, for social, economic and strategic growth, intends to the creation of new secondary time scale labs to synchronize all the device clocks in the country within one second of the Indian Standard Time (IST). An MoU was signed between CSIR-NPL and with the Ministry of Consumer Affairs on 28th December 2018 for the establishment of such dedicated laboratories of Legal Metrology Department in five cities, namely Ahmadabad, Bangalore, Bhubaneshwar, Faridabad, Guwahati along with one disaster recovery centre in Bangalore with traceability from National Time (IST).
  - To promote digital technologies, CSIR-NISCAIR has initiated the technical services for library modernization for S&T institutions.
  - CSIR-IHBT has prepared a hyperspectral library (http://nisa.geos.iitb.ac.in) consisting of spectral signatures of 42 tree species recorded during field surveys from various localities of Himachal Pradesh representing altitudinal transect from 511 to 2399 m amsl. The hyperspectral library from vegetations is collection of its reflectance simultaneously in hundreds of narrow adjacent spectral bands.
  - As part of Digital India initiatives, CSIR Mission - Mode Programme on Food and Consumer Safety Solution – (FOCUS) Website – Launched by Hon'ble governor Shri Ram Naik, Uttar Pradesh in the presence of Professor Alok Dhawan, Director, CSIR-IITR on Sep 14, 2018. This webportal contain the technological solution developed by CSIR and various databases on food safety. This portal serve as a Food Safety Gateway of CSIR.
- **Self-service Communication Kiosk:** CSIR-CMERI developed technology of digital communication such as e-kiosk. It is a self-service and integrated communication system suitable for installation in public places with minimal operator intervention. This system is perfectly customizable and can be used for any communication related applications. This system is designed to work with various optional channels of communications like 3G/4G data connectivity, broadband, LAN and WiFi.
- **i-Smart Street Light:** CSIR-CMERI has developed a smarter approach towards Energy Savings and Reduction of Environmental Pollutions. i-Street Lighting (Intelligent) is a solution towards energy savings and reduction of light pollution. The combination of advanced motion

Fig. 6.8.2: Hon'ble governor Shri Ram Naik, Uttar Pradesh launching the FOCUS web portal in the presence of Professor Alok Dhawan, Director, CSIR-IITR on Sep 14, 2018

sensors with dimmable LED drivers offers on-demand dynamic lighting through adjustment of intensity of individual streetlight by detecting the presence of pedestrians, bicycles, and cars. This way, it reduces energy consumption by up to 50% without compromising public safety and citizen comfort. Automatic identification of faulty lights greatly reduces the need for expensive visual inspections and enables a reduction of operation and maintenance cost.

- CSIR-CSIO, Chandigarh in collaboration with AIIMS, New Delhi has developed software to carry out 2-Dimensional Lateral and Posterior Anterior (PA) Cephalometric Analysis – AutoCEPH. It can perform 16 standard Lateral, 3Pnalyses and superimpositions. The software can be utilized by orthodontics specialties and cosmetic surgeons for patient diagnosis and treatment planning.

6.9 SMART CITIES

- CSIR-NPL has developed technology for proper indication of emergency signages that does not require continuous source of energy. The technology offers a simple and novel process of production of a non-toxic, non-radioactive, photo-luminescent powder that can be coated onto almost any object which causes it to continuously glow in the dark.
- CSIR-CSIO has developed Anti-Glare Filter Device renamed as Day & Night Glare Reducing Device (D&NGRD) for automobiles which is mounted on the car's/ transport vehicle's in place of sun-visor or on sun-visor in co-existence of the two to block the blinding glare caused by the sun-reflections and glare cause by the high beam light of the oncoming vehicles without compromising on forward and side vision look through the device.
- CSIR-CSIO has developed water quality monitoring system for detecting hazardous pollutants including nitrate, fluoride and arsenic. The system can be deployed for online monitoring of rivers for these pollutants, with a sampling setup.
- CSIR-SERC has designed and developed a ready to use pre-fabricated Glass Textile Reinforced Concrete Crash Barrier System for safety of road users. Glass textile reinforced concrete crash barrier is a unique product and not under practice anywhere globally as of today. It is capable of resisting impact forces in the event of vehicle collision resulting in less damage to vehicle and passengers.
- CSIR-SERC has developed a technology for emergency restoration system in case of power failure. It can be used for quick restoration of power lines during tower failure events. This technology can be adopted by the Power Ministry to improve the power transmission during failures.

IMPORTANT TECHNOLOGICAL CONTRIBUTIONS TO SUSTAINABLE DEVELOPMENT GOALS (SDGs)

IMPORTANT TECHNOLOGICAL CONTRIBUTIONS TO SUSTAINABLE DEVELOPMENT GOALS

7.0 Important technological contributions to Sustainable Development Goals

SDG 1 & 2: No Poverty and Zero Hunger

Technology for effective delivery of pheromones in fields

Pest attack results in a loss of food produce worth US$ 470 billion globally. Pests are conventionally managed by spraying pesticides that could pollute soil and ground water. Pest control using sex pheromones is a revolutionary technology to selectively treat pests, without the use of pesticides and without harming helpful insects. CSIR-NCL has developed technology for effective delivery of pheromones in fields. One of the major problems with delivery of agrochemicals in fields is that they get washed off by rain or dew. CSIR-NCL's technology uses food-grade, plant-based materials that help to stick the pheromone onto plant surfaces such that they are not easily removed. This increases the efficacy and minimizes wastage of expensive pheromones. This technology has been licensed to Pheromones Biotech LLP, Hyderabad.

Samba Mahsuri (SM93)

Samba Mahsuri is a popular rice variety in many states of India for its grain and cooking quality. CSIR-CCMB has developed a new variety of Samba Mahsuri rice, named as the SM93. It shows a 10-20% higher yield and matures 15-20 days compared to the parent variety. SM93 shows an enhanced tolerance towards an insect pest, Yellow Stem Borer. It is a pest of deep water rice in areas that suffers from continuous floods. It is known to cause 20% yield loss in early planted rice crops and 80% yield loss in late planted yield loss.

SM93 is currently undergoing the third year of National Field Trial conducted by Indian Council of Agricultural Research (ICAR). CSIR-CCMB's SM93 aims to achieve United Nation's Sustainable Developmental Goal of No Poverty and ZeroHunger by positively impacting farmers' incomes and crop production in the country.

Two seed varieties of opium poppy developed and transferred to industries

BROP-1 and Madakini, two seed varieties of opium poppy (BROP-1 and Madakini) developed by CSIR-NBRI were transferred to RUSAN Pharma Pvt. Ltd., Mumbai under the Material Transfer and Commercial Use agreement signed on November 05, 2018. BROP-1 is a synthetic uniform stable variety having three types of capsules, i.e. oily, parrot coloured and black peduncled. It is high opium yielding and rich in morphine. Madakini is high yielding multiple disease resistant/tolerant, stable and

uniform opium poppy variety. It also has high morphine content.

Incense cones from herbs and flowers

Incense burning usually emits dense smoke containing particulate matter, production of gases such as carbon monoxide (0.4-2.6 parts per million), carbon dioxide (396-517 parts per million) and produces volatile organic compounds (260-610 parts per billion). Incense smoke not only contains carcinogens (polycyclic aromatic hydrocarbons, carbonyls and benzene) but also irritants which leads to a number of respiratory diseases. CSIR-IHBT developed an environmental friendly herbal incense cones by utilizing herbs and flowers including the temple floral offerings.

Herbal cones are: Phthalate free; Charcoal free, with low CO (0.1-0.2 ppm) and VOC (200-210 ppb). Variety of incense cones have been standardized for various aromas such as Dhoop, Loban, Rose, Sandalwood, Guggal etc. Technology transferred to Dr. Gaurav Aggarwal, Public Health Consultant & Representative of Green Tech Solution, Kangra-176001, Himachal Pradesh

Popularization of Turmeric variety 'Kesari'

Under CSIR-Aroma Mission Project, a low temperature tolerant variety of Turmeric-Curcuma longa L. 'Kesari', has been developed by CSIR-NBRI, which apart from giving high rhizome yields, can also be a source of leaf essential oil. While other varieties of turmeric senesce with the onset of winters in North India, 'Kesari' grows for 230-240 days which ultimately reflects in terms of high yield due to longer growing period. The fully senesced leaves yield 1.40% essential oil on hydro-distillation while the highest amount of leaf essential oil (1.70%) is obtained from partially senesced leaves. The major constituents of the leaf oil in 'Kesari' are a-Phellandrenes (32%), terpinolene (26%), p-cymene 5.9%) and 1, 8 cineole (6.5%).

Bio-formulation against Fusarium wilt of tomato

CSIR-NBRI developed a technology for the control of Fusarium wilt of tomato. It is an eco-friendly bio-formulation and is a potential alternative to chemical fungicides. The bio-formulation has the ability to suppress pathogen spore formation and has a shelf-life of one year. The bio-control agent and its secreted products present in the formulation are of biological origin. Ecological toxicity test (soil and water) and the primary skin irritation test carried out at GLP lab showed that the formulation may not have adverse effect on human health. The field trial of the formulated product is in progress at Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh.

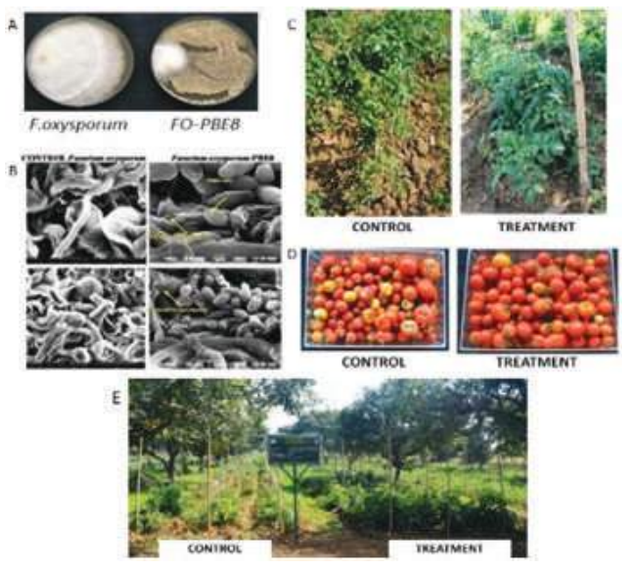


Fig. 7.I: A) Antagonistic activity of bio-control agent PBE8 Fusarium oxysporum; B) SEM micrograph of the antagonistic activity; C) In-Vivo bio-formulation application; D) Tomato yield post bio-formulation application and E) Field trial at Indira Gandhi Krishi Vishwavidyalay, Raipur, Chhattisgarh

Water-efficient Automated Smart Irrigation System (WASIS)

A functional prototype called "Water-efficient Automated Smart Irrigation System" (WASIS) was developed by CSIR-NISTADS. It is an automated irrigation system that responds

efficiently to crop water requirement (crop-wise and crop stage-wise) and field conditions such as soil moisture and rainfall.

WASIS helps reduce the energy and water footprints in agriculture, which accounts 80% of water consumption in India. It can have various socio-economic impacts such as increased crop yields, increased crop production, enhanced income of farmers, less production cost, better food security, improved nutrition, more employment generation, promotion of food production in areas of adverse climatic conditions, etc.

High yielding varieties of medicinal & aromatic plants developed by CSIR-CIMAP

S. No	Common Name	Plant Species	Variety Released	Photograph
1	Kewanch	Mucunapruriens L.	CIM Sfurti "More seed production and high L-dopa content"	
2	Ashwagandha	Withaniasomnifera	CIM-Pushti "Withanolide-A rich and leaf blight tolerant with good root textural quality"	
3	Ocimum	nterspecific Hybrid of Ocimumbasilicum XOimumkillimancharicum	CIM Shishir "High oil and high linalool content" and "cold and lodging resistant"	

SDG 3: Good Health and Well-being

Development of Microfluidic / Lab-on-a-chip device for breast cancer diagnosis

CSIR-CCMB has developed a fast and sensitive, non-invasive blood based micro RNA-microfluidic assay for early, accurate prediction of different grades, stages and types of breast cancer. The blood-based, and rather non-invasive nature of cancer detection (as compared to techniques like biopsy and radiological imaging) makes it an attractive method to screen the large reluctant women population in rural India. The assay is quick, easy and can predict early the types, grades and stages of breast cancer at one go. The assay can help in providing early warning System which can be used under Resource constraint settings (RCS) and personalized, accurate, preventive, democratized Molecular detection.

Peptide-based delivery of therapeutic nucleic acids to the brain

CSIR-CCMB has developed a new platform for efficient delivery of siRNAs to target genes responsible for early onset of neurodegenerative disorders. The innovation is patented in the US (US Patent No: US 10,208,098 B2 dated

Feb 19 2019). It is expected to serve unmet needs for incurable neurological conditions.

The technology utilizes the potential and utility of TARBP-BTP, a new fusion protein. This protein enables efficient delivery of siRNA (small RNA molecules that can manipulate gene expression) to the brain. This consequently reduces the build-up of toxic peptides in neurodegenerative condition such as the Alzheimer's Disease. The technology is at early stage of development.

Herbal soft drink technology

'NBIRA', the herbal soft drink developed by CSIR-NBRI, possesses all the advantages of a health drink and can be a substitute for other commercial soft drinks available in Indian market. NBIRA is made from a combination of five indigenous medicinal plants fortified with herbs reported in Ayurveda having health protective and promotive properties. No chemical preservative or colorants are used in this soft drink and is therefore, free from any toxicity. The herbal soft drink technology has been transferred to M/s 3D Nutrients, Ratlam (MP) on January 20 2019.

Fig. 7.2: 'NBIRA' A herbal soft drink

Validate a method for diagnosis and prognosis of rheumatic heart disease

Rheumatic heart disease (RHD) is characterized by damaged and deformed mitral valves resulting into scarring and narrowing (stenosis) of the tissue leading to cardiovascular complications and heart failure. Repeated streptococcal infection in the early childhood causes rheumatic fever and many of them develop rheumatic heart valve later. Though echocardiography can efficiently diagnose RHD, yet there is a need for biochemical marker which might be useful to monitor disease progression as well as performance of the subjects following different therapeutic interventions.

CSIR-IICB has identified PICP is one of the proteins which is robustly increased in the serum of the subjects suffering from rheumatic heart disease compared to control. So far 300 subjects has been tested and also checked in different subgroups of RHD. The receiver operating characterise curve analysis reveals 450 Jg/ml as a cut off concentration of plasma PICP above which RHD is detected. Accordingly, CSIR-IICB has developed a prototype of dipstick technology. The dip stick is tested in 20 subjects however the sensitivity needs to be improved.

Fig. 7.3: Rapid Test Device

Herbal Hair Colour

Herbal hair color has been developed by CSIR-NBRI from plants producing natural colors. This hair color does not contain any synthetic chemicals: Ammonia, Para phenylene diamine (PPD) and hydrogen per oxide. It will also

serve as a hair tonic for the natural growth of hairs. It is hydrophilic in nature having anti dandruff properties and safe to use with no side effects on skin. The technology/know-how has been transferredtoM/S KTC Products, Baddi, Himachal Pradesh on 26.9.2018. Product is available in market through e-commerce.

Fig. 7.4: Herbal Hair Color

Technology of Novel Osteo-inductive Agent CDRI S008-0399 as Medicated Bone Implant Material for Fracture Healing

India has the worst traffic accident rates worldwide with over 130,000 deaths annually. Many of these accidents lead to fractures of delayed union or non-union type that can result in multiple surgeries. CSIR-CDRI compound S008-0399 promotes osteoblast differentiation and mineralization at dose as low as 1 picomolar concentration and increases bone mineral density (BMD), mineral apposition rate (MAR) and bone formation rate (BFR) in osteopenic rat model. This bone inducing agent improves bone quality and restores trabecular micro-architecture in ovariectomized osteopenic rats and enhances bone healing in cortical bone defect animal model. The molecule was licensed to M/s Ortho Regenics Pvt Ltd, Hyderabad and technology of the product was transferred for fabrication of orthopaedic implants in combination with biodegradable bone inducing materials to enhance healing at the fracture site. These low cost medicated biodegradable bone implants will also reduce the cost of bone implant surgery as compare to metallic bone implants because they are biodegradable and will be resorbed during the process of new bone formation at the facture site. There will be no need for re-surgery to remove the implants or some other infection and wear and tear issue debris as in case of non-degradable implants.

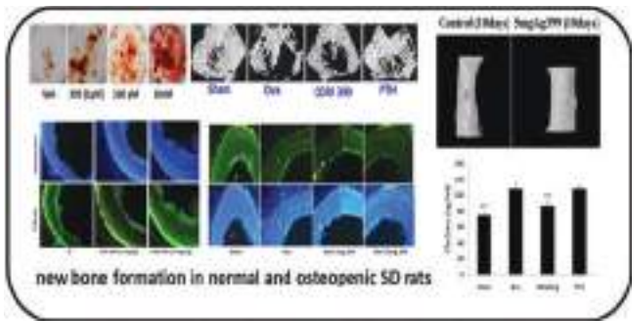


Fig. 7.5: Medicated Bone Implant Material for Fracture Healing

L-Asparaginase (HimAsnase™): an enzyme with no Glutaminase activity

Asparaginase hydrolyzes L-Asparagine to L-Aspartic acid and Ammonia. Particularly in the leukemic cells, this results in the depletion of asparagine that is required for growth of some tumour cells, due to lack of asparagine synthetase activity in tumour cells. Asparaginase therapy is an important component of acute lymphoblasticleukemia (ALL) treatment. High glutaminase activity is responsible for associated side effects and hypersensitive reactions. Therefore, asparaginase with low or no glutaminase activity is desired. L-asparaginase has enormous applications in reduction of acrylamide (a potential carcinogen) formation in starchy food products (potatoes chips, French fries).

Unique feature of IHBT HimAsnase™ developed by CSIR-IHBT are:

- Asparaginase with no glutaminase activity. It functions across <0ºC to >50ºC with varying activities at different assay temperatures.

- An efficient Asparaginase enzyme which has wide temperature functionality.
- Gene for asparaginase has been cloned and successfully expressed in the E. coli for commercial production.

Shiitake mushroom: vitamin D_2 Enriched

Shiitake (*Lentinula edodes*) is an edible mushroom which has high medicinal value. Vitamin D is essential for bone health and to boost immune system. A technology for enhanced production of ergocalciferols (Vitamin D_2) in Shiitake mushroom has been developed by CSIR-IHBT for captive cultivation for Vitamin D_2 enriched mushroom in 2 months with yield of 0.5-0.6 kg fresh fruiting body per kg of dried substrate. Encapsulated 500 mg shiitake powder meets 50% recommended dietary allowances (RDA) of Vitamin D_2.

Technology has been transferred to M/s Innotech Agro Postikum Pvt Ltd, Guwahati Biotech Park, IIT Guwahati, Assam and M/s Pravin Masalewale, 44, Hadapsar Industrial Estate, Hadapsar, Pune- 411013

Monk fruit (Siraitiagrosvenorii): low calorie natural sweetener

Monk fruit {Siraitiagrosvenorii(Swingle) C. Jeffrey ex A.M. Lu & Zhi Y. Zhang} is known for its intense sweet taste and as a non-caloric natural sweetener, attributed by its cucurbitane-type triterpene glycosides known as mogrosides. The extracted mixture of mogrosides is about 300 times sweeter than sucrose.

CSIR-IHBT, Palampur has introduced monk fruit from China through ICAR-NBPGR, New Delhi (Import Permit No.168/2017) and standardised agronomic practices; post-harvest management; and quality planting material.

Multigrain high protein mix

A low cost technology for commercial production of protein rich beverage mix, addressing protein and energy malnutrition has been developed by CSIR-IHBT. The product is a multipurpose food for use in beverage and smoothie mix that can be consumed with milk/water/fruit juices and as a protein fortifying food ingredient in breads and ready to eat foods.

Developed mix is 100% natural with nutrient dense ingredients (wholegrains: millets, cereals, pseudo-cereals and pulses). Provides 200-250 Kcal energy and 10 g protein per serving (50g). Meets 22% recommended dietary allowances (RDA) of proteins; Meets 10% RDA of dietary fibre; Meets 15% RDA of Iron and calcium.

The mix is free from preservatives, maltodextrin and thickeners nonhygroscopic and free flowing. Shelf life of the product is up to 10 months.

Technology transferred to: M/s Access India Impex Centre, Pvt Ltd, 602, Naurang House 21, Kasturba Gandhi Marg, New Delhi-110 001

Saffron based Nutraceutical Technology

CSIR-IIIM has developed a saffron-based nutraceutical product (IIIM-141) for brain-health. IIIM-141 showed unique ability to enhance expulsion of toxic amyloid-plaques from the brain via multiple-mechanisms, using a transgenic mouse model of Alzheimer's. The product also showed memory-enhancing properties with excellent safety profile. The new oral capsule-formulation was prepared for slow-release of the active ingredients ensuring that the bioactive constituent reaches in the brain, thereby enhancing the clearance of amyloid-plaques. Institute has filed a patent (IN201711036084; WO2019077621A1) on this product and published this study in two major US-based journals (ACS Chem. Neurosci. 2017, 8, 1756; ACS Omega, 2018, 3, 9572). The product and formulation-technology has now been licensed to the Pharmanza Herbals Pvt Ltd Gujarat for marketing it as nutraceutical product in Indian and US market. This product will be specifically beneficial for people, who are at higher risk of developing Alzheimer's

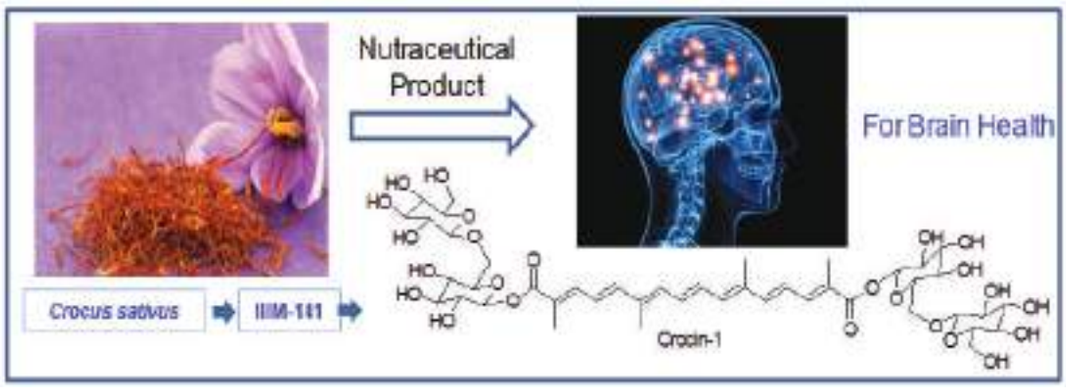


Fig. 7.6: Saffron based nutraceutical

or dementia, including the patients with early-onset of disease.

Development of Pothole Repair Machine

Potholes are one of the most visible and annoying forms of bituminous pavement distresses from the view point of a road user. Potholes have always been a problem for highway maintenance agencies because their treatment is complex, costly and time-consuming. The problem aggravates much during the rainy season, when pothole repair becomes more difficult because of adverse weather conditions and the large number of potholes that seem to develop at faster rate. To effectively address the cumbersome time consuming act for repair of potholes, compact and low cost Pothole Repair Machine is being developed by CSIR-CRRI indigenously in collaboration with industry. Demonstration of the machine in field is planned soon to validate the invention and also to popularize the invention among the state PWDs, state rural roads departments and contractors.

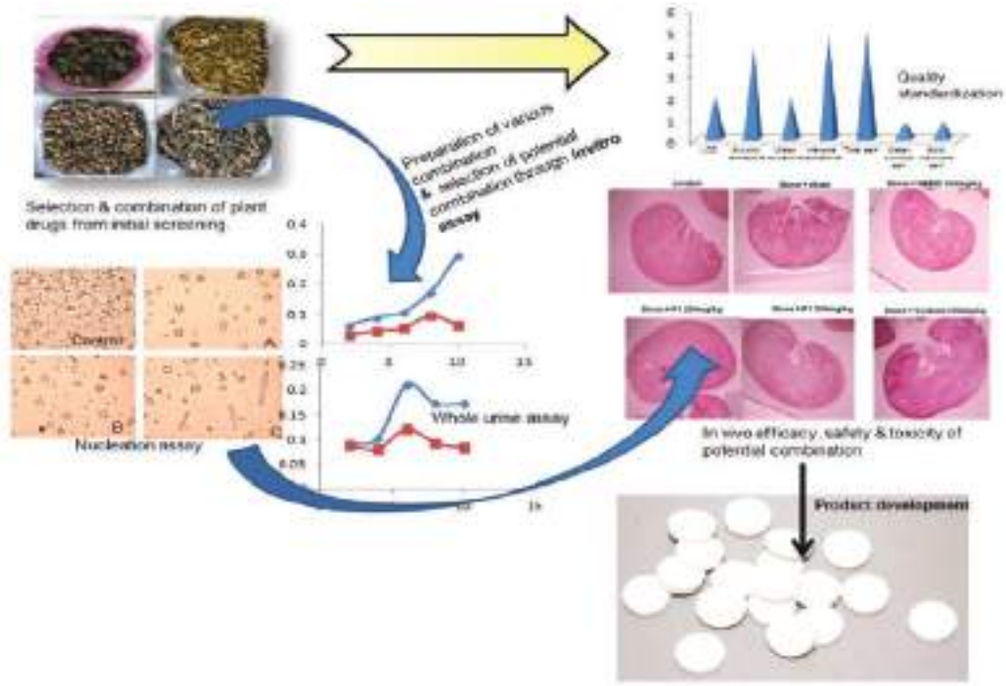


Fig. 7.7: URO-05: product procedures and developments

URO-05: A potential herbal combination for alleviating urolithiasis, nephrolithiasis and post lithotripsy conditions (ESWL)

CSIR-NBRI developed a herbal formulation – URO-05, which has been found effective in reducing stone formation as well as elimination of stones from kidney and urinary tract. The formulation is also effective in post lithotripsy conditions, prophylaxis and prevention of recurrence of lithiasis. It consists of limited number of ingredients and is cost effective, requires reduced dosage than existing market brands, and promotes better stone crystal clearance and healing of tissue damage.

Image-guided vascular vein visualizer (VeinViz)

In case of critical ill patients, intravenous (IV) therapy is considered as the fastest mean of providing fluids and medications through peripheral venous catheter. It is often a problem for clinicians to find and locate vein and in the process they pricks several time before placing the needle successfully, which causes pain and distress to the patient, and frustration to the clinicians. CSIR-CSIO is working to develop a non- invasive, real-time portable device for detection and visualization of peripheral subcutaneous veins of neonatal, obese and dark skin patients. A prototype of the device has been developed.

Fig. 7.8: Prototype of developed Vein-Viz Device

SDG 04: Quality Education

StAIRS (Student Advisory and Institutional Ranking System)

The ranking of universities and institutions plays as important role as a guide for budding young scientists in selecting academic destinations and career paths. There are currently more than twenty institutions/agencies in the world engaged in such ranking, with a wide variety of parameters and weights assigned to these parameters; many of the parameters used are subjective and not properly quantifiable. The wide diversity of ranking methods can make the scores quite confusing, and even misleading to the student. A platform for student advisory based on objective institutional ranking would fill a critical gap. CSIR-NISTADS has made an agreement with Novateur Consultancy & Assessment Solutions, LLP, Gurgaon for co-development, marketing and management of StAIRS as a self-sustainable Business Model.

SDG 06: Clean Water and Sanitation

Green Technologies for Quality Drinking Water

CSIR-CMERI has developed three technologies for supply of quality drinking water from groundwater sources. The newly developed technologies are based on the principles of oxidation, precipitation and filtration and do not require electric power and so are completely green.

In India, groundwater is the major source for drinking and domestic purposes. However, the presence of contaminants like iron, arsenic and fluoride in groundwater is also a matter of concern. The new technologies will ensure quality drinking water from groundwater sources free from iron, arsenic and fluoride contaminations.

The technologies are ready for commercialisation and would be transferred

to the private companies Sarvo Technologies Ltd. of Haryana and ISW Industries in Howrah in West Bengal for implementation across the nation.

Sensor System for Fluoride, Nitrate & Arsenic

As per recent surveys, around 37.7 million Indians are affected by waterborne diseases annually, 1.5 million children are estimated to die of diarrhoea alone and 200 million working days are lost due to waterborne diseases. The resulting economic burden is estimated at ₹ 36,600 crore every year. Additionally, it is estimated that the equipment market related to water technologies is worth approximately ₹ 200- 300 million, and expected to have double-digit growth rates every year. CSIR-CSIO has developed a sensor system where will estimate the water quality parameters such as fluoride, arsenic and nitrate concentration in potable water. The technology was transferred to M/s Ambtek Innovations Pvt. Ltd., Ambala Cantt.

Technology for separation of Sodium sulphate and Sodium Chloride from mixed salt concentrated brine

Successful deployment of CSIR-CSMCRI technology on commercial scale for the separation of sodium sulphate and sodium chloride from mixed salt concentrated brine at the CETP of Chinnakarai, Tirupur, Tamil Nadu – rendering a complete ZLD process for the first time. The project was implemented along with Water Investment Co. Ltd (TWIC), Chennai and M/s Chem Process Systems, Ahmedabad (for process equipment).18 CETPs are at Tirupur rendering effluent management of ~430 textile-dyeing clusters. Successful demonstration at Chinnakarai CETP would encourage other CETPs to deploy this technology to make Tirupur, Tamil Nadu clean and green.

Development of a Floor Cleaner and licensing of the technology

The wide range of floor disinfectants and cleaner products are available in the market but most of them are based on harmful chemicals. Mainly these type of products contain phenol or acid, which gives harmful effects on human health as well as for environment. Hence, there was a need to formulate a plant-based floor cleaner to minimize the risk of health problems and is environment friendly. In general, bacteria like Salmonella typhimurium, Staphylococus and Escherichia coli are commonly present on the floor and these bacteria are the causes of various infections.

CSIR-CIMAP has developed a unique formulation of aromatic floor cleaner that contains active molecules from plant sources. Lemon fresh natural floor disinfectant is intended to remove the harmful bacteria from the floor and provides healthy environment. Acid- and phenol-free water soluble floor cleaner removes germs and stains and also provides long lasting freshness. The technology of this formulation has been licensed to M/s. Saksham Herbals & Organics Pvt Ltd, New Delhi-110043.

SDG 07: Affordable and Clean Energy

Semi Continuous Bio Diesel Plant

CSIR-CMERI has developed a semi continuous Bio Diesel plant from oil or fat. The salient technical features are:

- Produce biodiesel from any oil or fat irrespective of its FFA content
- Produces 600 litre of biodiesel in 24 h
- Minimum manual intervention
- Possibility of scaling up to industrial model
- Peak power requirement is 3kW
- Low cost
- Biodiesel produced is per ASTM / BIS standard and suitable to be used in Gen set / Tractor / Diesel vehicle.

Technology transferred to M/s Sains Engineering Works, Janta Nagar, Gill Road, Ludhiana, Punjab.

Technology for Biogas Up-gradation

Biogas is one of the renewable energy sources with favourable CO_2 balance. It can be formed by anaerobic decomposition of large variety of organic wastes. It consists of primarily methane (CH_4), carbon dioxide (CO_2) and small amounts of H2S and water. Methane, which is present in the concentration range of 50-70 % is one of the greenhouse gases with a global warming potential of 20 folds that of CO_2. Utilization of methane as a fuel for varied uses like heating, electricity generation and transportation fuel is a step towards reducing greenhouse gas emission and utilization of waste materials.

CSIR-IIP has developed a VSA based process for producing high purity methane gas from biogas mixture at laboratory scale. This research work was initially carried out in collaboration with University of Melbourne, Australia under Australia India Strategic Research (AISRF) project funded by Department of Science and Technology, Govt. of India. The laboratory scale process was developed in a two column VSA unit. The simulated biogas feed comprising 60% methane (CH_4) and 40% carbon dioxide (CO_2) was used for this study. The feed rate used in experimental studies was 2.9 Nm3/day.

Process highlights:

- Process is based on simple VSA cycle configuration
- The process simultaneously produces high purity methane and carbon dioxide
- Methane purity up to 96% with over 90% recovery has been obtained
- The productivity of VSA process developed is four times higher than similar process reported for biogas up gradation

New Method for Increasing Gas Oil Yield or Atmospheric Distillate Yield and Energy Efficiency in Crude Oil Distillation in Petroleum Refinery

Fig. 7.9: CSIR-IIP's Biogas Up-gradation Plant Installed at Pune Municipal Corporation's Katraj Site

Crude Distillation Unit (CDU) has the maximum capacity in petroleum refinery which implies that small improvement in its performance shall affect the gross margin of refinery significantly. CSIR-IIP has developed and patented methods (NM) for crude processing in CDU for a simultaneous increase in distillate yield and energy efficiency. In one newly developed method (PC1), Flash Drum (FD) vapour is superheated and routed to striping section of ADC. In the second method (PC2), water is also added to desalted crude to facilitate the more vaporization in FD and better utilization of the low-level heat for heavy crude processing. The schematic of the patented methods is given in Figure.

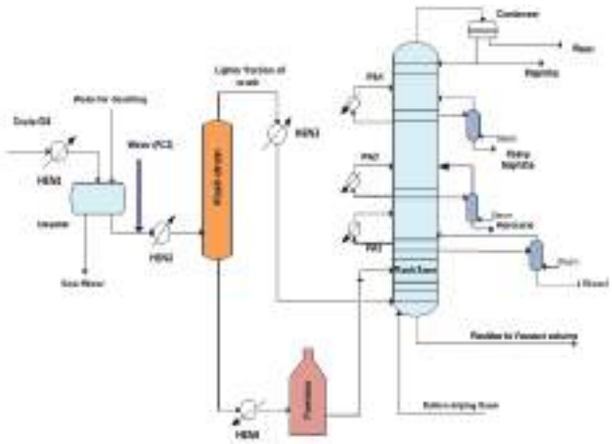


Fig. 7.10: Schematic of the CDU with a new method of crude processing

Improved PNG (Piped Natural Gas) Burner

There are more than 50 lakh registered domestic PNG users in India. Due to unavailability of dedicated PNG burner / stove customers are using common LPG stoves modified for PNG which is unsafe and highly inefficient. In view of this, CSIR-IIP has developed a domestic cooking burner for the efficient and safe application of Piped Natural Gas (PNG) with the financial support of PCRA, New Delhi. The developed PNG burner can save up to 25% of the precious fuel (PNG) ensuring the user safety at the same time. The developed burner has been tested at five different household locations in Delhi-NCR region. The burner has also been tested in the ministerial canteen at Shashtri Bhawan, New Delhi. The field trials have confirmed the fuel saving potential of the developed burner. The product is now ready for commercialization.

Fig. 7.II: Improved PNG Burner

SDG 08: Decent Work and Economic Growth

Synthesis of Polychlorotrifluoroethylene (PCTFE) from Chlorotrifluoroethylene (CTFE) by CSIR-IICT

PCTFE is a fluorine rich engineering thermoplastic with outstanding physical and mechanical properties. Its non-flammability, chemical resistance, near zero moisture absorption and excellent electrical properties make it a unique polymer, even within fluoropolymer family. Its ability to function in the temperature range of -2400C to 2000C

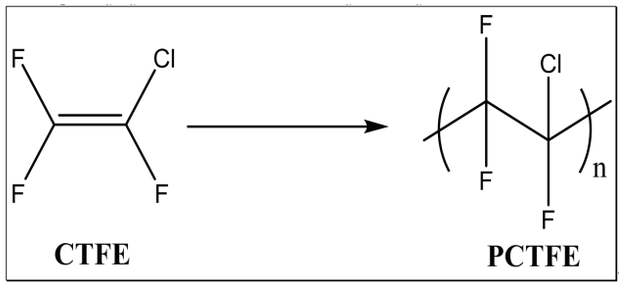


Fig. 7.12: M/ S Gujarat Fluorochemicals Ltd approached CSIR-IICT for a laboratory scale process for synthesis of this polymer. Such a process was successfully developed and demonstrated to the client on a 400 /g batch scale

makes it a speciality polymer. It is widely used in protection of sensitive electronic equipment, pharmaceutical blister packaging, chemical tank liners, O-rings, seals, gaskets etc.

Liquid-Liquid Micro-separator

CSIR-IICT has developed Liquid-Liquid Micro-separator for continuous separation of organic solvents and water (based on polarity difference). It can help overcome all Liquid-Liquid extraction related problems with ease.

- There is no need for multiple back-washes;
- Emulsion can be separated using this technology; and
- Traditional batch extraction processes require long intermediate layer separation time which can be avoided with our product.

The device works on the principle of wettability of immiscible phases onto a porous membrane.

When immiscible phases i.e. aqueous and organic streams is sent into the separator, the organic phase has an affinity for the membrane and fills the pores, the other phase (aqueous) is repelled.

Fire Retardant Water Based Clear/ Transparent Coating for Wood & Wood Based Interiors

CSIR-CBRI developed coating that could be used on all types of wood and wood based interiors (i.e. the materials / products used inside the building, either existing or new). The application of coating may be done by brush, roller or spray gun. The raw materials include amides, phosphoric acid (specified % available commercially), and water, Boron compounds, catalyst and preservative in specified quantities. The reaction is to be carried out in stages using specified quantities of ingredients at specified temperatures for specified time. The resultant product is "Fire Retardant Water Based Clear/ Transparent Coating". The technology was transferred to M/s Paramount Intercontinental Pvt Ltd, Sonepat.

NVG Compatible LED Lights for Helo Deck Visual Landing Aid System (HVLAS) on Indian Navy Ships

HVLAS provides operations. The system Deck illumination with Night Vision Goggle Compatibility for night also provides clearance to helicopter whether landing is possible or not and if yes then the exact moment of landing for the helicopter to make safe approach or abort.

The HVLAS has been designed by CSIR-CSIO as an integrated system such that there is coordinated operation of various Lights and optical references to indicate safe approach path to the approaching helicopter. The system also caters to provide warning to abort landing in case the ambient conditions are not conducive for landing. The NVG compatible HVLAS is an integrated solution with the main constituents being the Stabilized Horizontal Reference System, the Stabilized Glide Slope Indicator, the LED Deck Lights, Landing Safety Officer (LSO) Panel and the Landing Support Software including the Landing Period Designator and finally the Centralized Control Unit. The technology was transferred to M/s Elcome Integrated Systems Pvt Ltd, Mumbai.

Aluminium foam for blast resistance and crashworthiness and light weight sandwich structure

The technology developed by CSIR-AMPRI called (AMPRIALFOAM)is based on foaming liquid metal (Aluminium and its Alloys) having controlled viscosity and temperature using foaming agents like metal hydride which is dispersed into the melt through mechanical stirring. After foaming the cruscible in which foam is made is ejected from the furnace and cooled through mixed air plus moister mixture at high pressure. The crucibles are split type and made of conducting materials. Depending of the shape of crucible cavity the shape of foam ingot varies. The foam materials float over water and have fine uniform porosities.

Being so light and lots of pores, these materials have huge opportunity to be used as foam core panels or foam filled tubes for light weight structures, sound and vibration arrester, impact and blast resistance and crashworthiness applications

Foam filled crash boxes were tested at ARAI Pune and showed excellent results showing the capability of avoiding casualties due to accidental collision of the car. CSIR-AMPRI can make AMPRIALFOAM at a cost of ₹ 1000/ per kg and at a scale of 150 kg/day.

SARAS PT1N – Demonstration at Aero India 2019

The new upgraded version of SARAS PT1N, the indigenous transport aircraft developed by CSIR-NPL "successfully" performed flight demonstration on all five days at Aero India 2019 (20-24 February 2019). The dignitaries, DG,CSIR, VIPs, and delegates witnessed the flying demonstration of SARAS PT1N and highly appreciative of effort put in by the entire team of NAL, ASTE, DGAQA, CEMILAC and HAL in reviving the project after nearly nine years.

Fig. 7.13: Saras PTIN flight demonstration at Aero India 2019

SAR Evaluation System

A Specific Absorption Rate (SAR) evaluation system consisting of E-Field Sensor, Tissue equivalent liquid, Robotic automation and a controlled GUI has been developed by the CSIR-NPL, which is capable of evaluating SAR upto 3W/kg with an expanded uncertainty of ±0.15W/kg per 1.6W/kg. The very first centre will be established at TEC, New Delhi based on CSIR-NPL technology for commercial compliance testing of mobile phone SAR based on IEEE 1528-2013 and IEC-62209-1, 2 as a transfer standard.

Fig. 7.14: SAR measurement setup at CSIR-NPL

Structural Integrity Assessment of Reactor Containment Building during proof test

Bharatiya Nabhikiya Vidyut Nigam Limited (BHAVINI), is a Public Limited Company under Department of Atomic Energy (DAE), established with the objective of constructing and commissioning the first 500 MWe Fast Breeder Reactor (FBR) at Kalpakkam, Tamilnadu, and to pursue construction, commissioning, operation and maintenance of subsequent Fast Breeder Reactors for generation of electricity. BHAVINI sought advanced testing expertise of CSIR-SERC for commissioning of a 500MWe Prototype Fast Breeder Reactor (PFBR). The safety and structural integrity of the reactor containment building was ensured by CSIR-SERC during the proof test before commissioning of the reactor. The PFBR is the forerunner of the future Fast Breeder Reactors and is expected to provide energy security to the country. Advanced testing expertise of CSIR-SERC,was used for PFBR at Kalpakkam, which is critical for its operation.

Fig. 7.15: Reactor containment building at Kalpakkam

Biometric-based Exploder

Exploder is a device that triggers detonators by generating electric current in order to initiate firing of explosive charges. It is also called blasting machine which helps in safe and controlled blasting to avoid the chances of misfire. It has vast applications in rock excavation in mines, road and other construction activities as well as demolition activities.

Different types of exploders available in the market are found unsafe if it is stolen and misused by illegal nexus, militants etc. To avoid such type of misuse, the biometric-based exploder has been developed by CSIR-CIMFR. It can only be operated by those peoples who are biometrically registered with the specific device. The device comprises of an embedded microcontroller, converter circuit, rectification

circuit, safe discharge circuit, authentication circuit and display unit. The fingerprint scanner with the help of embedded micro-controller registers authorized personnel using their finger print upto 20 numbers. Once registered, no other person can use these devices. Two types of exploder have been developed, one for underground mines and another for opencast mines. M/s Pranay Enterprises, Hyderabad has been selected for technology transfer and commercialization of the patent filed product.

Benefits:

- Control misuse of exploder by the unauthorized person/Naxalites
- Eliminates chance of misfire
- Battery level indication with internal locking of the device to improve safety
- Firing can be cancelled as and when required without any risk

(a) (b)

Fig. 7.16: Biometric-based exploder: (a) for opencast mines and (b) for underground mines

Stone dust-precipitator systems for stone carving artisans

During the field visit it was observed that a large workmanship in Sirohi and surrounding areas are artisans and work on stone carving, which is the key source of income for them. Most of them are illiterate and are tribals. Some of them work from home and also those who are working in factories do not use protective means. Due to the working without protection, silica dust enters into the lungs by inhalation of breath. It is marked by inflammation and scaring of the lungs resulting in nodular lesions in the upper lobes of the lungs and after few years of working a large number of them dies due to silicosis.

CSIR-CEERI developed a stone dust-precipitator system for stone carving artisans, that provides dust free environment to the workers and is ready for deployment in smaller factories. This system collects the tiny dust particles with its high suction power, which is near about 10 times more than that of the inhaling power of human beings. The system is based on vacuum technology and in this system there is a main chamber, which works as a junction of dust collecting branches.

To create a vacuum in this chamber, a high speed exhaust kit is placed at the top, which sucks air from the chamber continuously and throws it outwards. There are four filters fitted around the chamber, which separates the stone dust from air. These filters consists of continuous water spray, so that the stone dust gets removed from filters and collected in the dust collector in the form of sludge along with water. A standalone system for single artisan is also developed.

Biomass oven cum dryer

CSIR-IMMT has designed and developed of biomass oven cum dryer. The traditional practice of drying agricultural produce is by direct exposure to sunshine in the field of country yards and the roads by direct exposure to sunshine. It involves the risk of weather damage, losses in fields and losses during storage and transportation due to improper and incomplete drying. As compared with sun drying, biomass dryers can generate higher air temperature and consequences lower relative humidity. They are both conductive to improved drying rates and lower final moisture contents of the agricultural produce.

SDG 09: Industry, Innovation and Infrastructure

Technology for packaged fiber lasers for material processing applications

Prototype module of Pulsed Yb-fiber laser of 20W power was developed and field-trial

Industry Grade Autoclave Lab Scale Autoclave

Fig. 7.17: CSIR-NAL's Autoclave Technologies

was successfully done by CSIR-CGCRI using the module in marking machine technology is useful for packaged fiber lasers for material processing applications such as metal cutting, marking and surgical applications. The developed 100 W CW fiber laser at 1μm delivers a good quality beam at a wall plug efficiency of> 30%. The laser can be used for cutting coronary stent and micro welding. The pulsed fiber laser can be used for marking engraving on metal surface (anodized alumina, stainless steel). The 2 μm 30 W Thulium laser canbe used for precise incision of soft tissueswhich is applicable in the surgical sector of medicine. It is far more efficient than their crystal-based Holmium laser counterpart due to smaller size, high wall plugs efficiency and rugged nature.

Industry Grade and Lab Scale Autoclave

Autoclaves are used to manufacture airworthy composite components under suitable settings of pressure, vacuum and temperature. CSIR-NAL now has the expertise and capability in building large computer controlled autoclaves with associated sub systems. Laboratory has developed several autoclaves, over the years, for aerospace applications.

The laboratory developed four variants of autoclaves are meeting various requirements. While Mark-IV is the largest indigenous autoclave ever developed in the country with a working space as big as 4.4m (D) x 9m (L) meant for production houses, the Mark-III is specially built for ever growing R&D needs for high temperature composites.

CSIR-NAL also developed an affordable lab scale autoclave to meet the requirements of Academic & Research Institutions working in the area of Polymer composites. The compact lab scale autoclave (0.9m diameter and 1.0m length workspace) provides all the features of a large autoclave. Indigenous Autoclave costs 70% of the cost of imported Autoclave

Tape casting process for production of Alumina and Zirconia ceramic substrates

Alumina ceramic substrates are in great demand in the country for space and electronics industries and they are being imported. Zirconia substrates find application in the fabrication of solid oxide fuel cells (SOFC) and oxygen sensors. CSIR-NAL has developed alumina and zirconia substrates. The properties of indigenously developed alumina ceramic substrates exceed the benchmarked specifications. The technology has been transferred to M/s. Carborundum Universal Ltd. (CUMI) and CUMI has successfully commissioned an industrial scale tape-casting facility for the production of ceramic substrates

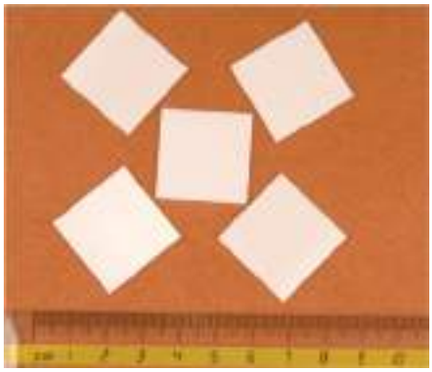


Fig. 7.18: CSIR-NAL developed alumina and zirconia substrates

VTOL UAV

The development of mini UAV configured for two major applications has been successfully completed in the reporting period. While Surveillance is the primary objective of the project, however based on request from the users, the UAV is also configured for geo-spatial mapping applications. Efforts are on for the commercialization of the product. CSIR-NAL team has designed and developed the first version of the vehicle with 5 kg payload. Initial flight tests were conducted. For quick aerial maps of small area corps using multispectral cameras, a quad copter has been designed and developed.

Fig.7.19: Hex-copter for Electro Magnetic and Quad-copter for Agricultural surveillance

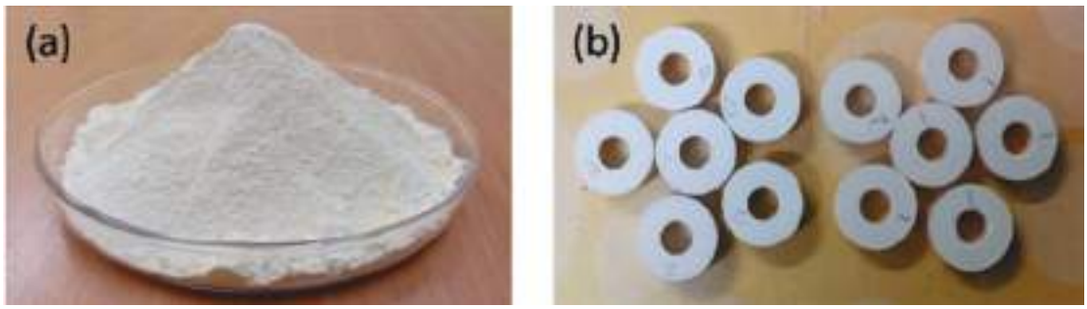
30-HP Wankel Engine

All the components of first prototype (PT-01) 30 hp air cooled engine were fabricated and engine was assembled by CSIR-NAL. The motoring trails were completed on the motoring rig. The engine was installed on the thrust test rig. The running-in tests, performance tests and endurance tests were conducted. The engine developed a thrust of 40 kgf at 7200 rpm and the fuel consumption rate is 9 lit/h. The 30 hp engine technology was demonstrated on the ground and engine has been tested for more than 20 hours on the thrust test rig.

Fig. 7.20: 30 hp Wankel engine in the Test Rig

PZT powders and rings for accelerometer application

CSIR-NAL has made significant contributions in the area of special materials. In the reporting year, CSIR-NAL has signed a non-exclusive license agreement with M/s IPA Pvt Limited for processing of PZT powders and their products on commercial scale for accelerometer applications. Similarly, these materials undergo dimensional change when subject to an electric field, therefore also used in actuation applications. PZT powder is also used for fabrication of various types of components such as in the form of rings, circular discs, rectangular and square shaped plates, multi-layered (ML) stacks, unimorphs, bimorphs etc., these devices are widely used for many engineering applications such as aerospace vibration control, precision fluid flow control, underwater sonar transducers, accelerometers,



(a) PZT Powders, (b) PZT Rings for accelerometer application

Fig. 7.21: PZT powders and rings for accelerometer application

force transducers, vibration sensors, vibration energy harvesting etc.,

Mechanical Strength Assessment of Polymer Insulator strings

This HVDC transmission project is the largest of its kind, traversing three states i.e. Gujarat, Rajasthan and Haryana.

Fig. 7.22: Full-scale testing of transmission line towers

CSIR-SERC undertook the mechanical strength assessment of +/- 500 kV HVDC composite silicon rubber long rod single 'V' suspension and quad tension strings line. These strings are tested for assessing the mechanical strength of the hardware fittings and the polymer insulator strings to ensure the safety and reliability of HVDC power conductors which it supports. The polymer insulator string is lightweight and designed for HVDC high voltage direct current applications. The polymer insulator reduces the vertical loads in the tower. The HVDC transmission reduces the transmission losses and it results in 11% savings. Five states namely Delhi, Uttar Pradesh, Rajasthan, Punjab and Haryana are benefitted by this project.

Structural Integrity Assessment of Scherzer Span of Pamban Bridge for Southern Railway

Pamban Bridge is a railway bridge connecting the town of Rameswaram on Pamban Island to mainland India. The bridge is located at 655/2 km to 657/4km in between Mandapam and Pamban station. The Pamban Railway bridge was constructed between August 1911 and December 1913 and opened for traffic in February 1914. The rail bridge is, for the most part, a conventional bridge resting on concrete piers, but has a double-leaf bascule section midway, which can be raised to let ships and barges pass through. German engineer Scherzer designed the central part of the bridge that opens up to allow ferry movement.

Southern Railways approached CSIR-SERC for carrying out the structural integrity assessment of the Scherzer span of the Pamban railway bridge. In this connection CSIR-SERC has carried out the instrumentation and response measurement during static load testing of the pamban railway bridge for assessing the structural integrity including non-destructive testing of the super structure. Totally 98 locations were instrumented with electrical resistance strain gages on various truss members on Mandapam leaf and Pamban leaf of the bridge. Tip deflections of each leaf were measured using Linear Varying Displacement Transformers (LVDTs). The instrumented strain gages and displacement transducers were connected to microprocessor based high speed

Fig. 7.23: Structural integrity assessment of the Scherzer span of the Pamban railway bridge

data acquisition system. The bridge was tested using a special train formation comprising of one WDG loco+4 AC 3 Tier Coaches (empty) + 4 General Sitting (GS) Coaches (empty). The axle load of the loco, AC 3 tier coach and GS. Static load testing was carried out by placing the first axle of the loco at each nodal point of the truss (14 nodal points). At each load position the strain and displacement responses for instrumented sensors were recorded.

Based on the field investigations carried out, the Southern Railways have come forward requesting CSIR-SERC to continuously monitor the bridge for the next two years, thus facilitating the uninterrupted traffic flow.

Intelligent Dry Fog Dust Suppression System

Intelligent dry fog dust suppression system for industrial applications developed by CSIR-CIMFR is a smart solution for removing dust generated during different mining activities such as extraction, loading and unloading, transportation, storage and processing as well as other industrial processes. The system utilizes hybrid nozzle by combining the features of ultrasonic nozzle and atomizing nozzle to spray dry fog which provide atomization of water drops in the range of sub-micron metre size (1–20 μm size) for proper agglomeration with dust particles (PM2.5 and PM10) and allowing them to settle down by adding less than 0.1% moisture in the surrounding atmosphere. The system can operate in manual as well as automated mode using programmable logic controller, proximity sensor, zero switch sensor, machine status sensor, under belt sensor and pollution sensor, and the automatic operating mode can be selected from remote operation facility. The technology has been filed for patent and licensed to M/s Control Systems and Solutions, Kolkata. The system has been installed in Donimalai Crushing and Screening Plant of NMDC Limited located at Ballery district in Karnataka state.

Fig. 7.24: Dry fog dust suppression system installed in Donimalai Iron Ore Mine of NMDC Limited:
(a) Air compressor and receiver, (b) Control panel, (c) Dry fog nozzles, and
(d) Dust emission status before and after installation of the system
DIOM

Controlled blasting technology for construction of Bangalore and Mumbai Metro Rail Projects

CSIR-CIMFR was appointed as a technical consultant for Bangalore and Mumbai Metro Rail Corporation for design and monitoring of controlled blasting for rock excavations at three major stations at Bangalore and two major packages covering 6 underground stations at Mumbai. The proposed blasting zones are surrounded by very sensitive and critical structures like temples, high raise structures old buildings etc. at a minimum distance range of 10-30m, making the blast design as the most challenging task. The rock excavation required at Bangalore Metro was 1.5 lakh cubic meters and at Mumbai Metro was 2.5 lakh cubic meters for both Package-1 &7.

CSIR-CIMFR developed tailor-made controlled blasting technology for opencut applications like Sensitive Urban Metro Rail construction projects as well as for underground civil and infrastructural projects like tunnels and caverns. Application of this technology fetched substantial and consistent revenue for the institute and tangible benefits in terms of safety and productivity improvement to clients. These user friendly blasting techniques ensured total control of all the environmental problems due to blasting and confidence building measures in habitats in the vicinity of Metro Rail construction projects.

MEMS Technology Based Pressure Sensor

MEMS technology-based pressure sensors for low (0.5 bar) and high pressure (100 bar, 200 bar) applications with operation at elevated temperatures (100 – 200 Degree C) for diffused, polysilicon and SOI based pressure sensors have been developed and successfully delivered to BARC Mumbai. Stainless steel housing with capability of holding 200 bar pressure at elevated temperature has been successfully developed and implemented for MEMS pressure sensor. The Development of MEMS technology-based Pressure Sensors was carried out under the MoU between BARC Mumbai and CSIR-CEERI Pilani.

Air Conditioner Efficiency Monitoring System (ACE Meter)

ACE Meter has been designed by CSIR-CSIO to evaluate the running performance of window air conditioners installed in residential and commercial establishments by logging basic parameters of the air-conditioner, as its performance deteriorates over time. At present there is no standalone instrument available which can generate the Energy Efficiency Ratio (EER) of an air-conditioner unit. The instrument provides facility of data-logging and computer compatibility and is easy to install and operate.

Fig. 7.25: Controlled blasting technology for construction of Bangalore and Mumbai Metro Rail Projects

Fig.7.26: Developed Prototype in Laboratory Set-up

Design and Development of indigenized Customized Microprobe Positioning System

An indigenized Customized Microprobe Positioning System was designed and developed by CSIR-CSIO which was successfully handed over to the INST, Mohali within the delivery deadline, has led to significant savings in foreign exchange, as acknowledged by the user.

Unattended Seismic Ground Movement Detection System

Seismic sensors are important tools of security system that focus on security in unmanned areas, to detect, identify, and locate sources. During the year, unattended seismic activity node has been realized and installed at CSIR-CSIO campus for data recording and further results validation as shown below. The ground activity can be detected using seismic sensors i.e. geophones and are placed as an array to cover the required regions. CSIR-CSIO has designed 'Seismic Ground Movement Detection System' which is a customizable intelligent system which is capable of interfacing with a number of seismic sensors and has a number of in-built detection algorithms.

Fig.7.27: Unattended Seismic Ground Movement Detection System installed at CSIR-CSIO campus

SDG 11: Sustainable Cities and Communities

Stepwise repeated D-stabilisation and Stabilisation of collapsible soil mass by "Soil Nailing Technique" used for construction of Railway/Road underpasses

Underground structures are generally constructed by conventional cut and cover method involving large-scale excavation which, sometimes are highly disruptive to sudden collapse and harmful to neighbouring properties. To overcome the deficiencies, CSIR-CRRI has innovated a noble technique for the construction of underpasses under the live road/rail loading conditions. The combo technique 'soil nailing with box jacking' for construction of underpass through the collapsible soils without disturbing the ground structure has been undertaken. This technique reinforces the ground by insertion of designed soil nails at the desired site. During the process of underpass construction the soil nailing increases the load bearing/tensile capacity of existing soil, restrained the lateral as well as vertical displacements and also prevents the sudden collapsible behaviour of soil under loading conditions. Therefore many rail/road underpass projects (rail underpass- (i) Yamuna bazar, (ii) Apsara Border, Delhi, (iii) Shahibabad, and road underpass- (iv) Delhi-Gurgaon National Highway near IGI airport) through the collapsible (sandy soil) have been successfully and safely completed using the soil nailing with box jacking.

Air Quality linked Traffic Alert System (AQTAS)

For making the commuters aware of the information of real-time traffic emission and air pollution, CSIR-NISTADS developed a prototype Air Quality linked Traffic Alert System (AQTAS) for smart management of traffic based on observations and findings. AQTAS will display real time pollution level to commuters to enable them to take an appropriate alternative traffic route to avoid exposure to extreme pollution events.

SDG 12: Responsible Consumption and production

Synthesis of styrene from refinery distillates (C6-C20)

Styrene is one of important co-monomers in polymer industries and there is no indigenous process for its production. 100% styrene is imported and utilized to meet the demand. CSIR-IIP is currently working to develop a novel pathway for the utilization of light to middle distillates in refinery to synthesize styrene. The conventional route of ethylbenzene dehydrogenation is cost intensive due to complexity of separation of styrene from feed because of close boiling points. Hence, the synthesis of styrene from refinery distillates will not only provide a cost effective synthesis, but also provide an alternate and novel route for refinery-petrochemical integration for meeting the demand of styrene.

Automatic Rice Classification System

Automatic rice classification system developed by CSIR-CSIO is based on flat-bed scanner and image processing. The rice grains are classified as per uniform specifications of rice given by Government of India. The rice sample (usually 20 gm) is drawn randomly from the rice consignment received by the government agencies and is placed on a sample holder on a flat-bed scanner. The scanner scans the rice grains at a pre-determined resolution and the acquired image is given to the image processing software for detailed analysis. The method reveals size and colour features of the rice grains. The technology was transferred to M/s Ambala Associates, Ambala.

SDG 13: Climate Action

Evaluation of WRF simulated multi-level soil moisture, 2m air temperature and relative humidity with in-situ observations over India

The accurate forecasting of near surface weather parameters is essential for prediction of extreme weather events, air pollution modelling, fog forecasting, and crop yield. CSIR-4PI focused on the evaluation of skill of Weather Research and Forecasting (WRF) model in simulating multi-level soil moisture, 2m-air temperature (T2m) and 2m-relative humidity (RH2m) over five different locations in India. The WRF model simulations were carried out for 30 cases during different seasons with two different land surface schemes (Noah and RUC). The simulations were compared with in-situ observations which were deployed to routinely measure at 30-minute time interval over the selected five locations. Statistical evaluation showed that though the model could simulate soil moisture reasonably well (majority of the cases fall in <25% relative error (RE) category) at different depths over Delhi and Gulbarga, the model errors were high (most of the cases fall in >50% RE category) over Almora, Hyderabad and Cochin. In general, the diurnal variation showed that the model underestimated (overestimated) afternoon temperatures during non- rainy (rainy) days. The RH2m were also well simulated by the model over the locations Hyderabad, Gulbarga, and Cochin, though it underestimated RH2m during morning hour over the locations of Almora and Delhi.

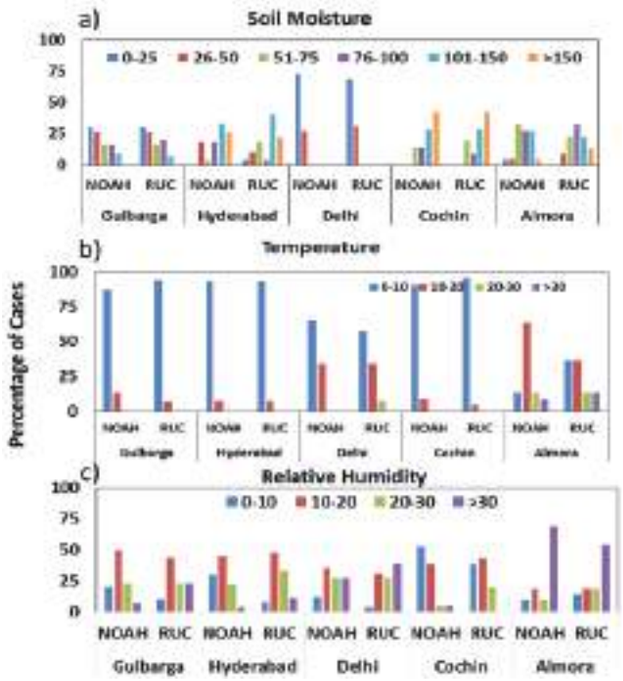


Fig.7.28: Percentage of cases in different error bins for the parameter surface soil (a) moisture, (b) temperature, and (c) relative humidity

SDG 14: Life Below Water

Carbon Cycle and Ocean Modelling

Effect of Iron Limitation on the Specific Growth Rate of Phytoplankton: Detailed analysis of the results of numerical simulations of a marine biogeochemical model was carried out by CSIR-4PI to understand the effect of iron limitation parameter (Fe:N)irr on the Deficiency of Iron (through chlorosis factor which is a function of Fe:N ratio, which modulates Chl:N ratio), Leibig Limitation for nutrient uptake, Specific Growth rates for Large and Small Phytoplankton, in the north Indian Ocean. It was noted that if (Fe:N) irr is decreased, Chlorosis is increased (i.e., iron limitation is reduced), specific growth rate for large and small phytoplankton are increased during some months and at some regions in the Arabian Sea which is reflected in the increase of primary productivity for both large and small phytoplankton. It was also observed that there is no change in primary productivity when (Fe:N)irr is decreased in the east of 65° E in the Arabian Sea. This study has shown that primary productivity and chlorophyll increase, nitrate and pCO2 decrease during January-March and September- December, when iron limitation is reduced in the north and north-west regions of the Arabian Sea.

Seabed Resident Profiler

The Seabed Resident Profiler consists of two interconnected systems. Firstly, the seabed

unit which houses a winch, sensors, batteries, electronics and is anchored to the seabed through an acoustic release. The seabed unit with the anchor weight is negatively buoyant. However, CSIR-NIO has designed the same to be positively buoyant after release of the anchor weight. After completion of a mission and release of the anchor weight, the SREP float to the surface. The second subsystem is a profiling unit which is connected to the seabed unit through the winch rope and acoustic communication. The profiling unit is positively buoyant and houses scientific and operational sensors.

SREP deployed from ship sinks to the seabed and gets anchored; based on mission program and after communication between seabed unit and profiler the winch releases rope to enable profiler to travel up the water column and retracts after specified vertical column is traversed; The SREP enters sleep mode until next mission time; After completion of entire mission, the acoustic release is energised and the SREP floats to surface to be hauled back to the ship.

Fig. 7.29: Seabed unit with profiler unit

Deployments: The SREP was successfully deployed off Goa from 15th June to 29th July 2018 during the monsoons.

SDG 15: Life on Land

Pilot Deployment of Intelligent Elephant Movement Detection and alert system near Kansrao railway track, Rajaji Tiger Reserve, Dehradun

In accordance with UN Sustainable Development Goal 15, a pilot deployment of an intelligent seismic sensing system to track moving elephants christened as eleSeis Alert has been initiated at Kansrao range, Rajaji Tiger Reserve (RTR), Uttarakhand. Indian railways passes through RTR for a distance of about 11 km and often there are incidents of elephants falling in the trap of running wheels while crossing the track for quest for water and food. CSIR-CSIO with a collaborative effort from Worldwide Fund for Nature-India, Wildlife Institute of India, Dehradun and Uttarakhand Forest department eleSeis Alert has been deployed from last 1 year for detection of moving elephants near the vicinity of railway track.

Fig. 7.30: CSIR-CSIO Intelligent Seismic Sensing System deployed at site

IMPORTANT SCIENTIFIC & TECHNICAL ATTAINMENTS

IMPORTANT SCIENTIFIC & TECHNICAL ATTAINMENTS

8.0 IMPORTANT SCIENTIFIC & TECHNICAL ACHIEVEMENTS – (ACADEMIC IMPACT)

Inflammasome activation in Kupffer cells confers a protective response in non-alcoholic steatohepatitis

Inflammasome activation in liver macrophage related to non-alcoholic steatohepatitis has been explored by CSIR-IICB. Hepatocellular death or ballooning distinguishes the transition of simple steatosis to irreversible non-alcoholic steatohepatitis (NASH). However, the molecular mechanism of hepatocellular apoptosis in NASH is largely unclear, and discovery of endogenous mediators that could prevent or inhibit cell death is thereby critical in intercepting NASH progression. CSIR-IICB has identified pigment epithelium-derived factor (PEDF), a secreted, moonlighting hepatokine as 1 hepatoprotective agent in mice with diet-induced NASH. Hepatic PEDF expression is induced by IL-1β, which is derived from inflammasome activation in liver-resident Kupffer cells. This study highlights PEDF as a functionally important hepatokine in NASH progression by linking inflammasome activation and hepatocellular death.

Discovery of a major-groove-specific nuclear-localizing, cell-penetrating tetrapeptide.

Identification of key amino acids is required for development of efficient cell-penetrating peptides (CPPs) and has tremendous implications in medicine. CSIR-IICB has studied the importance of two amino acids, arginine and tryptophan, in cell penetration and developed short, non-toxic tetrapeptides with excellent potential for cell penetration and nuclear localization. Among them, Glu-Thr-Trp-Trp (ETWW) emerges as the most promising. Results suggest that it enters into cancer cells following an endocytic pathway and binds at the major groove of nuclear DNA, where successive tryptophan plays major role. CSIR-IICB subsequently showed that it is not a P-glycoprotein substrate and is non-toxic to PC12-derived neurons, suggesting its excellent potential as a CPP. Furthermore, its potential as a CPP is validated in multi-cellular 3D cell culture (spheroid) and in in vivo mice model. This study provides major fundamental insights about the positional importance of tryptophan and opens new avenues toward the development of next-generation CPPs and major-groove-specific anticancer drugs.

High Performance Computing and Cyber Security

- **Adaptive Traffic Signal Control in Vehicular Networks: Simulation model developed by CSIR-4PI**

Existing road intersection management is done through traffic lights. The inefficient traffic light control causes numerous problems, such as long delay of travellers, huge waste of energy and worsening air quality. It may also contribute to vehicular accidents. Artificial Intelligence provides the ability to continuously learn to augment its ability to make good judgment by recognizing its

surrounding. Reinforcement learning (RL) is a part of machine learning paradigm where an agent aims to maximize the reward by choosing the right action, by interacting with the environment repeatedly to develop a suitable policy. The comparison in traffic condition with and without using the Re-inforcement learning. Here, the number of vehicles on the road at a time is treated as the parameter to define the performance. It can be seen that, in the initial stage, there are not much improvement in the case, where the signal is controlled using RL. However, as the time progresses, the RL learns from the traffic pattern and improves the traffic condition. The results is an outcome of the simulations carried out using SUMO (Simulation of Urban Mobility)

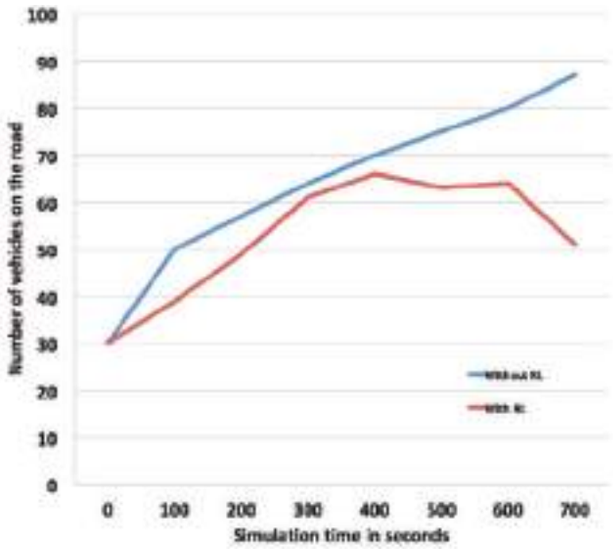


Fig. 8.I: Number of vehicles on the road for the two scenarios of traffic control (one with RL and one without RL). Decrease in the number of vehicles on the road is an indication of the increase in efficiency

- **Highly sensitive detection of dipicolinic acid with a water-dispersible terbium-metal organic framework**

The sensitive detection of dipicolinic acid (DPA) is strongly associated with the sensing of bacterial organisms in food and many types of environmental samples. The demand for a sensitive detection method for bacterial toxicity has increased remarkably. Herein, CSIR-CSIO investigated the DPA detection potential of a water-dispersible terbium-metal organic framework (Tb-MOF) based on the fluorescence quenching mechanism. The Tb-MOF showed a highly sensitive ability to detect DPA at a limit of detection of 0.04 nM (linear range of detection: 1 nM to 5 μM) and also offered enhanced selectivity from other commonly associated organic molecules. The present study provides a basis for the application of Tb-MOF for direct, convenient, highly sensitive, and specific detection of DPA in the actual samples.

- **MOF-Bacteriophage Biosensor for Highly Sensitive and Specific Detection of Staphylococcus aureus**

To produce a sensitive and specific biosensor for Staphylococcus aureus, bacteriophages have been interfaced with a water-dispersible and environmentally stable metal–organic framework (MOF). The conjugation of the MOF with bacteriophages has been achieved by CSIR-CSIO through the use of glutaraldehyde as cross-linker. Highly sensitive detection of S. aureus in both synthetic and real samples was realized by the MOF–bacteriophage biosensor based on the photoluminescence quenching phenomena: limit of detection (31 CFU/mL) and range of detection (40 to 4 × 108 CFU/mL). This is the first report exploiting the use of an MOF–bacteriophage complex for the biosensing of S. aureus. The results of study highlight that the proposed biosensor is more sensitive than most of the previous methods while exhibiting some advanced features like specificity, regenerability, extended range of linear detection, and stability for long-term storage (even at room temperature).

Antiproliferative efficacy of curcumin mimics through microtubule destabilization

Curcumin possesses an attractive chemical structure with highly conjugated diferuloylmethane core. CSIR-CIMAP has designed and prepared curcumin mimics with an additional bridged phenyl ring in conjugation. Fourteen diverse

analogues were evaluated against a panel of human cancer cell lines. The best analogue of the series i.e. compound 6a exhibited potent cytotoxicity against A431, epidermoid carcinoma cell line and DLD1, colorectal adenocarcinoma cell line. Further, in acute-oral toxicity experiment in rodent model, compound 6a was given in three different oral doses to Swiss albino mice. There were non-significant changes in various biochemical parameters and major body organs studied, including their absolute and relative weights. It was tolerable up to 300 mg/kg dose in Swiss-albino mice. The present study shows that the novel Curcumin mimic 6a is a safe and efficacious anticancer compound. However, it needs to be optimized for better efficacy.

Rutin protects t-butyl hydroperoxide-induced oxidative impairment via modulating the Nrf2 and iNOS activity

Rutin (quercetin-3-O-rutinoside), a flavonoid, is predominantly found in the buckwheat, cranberries, mulberry and citrus fruits. It is used as a restorative in the preparation of herbal medicine, multivitamin. CSIR-CIMAP aimed to elucidate whether rutin attenuates oxidative stress and its possible mechanism of action in ameliorating the deleterious effect of t-BHP and provide evidence that rutin protects the antioxidant status of erythrocytes and liver via Nrf2 and iNOS pathway from oxidative stress. The study concluded that the dietary factors wherein rutin is an ingredient could be helpful in the maintenance of the intracellular redox-homeostasis and thus may be effective against oxidative stress-related secondary complications.

Multifunctional amines enable the formation of polyamide nanofilm composite ultrafiltration and nanofiltration membranes with modulated charge and performance

Conventional thin film composite (TFC) nanofiltration (NF) membranes are positively or negatively charged with an active layer thickness of several nanometers depending on the preparation conditions. Low molecular weight cut-off (MWCO) ultrafiltration (UF) membranes obtained by the phase inversion process show low permeate flux due to the formation of a several micrometre thick skin layer. CSIR-CSMCRI has developed an extremely simple route to produce novel TFC NF (MCO~180 Da) and UF (MWCO~1 and 10 kDa) types of membranes with an active layer thickness in the range of 12–36 nm via supported interfacial polymerization using polyethyleneimine (PEI) as a monomer. TFC NF membranes exhibited a permeate water flux of 19–24 L m2 h-1bar-1 which is about 4–5 times higher than those of PEI-based membranes and 1.3–4 times higher than few commercial NF membranes of similar MWCOs. The process is scalable, and the membranes are useful for the separation of charge and neutral solutes with high efficiency.

Picomolar detection of retinol binding protein - 4 for early management of type II diabetes

Type (II) diabetes is one of the major threats to mankind as it causes insulin resistance in human body. Retinol Binding Protein 4 (RBP4) is currently considered as a potential biomarker for early management of thisdisease and its low-level detection is animportant task. A novel RBP4 biosensorhas been developed by CSIR-CSMCRI using homemade plastic chip electrodes (PCEs) as a platform for self-assembledmonolayer (SAM) of 4-ATP and further functionalization with glutaraldehyde. Anti RBP4 is used as biorecognitionspecies and electrochemical impedance spectroscopy was used for analysis. A wide concentration range from 100 fg/mL to 1 ng/mL has been tested and a low limit of detection (LOD) of 100 fg/mL has been achieved. This is the first report forfabrication of electrochemical biosensor of RBP4 using Ag-Ab interaction having such low LOD. Excellent reproducibility and quick measurement makethis

biosensor extremely useful for the biomedical industry.

Mitigation of Climate change using seaweed based biostimulant: A case study with sugarcane cultivation in India

Strategies for sustainably increasing sugarcane productivity without any negative implications to the environment are challenging. CSIR-CSMCRI demonstrated successfully the potential of an agro-technique involving foliar applications of Kappaphycusalvarezii seaweed based biostimulant in combination with recommended rate of synthetic fertilizers (RRF) for sustainably enhancing sugarcane production and mitigating environmental impacts. Kappaphycus seaweed extract (KSWE) applied at 5% concentration enhanced cane productivity by 12.5 and 8%, respectively, in plant and ratoon crops. The present study advocates a paradigm shift in policy to encourage use of biostimulants in the context of mitigating adverse effects of global climate change and expecting better returns from sugarcane cultivation.

Specific Cholesterol Binding Drives Drastic Structural Alterations in Apolipoprotein A1

The Apolipoprotein A1 (ApoA1) is the major constituent (70%) of high-density lipoproteins (HDL) and yet, the functional monomeric lipid-free form of the protein remained to be solved. CSIR-IGIB has constructed the first complete ApoA1 monomer structure using large-scale multiple independent atomistic molecular dynamics trajectories. It proposes a mechanism whereby ApoA1 opens in a stagewise manner and mutation at the novel N-terminal site abrogates ApoA1 opening. Thus, availability of the first complete lipid-free structure of ApoA1 shall enable to deciphering the molecular mechanisms of further downstream reactions in reverse cholesterol pathway and shall significantly advance in understanding and maintaining cardiovascular health.

Zinc Oxide Nanoparticles Dispersed in Ionic Liquids Show High Antimicrobial Efficacy to Skin-Specific Bacteria

Zinc oxide (ZnO) nanoparticles have antibacterial properties and are used in many commercial products that exploit this property. However, since these nanoparticles show tendency to aggregate, their efficacy can be reduced. CSIR-IGIB has demonstrated that maximum efficiency is obtained for ZnO nanoparticles dispersed in imidazolium-based ionic liquid against skin-specific S. epidermidis. The dispersion is also biocompatible and non-toxic to normal skin keratinocytes. S. epidermidis is a prevalent causal agent for different hospital-acquired infections. In most cases, antibiotic-based therapies are not very effective for combating these infections. The ZnO-IL combination can be developed as a potent antibacterial formulation for treating such infections.

Differential transcriptome modulation leads to variation in arsenic stress response in Arabidopsis thaliana accessions

Arsenic (As) is a ubiquitous metalloid and a health hazard to millions of people worldwide. The presence of As in groundwater poses a threat as it not only affects crop productivity but also contaminates food chain. In recent past, natural variation in Arabidopsis thaliana has been utilized to understand molecular and genetic adaptation under different stresses. Responses of Arabidopsis accessions were analyzed at biochemical and molecular levels towards arsenate [As (V)] stress at CSIR-NBRI. On the basis of reduction in root length, accessions were categorized into tolerant and sensitive ones towards As (V). A number of genes associated with defense and stress-response, transport system, regulatory mechanisms and biochemical processes showed differential expression in contrasting accessions.

Application of four novel fungal strains to remove arsenic from contaminated water in batch and column modes

CSIR-NBRI identified four novel fungal strains (FNBR_3, FNBR_6, FNBR_13, and FNBR_19) that can remove arsenic from contaminated water in batch and column modes. Alginate beads containing 0.1 g biomass were used in a batch experiment (200 mg l-1As; pH 6). Changes in the surface of fungal cells and intracellular As-uptake by fungal biomass were also confirmed by scanning electron microscopy combined with X-ray energy dispersive spectrometer. The presence of different functional groups on fungal cells capable of As-binding was investigated by FTIR. The As-removal by immobilized fungal beads tested in the packed columns also. The As-adsorption by biomass (qe as mg g-1) were recorded as 59.5 (FNBR_3 and FNBR_6), 74.8 (FNBR_13), and 66.3 (FNBR_19) in the column and validated by Thomas model.

Zinc oxide-NP catalyzed direct indolation of in situ generated bioactive tryptanthrin (Green Chemistry

A ZnO-NP catalyzed direct indolation of in situ generated tryptanthrin viaC–H functionalization and C–C bond formation has been developed by a team of researchers from CSIR-CDRI. This novel and greener approach has been effectively utilized to accomplish the synthesis of 6-hydroxy-6-(1H-indol-3-yl)indolo[2,1-b] quinazolin-12(6H)-one derivatives in good to excellent yields with high product selectivity. Besides the in situ approach, a direct indolation of tryptanthrin has also been developed.

siRNA delivery using a cationic-lipid-based highly selective human DNA ligase I inhibitor

A team from CSIR-CDRI & IICT illustrated the serendipitous discovery of a cationic-lipid-based human DNA ligase (hLig) I inhibitor and the development of siRNA delivering, a hLigI-targeted cationic-lipid-based non-viral vector. They have tested a small in-house library of structurally similar cationic lipo-anisamides for antiligase activity, and amongst tested, N-dodecyl-N-(2-(4-methoxybenzamido) ethyl)-N-methyldodecan-1-ammonium iodide (C12M) selectively and efficiently inhibited the enzyme activity of hLigI, compared to other human ligases (hLigIIIβ and hLigIV/XRCC4) and bacterial T4 DNA ligase. Furthermore, upon hydration with equimolar cholesterol, C12M produced antiligase cationic liposomes, which transfected surviving siRNA and showed significant inhibition of tumor growth.

Ammonium trichloro [1,2-ethanediolato-O,O']-tellurate cures experimental visceral leishmaniasis by redox modulation of Leishmania donovani trypanothione reductase and inhibiting host integrin linked PI3K/Akt pathway

In an endeavor to search for affordable and safer therapeutics against debilitating visceral leishmaniasis, a team from CSIR-CDRI examined antileishmanial potential of ammonium trichloro [1,2-ethanediolato-O,O']-tellurate (AS101); a tellurium based non-toxic immunomodulator. AS101 showed significant in vitro efficacy against both Leishmania donovani promastigotes and amastigotes at sub-micromolar concentrations. AS101 could also completely eliminate organ parasite load from L. donovani infected Balb/c mice along with significant efficacy against infected hamsters (>93% inhibition). Analyzing mechanistic details revealed that the double edged AS101 could directly induce apoptosis in promastigotes along with indirectly activating host increased ROS generation and anti-leishmanial IgG production. AS101 could inhibit IL-10/STAT3 pathway in L. donovani infected macrophages. These findings provide the first evidence for the mechanism of action of AS101 with excellent safety profile and suggest its promising therapeutic potential against experimental visceral leishmaniasis.

Biofilm: a resource of anti-biofilm agents and their potential implications in targeting antibiotic drug resistance

Biofilms play an important role in the antibiotic drug resistance, which is threatening public health globally. Almost, all microbes mimic multicellular lifestyle to form biofilm by undergoing phenotypic changes to adapt adverse environmental conditions. Many anti-biofilm agents have been experimentally validated to disrupt the biofilms during last three decades. To organize this data, CSIR-IMTECH developed the 'aBiofilm' resource (http://bioinfo.imtech.res.in/manojk/abiofilm/) that harbors a database, a predictor, and the data visualization modules. The database contains biological, chemical, and structural details of 5027 anti-biofilm agents (1720 unique) reported from 1988-2017. These agents target over 140 organisms including Gram-negative, Gram-positive bacteria, and fungus. They are mainly chemicals, peptides, phages, secondary metabolites, antibodies, nanoparticles and extracts. They show the diverse mode of actions by attacking mainly signaling molecules, biofilm matrix, genes, extracellular polymeric substances, and many more. The QSAR based predictor identifies the anti-biofilm potential of an unknown chemical with an accuracy of ~80.00%. This comprehensive platform would help the researchers to understand the multilevel communication in the microbial consortium. It may aid in developing anti-biofilm therapeutics to deal with antibiotic drug resistance menace.

Drug and nanoparticle-mediated rapid naked eye water test for pathogens detection

Inspired by the interaction of colistin with lipopolysaccharides (LPS) of the bacterial outer membrane, CSIR-IMTECH described a simple, cost effective and rapid assay for the detection of bacterial contamination in water samples. Colistin, a bactericidal drug, has been used in a receptor configuration for detection of pathogenic microorganisms without involving any tedious sample preparation step. The approach employs the cationic antibiotic drug for dual purpose, firstly, as a primary binder for pathogens and secondly, as an aggregator for negatively charged Gold nanoparticles (GNPs). The former consists of colistin binding to bacteria in water that renders GNPs free in solution thus depicting red color and the latter shows colistin driven aggregation of GNPs producing blue colored solution. The assay works in a two-step procedure that involves addition of colistin and GNPs to the water sample before results can be visualized based on color change. The assay is sensitive at a concentration up to 10 bacterial cells mL_1 in a time frame of 5 min without requiring any expensive reagents and instruments.

Alternative route for improving photosynthesis in crop plants

CSIR-IHBT identified a unique pathway for re-assimilation of photorespired CO_2 and NH_3 in C_3 plants at high altitude. Pathway was transplanted with success in Arabidopsis, a C_3 plant species; the transgenics showed improved photosynthesis and yield, and reduced photorespiratory losses. The work which shows an alternative route for improving photosynthesis in crop plants through introduction of C4-like traits into C_3 plants, was well appreciated by the F1000 prime group (a faculty of more than 8,000 international leading experts in biology and medicine).

Purification, identification and characterization of two novel antioxidant peptides from finger millet (Eleusinecoracana) protein hydrolysate

CSIR-IHBT successfully identified antioxidant peptides from a finger millet protein hydrolysate. Two potential antioxidant peptides were identified as TSSSLNMAVRGGLTR and STTVGLGISMRSASVR. Synthetic peptides with the same sequence were synthesized and

characterized for their antioxidant activity. Molecular docking studies revealed that potential antioxidant activity from both peptides resulted from the interaction of serine and threonine residues with free radicals. The current study suggested that natural peptides identified from finger millet have potent antioxidant activity and regarded as a promising source for a functional food ingredient.

Plant virology studies

In the area of virology, wildly growing Ficuspalmata was identified as a natural host of apple stem grooving virus, a very important virus of apple. In another study, Rumexnepalensis was identified as an off-season host of Tomato leaf curl virus. Interestingly, P. kurroa, an ethnopharmacologically important endangered medicinal herb, traditionally used in several preparations of Indian Ayurvedic medicine, was found to be naturally infected by a complex of alternanthera yellow vein virus and cotton leaf curl Multan betasatellite when grown at mid hill altitude in Palampur. Alternate hosts are important for survival of the viral pathogens during unfavourable conditions.

Rhamnolipid from a Lysinibacillussphaericus strain IITR51 and its potential application for dissolution of hydrophobic pesticides.

Rhamnolipid produced from a Lysinibacillussphaericus IITR51 was characterized and its ability for dissolution of hydrophobic pesticides were evaluated by CSIR-IITR. L. sphaericus produced 1.6 g/L of an anionic biosurfactant that reduced surface tension from 72 N/m to 52 N/m with 48% emulsification index. The biosurfactant was found stable over a wide range of pH (4.0-10.0), temperature (4-100 °C), saltconcentration (2-14%) and was identified as rhamnolipid. The bacterium utilized benzoic acid, chlorobenzene, 3- and 4-chlorobenzoic acid as sole source of carbon and was found resistant to arsenic, lead and cadmium. Furthermore, the isolated biosurfactant showed antimicrobial activities against different pathogenic bacteria. The results obtained indicate the usefulness of rhamnolipid for enhanced dissolution and thereby increasing the bioavailability.

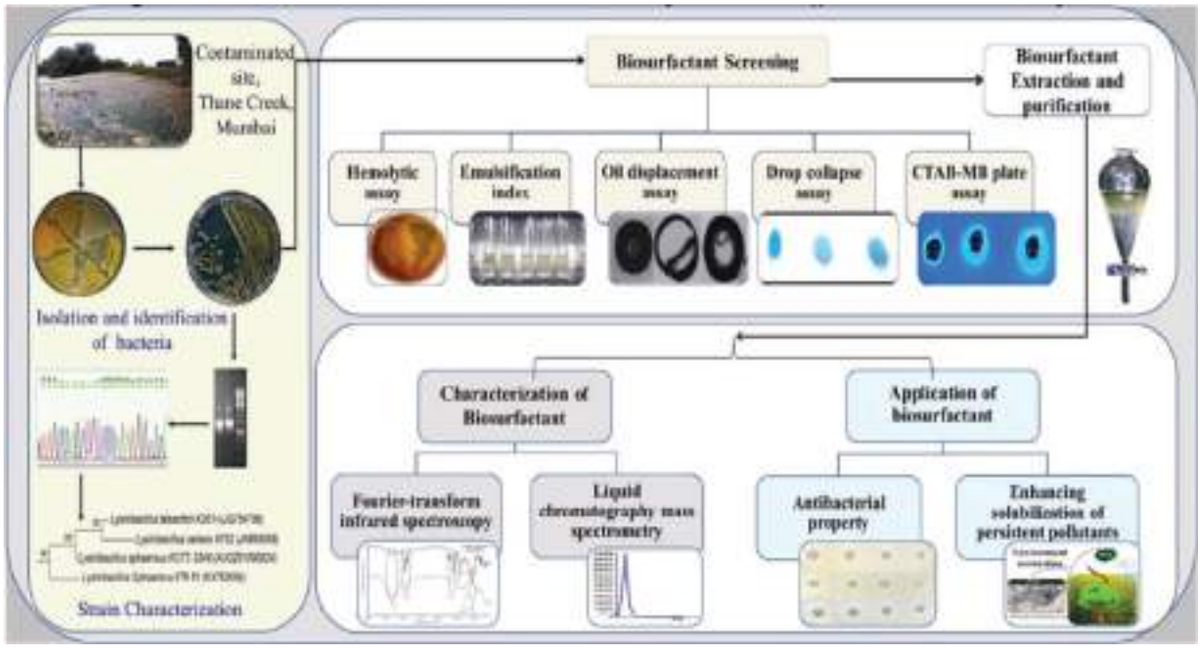


Fig. 8.2: Anoinic biosurfactant by bacteria

Improved polycyclic aromatic hydrocarbon degradation in a crude oil by individual and a consortium of bacteria.

In this study, CSIR-IITR reported the ability of Stenotrophomonas maltophilia, Ochrobactrumanthropi, Pseudomonas mendocina, Microbacteriumesteraromaticum and Pseudomonas aeruginosa to degrade multiple polycyclic aromatic hydrocarbons (PAHs) present in crude oil. The PAHs in the crude oil sample obtained from Digboi oil refinery, India were estimated to be naphthalene (10.0 mg L-1), fluorene (1.9 mg L-1), phenanthrene (3.5 mg L-1) and benzo(b)fluoranthene (6.5 mg L-1). Consortium of these bacteria showed enhanced biodegradation of 89.1%-naphthalene, 63.8%-fluorene, 81% of phenanthrene and 72.8% benzo(b)fluoranthene in the crude oil. The degradation was further improved up to 10% by consortium on addition of 40 μg mL-1 rhamnolipid JBR-425 biosurfactant. These results suggest that the developed bacterial consortium has significant potential in PAH remediation.

Preclinical development of Crocus sativus based botanical lead IIIM-141 for Alzheimer's disease

CSIR-IIIM has shown that Crocus sativus extract (IIIM-141) display promising efficacy in a genetic mice (5XFAD) model of Alzheimer's disease (AD). IIIM-141 is primarily a mixture of crocins containing trans-4-GG-crocin (36% w/w) as the principal component. The acute oral toxicity study has shown that IIIM-141 is safe up to the dose of 2000 mg/kg, with no effect on the body weight, and biochemical/ hematological parameters of the rats. The repeated oral administration of IIIM-141 for 28-days at 100 mg/kg dose, does not caused any pre-terminal deaths and abnormalities in Wistar rats. The pharmacokinetic analysis indicated that after oral administration of IIIM-141, the majority of crocin gets hydrolyzed to its aglycone crocetin. The sustained release capsule formulation was developed, which showed improved in vitro dissolution profile and significantly enhanced plasma exposure in the pharmacokinetic study. The data presented herein will serve as the benchmark for the further research on this botanical candidate.

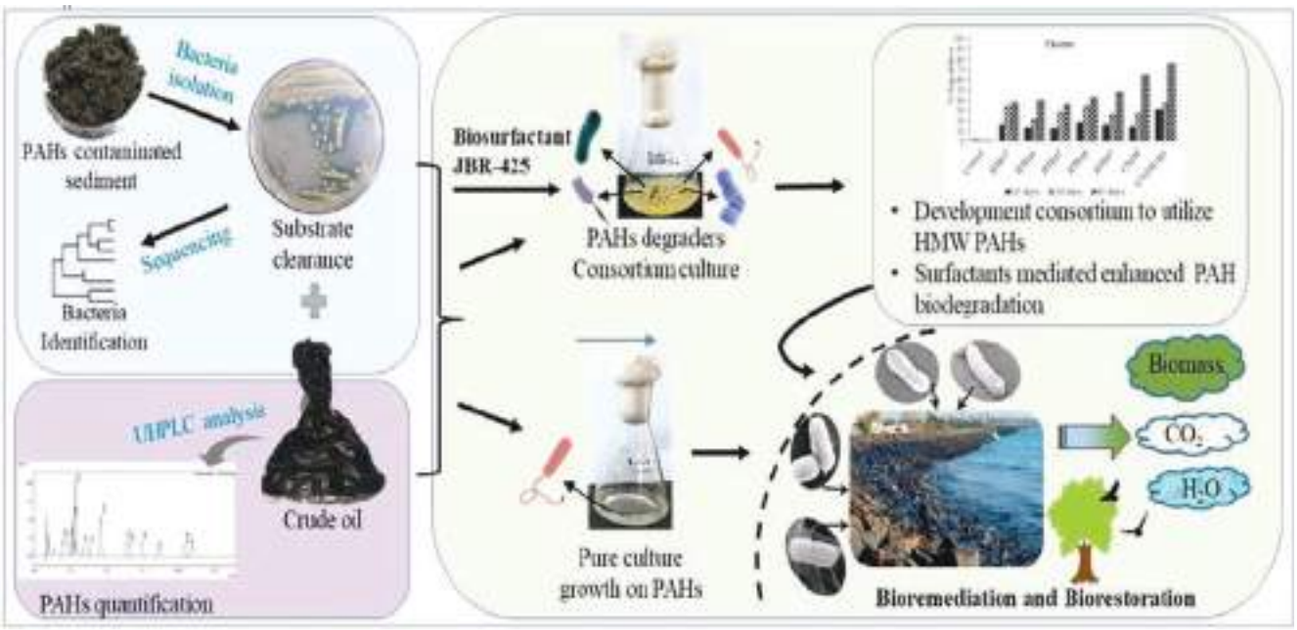


Fig. 8.3: PAH remediation by bacteria

AKT Inhibition Modulates H3K4 Demethylase Levels in PTEN-Null Prostate Cancer

Hyperactivated AKT kinase due to loss of its negative regulator PTEN influences many aspects of cancer biology, including chromatin. AKT primarily regulates Acetyl-CoA production and phosphorylates many histone-modulating enzymes, resulting in their activation or inhibition. Therefore, understanding the therapeutic impact of AKT inhibition on chromatin-related events is essential. Here, CSIR-IIIM reported that AKT inhibition in prostate-specific PTEN knockout mice significantly induces di- and trimethylation of H3K4 with concomitant reduction in H3K9 acetylation. It was observed that miR-137. The mechanism by which AKT kinase modulates the prostate cancer epigenome through regulating H3K4 methylation has been identified. Additional studies on AKT inhibition-mediated induction of H3K4 methylation will help in designing strategies to enhance the therapeutic efficacy of PI3K/AKT inhibitors.

Nitromethane as a Carbanion Source for Domino Benzoannulation with Ynones: One-Pot Synthesis of Polyfunctional Naphthalenes and a Total Synthesis of Macarpine

A one-pot, transition-metal-free, domino Michael/ SNAr protocol of general applicability has been devised by CSIR-IICT for the regioselective synthesis of polyfunctional naphthalenes by employing nitromethane and ortho-haloaryl ynones. Nitromethane has been utilized as a one carbon carbanion source that is incorporated into a variety of ynones to end up as an aromatic nitro substituent. The methodology has been further extended to alicyclic o-haloynones to increase functional diversity pattern and to deliver various benzocarbocyclicscaffolds. The efficacy of this methodology of domino process has been well demonstrated by total synthesis of quarternary benzophenanthridine plant alkaloid macarpine which displays cytotoxic activity against HeLa S3 tumor cell lines with an IC50 of 0.192 mg/mL.

A lipid-based cell penetrating nano-assembly for RNAi-mediated anti-angiogenic cancer therapy

Limited tumor tissue penetration is one of the key impeding factors retarding successful in vivo exploitations of anti-angiogenic cancer therapy. CSIR-IICT reported the design of a cell penetrating peptidedecorated lipid nano-assembly which, upon systemic administration, induces significant mouse tumor growth inhibition via enhanced tumor infiltration of encapsulated anti-angiogenic siRNA.

Awareness Campaign at 100 traffic intersections of Delhi and related studies

When the vehicles are waiting for their turn to clear a signalized intersection, the drivers normally do not keep the engines off and this result in extra fuel consumption due to idling and increased vehicular emissions. This fuel consumption can be saved along with reduction in corresponding emissions by switching off the vehicle engine during idling at signals. A 40 days long awareness campaign was carried out by CSIR-CRRI at 100 signalized intersections in Delhi to create awareness amongst drivers regarding switching off their engines during idling. Impact of awareness campaign was estimated based on the number of vehicles switching-off their engines during idling which is further used to estimate idling fuel losses and corresponding emissions.

The study established that there was 9357 CO_2e (CO_2 equivalent) tonnes of emissions per day at selected 100 signalized intersections before the start of campaign, which reduced to 7976 t/day CO_2e after the study (~14%). Thus, the study helped in saving ~1381 CO_2e tonnes of emissions per day.

Impact of Road Condition on Fuel Consumption of Vehicles

Five roads in NCR were selected by CSIR-CRRI to quantify the fuel consumed per km for typical small car with petrol fuel, big car (SUV) with diesel fuel, and diesel truck in loaded and unloaded conditions. Fuel consumption tests were conducted on good, fair and bad condition of roads to find the fuel consumed by these vehicles for different road conditions at three steady speeds 20, 50 and 70 kmph for the test sample length of 1100 km with fuel sensor installed and road condition measured in term of IRI (International Roughness Index). Section is defined based on IRC guideline (good, fair and poor). Correlations between road condition and fuel consumption for pertro, diesel and truck were established.

This study by CSIR-CRRI showed that good roads with IRI<2.8 have lesser fuel consumption as compared to bad roads with IRI>4.00. Also, saving in fuel is observed at optimum speed of 50 kmph. Maintenance cost to maintain the roads from poor to good is estimated approximately ₹ 25.83 lakh/ km/lane/ year and for poor to fair is ₹ 12.04 lakh per km, whereas fuel cost for poor to good condition, poor to fair were found ₹ 14.45 lakh/ km/ lane/ year and ₹ 41.17 lakh/ km/ lane respectively. The fuel cost was estimated ₹ 41.6 lakh whereas maintenance cost was ₹ 85 lakh km/lane for poor to good for CC roads.

To maintain fair to good condition, the fuel cost was estimated ₹ 15.33 lakh/ lane/ year verses maintenance cost of ₹ 0.5 lakh/ km/ lane/ year. The result in this study will be guiding factor for road maintenance department for utilising the fuel loss comparison verses maintenance cost and decide priority in maintenance activity. A dissemination of the results was done by organizing a national level workshop in CSIR-CRRI on July 05, 2018.

N-richcarbonnano-onionsfromcollagenbiowastesforoxygenreduction reaction

A facile strategy was developed by CSIR-CLRI to synthesize nitrogen-rich carbon nano- onion architectures from the renewable biological resource, collagen, for use as a metal-free ORR catalyst. The product contains an appreciably high percentage of nitrogen (7.5%) integrated into the carbon molecular skeleton. The materials exhibit outstanding ORR electrocatalytic activity with low onset potential, high current density, superior methanol crossover immunity and better durability than the benchmark Pt/C catalyst in alkaline medium. The findings ascertain that renewable biomasses can be easily transformed into novel carbon nanostructures with excellent catalytic activity.

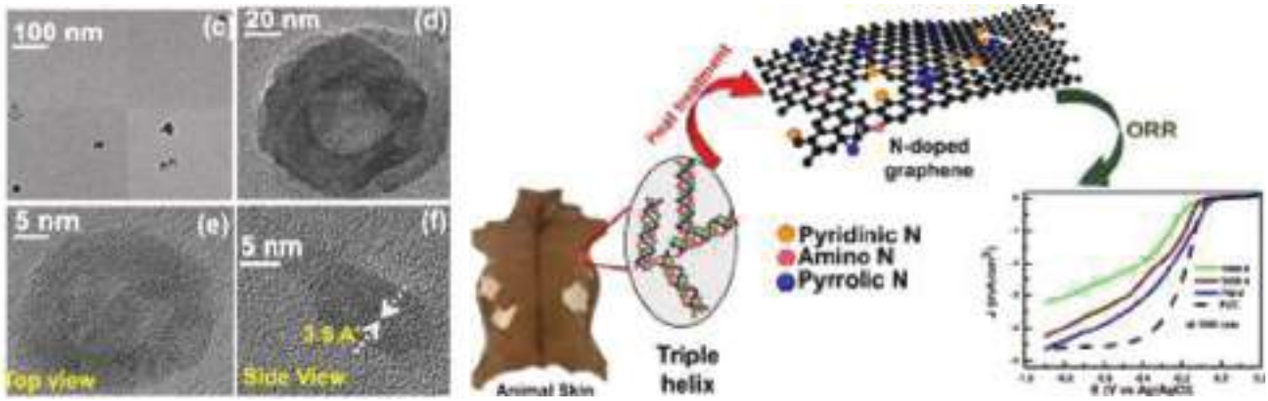


Fig. 8.4: Nano-onions with ORR electrocatalytic activity

Removal of Proteins in High TDS Leather Wastewater by Protease immobilized Nanoporous- Activated Carbon

The technology development was carried out by CSIR-CLRI for the degradation of proteins in high soak liquor (TDS containing wastewater) discharged from leather industry, and the degradation was achieved by halotolerant protease-immobilized functionalized nanoporous- activated carbon (STPNPAC). The protein present in soak liquor was completely fragmented by 90 min at pH 6 and 30^{0}C using STPNPAC-packed bed reactor. The biodegradability index of soak liquor was increased to 0.426, highly favorable for the complete removal of organic components in subsequent operations.

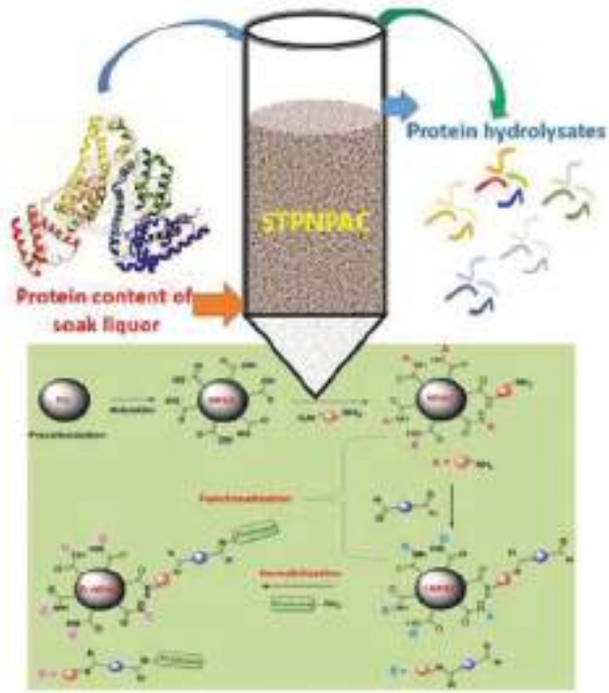


Fig. 8.5: Protein degradation by protease using STPNPAC reactor

Bi-functional Fe@C nanoparticles from collagen biowastes for energy and environmental applications

Bi-functional iron encapsulated carbon (Fe@C) nanoparticles were synthesized from collagen bio-waste for energy and environmental remediation applications. A simple high-temperature treatment transformed highly insulating and paramagnetic collagen-FeCl3 scaffolds into perfectly conducting and ferromagnetic bi-functional Fe@C nanoparticles. The structural and morphological analysis reveals that different phases of Fe nanoparticles are embedded in the graphitized carbon matrix forming a core-shell type of nanostructures. The mesoporous nanoparticles showed an exceptional photocatalytic activity towards 100% degradation of methylene blue within 80 min of sunlight irradiation. CSIR-CLRI demonstrated that the presence of Fe nanoparticles in graphitic carbon lattice enabled an outstanding Li^+ storage property with large reversible specific capacity (~384 mAh/g) after 75 cycles. CSIR-CLRI results provide a cost-effective, scalable and sustainable approach for the synthesis of functional nanomaterials from industrial bio-waste for applications in energy and environmental remediation.

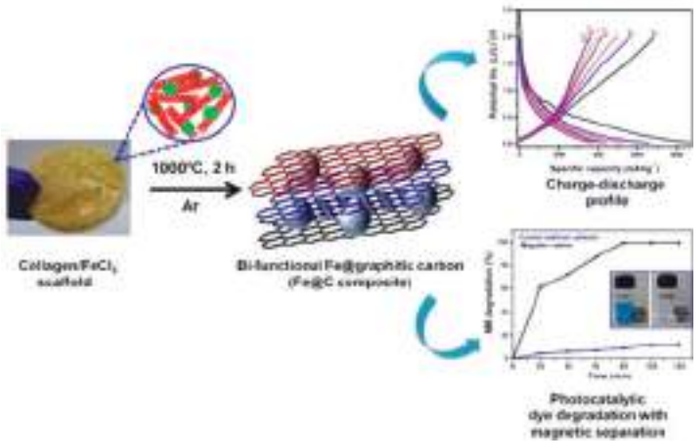


Fig. 8.6: Bi-functional ironencapsulated carbon(Fe@C) nanoparticles synthesized from collagen bio-waste

Shrinking the Hydrogen Overpotential of Cu by 1 V and Imparting Ultralow Charge Transfer Resistance for Enhanced H2 Evolution

Copper and its oxides are among the best electrocatalysts for the electrochemical conversion of CO_2 to value-added small organics because of its high hydrogen

overvoltage, making the hydrogen evolution reaction (HER) a poor side reaction. CSIR-CECRI found an interesting result that turned the nature of surface-oxidized Cu upside down in electrochemical H_2 evolution. It is commonly known that the electrochemical reactivity of a metal ion is highly sensitive to the anion to which it is coordinated in the electrolyte. In the case of Cu, when it is in the form of copper oxide, the hydrogen overvoltage is huge. Nonetheless, it was found that when Cu is in coordination with Se^{2-} ions as Cu_2Se, the hydrogen overvoltage was shrunken by ~1 V, imparting ultralow charge transfer resistance (RCT) that varied from 0.32 to 0.61 Ω depending on the means by which selenization was carried out. The wet-chemical method yielded honeycomb-like hierarchical arrays of Cu_2Se sheets on Cu foam (designated as Cu_2Se-ch/Cu), and the hydrothermal method yielded a uniform array of spiky rods of Cu_2Se (designated as Cu_2Se-ht/Cu). The HER electrocatalytic studies carried out in 0.5 M H_2SO_4 showed that Cu_2Se-ch/Cu and Cu_2Se-ht/Cu had similar kinetics, with Tafel slopes of 32 to 35 mV dec^{-1}, which is closer to the state-of-the-art Pt/C. Interestingly, the Cu_2Se-ch/Cu delivered a total kinetic current density of −1200 mA cm^{-2} when polarized up to −0.85 V vs RHE, whereas Cu_2Se-ht/Cu delivered a maximum of −780 mA cm^{-2} only.

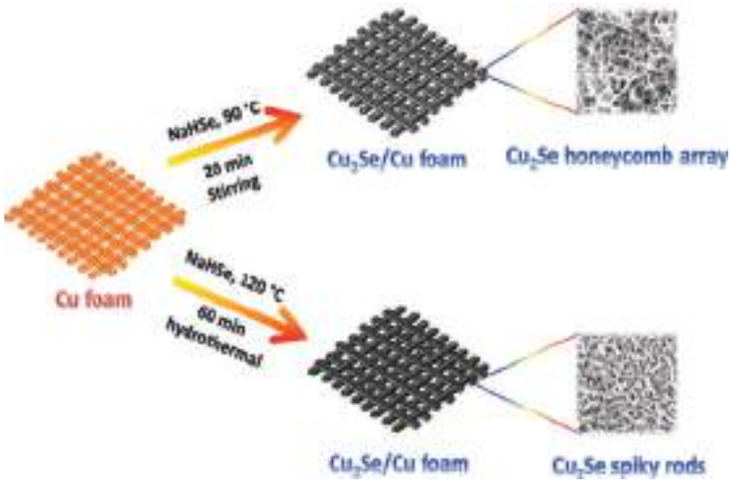


Fig. 8.7: Schematic Depiction of the Selenization of Cu Foam by Conventional Heating and Stirring and Hydrothermal Reaction Conditions

MoS2 Quantum Dots as Efficient Catalyst Materials for the Oxygen Evolution Reaction

The development of an active, earth-abundant, and inexpensive catalyst for the oxygen evolution reaction (OER) is highly desirable but remains a great challenge. By combining experiments and first-principles calculations CSIR-CECRI demonstrate that MoS2 quantum dots (MSQDs) are efficient materials for the OER. Our theoretical and experimental findings provide important insights into the synthesis process of MSQDs and their catalytic properties and suggest promising routes to tailoring the performance of the catalysts for OER applications.

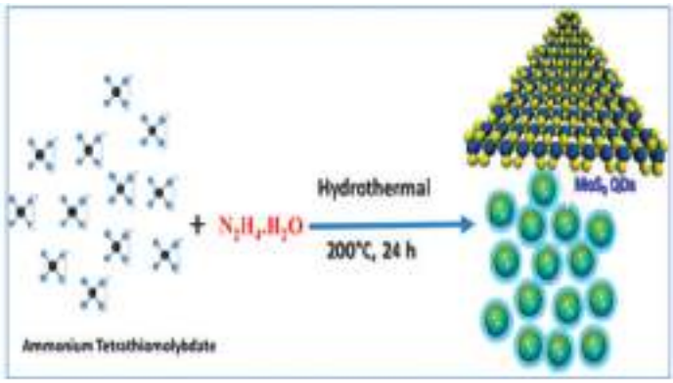


Fig. 8.8: Schematic representation of the MSQD synthesis. Ammonium tetrathiomolybdate was used as a single precursor for MoS_2 growth

Metal–organic framework@SiO_2 as permselective separator for Lithium–Sulfur batteries

The shuttling of polysulfides between the electrodes in a lithium–sulfur battery (Li–S) system remains a challenge to be addressed in order to realize the full potential of this promising technology. In order to overcome this issue several strategies have been adopted by CSIR-CECRI. In this work, UiO-66-NH2@SiO_2 was successfully synthesized and coated on a commercial Celgard 2320 membrane. The coating of UiO-66-NH2@SiO_2 on a Celgard 2320 membrane has not only enhanced

the thermal stability and wettability but also other electrochemical properties such as ionic conductivity, compatibility and charge–discharge behavior. The enhanced discharge capacity was attributed to the electrostatic and/or H-bonding interactions between the polysulfide and UiO-66-NH2@SiO_2 as evidenced by its positive zeta potential (+56.42 mV). More importantly, the permselective properties of the membrane significantly play against the self-discharge of Li–S cells in which 98.5% of its capacity was retained even after 40 h which is superior to earlier reports.

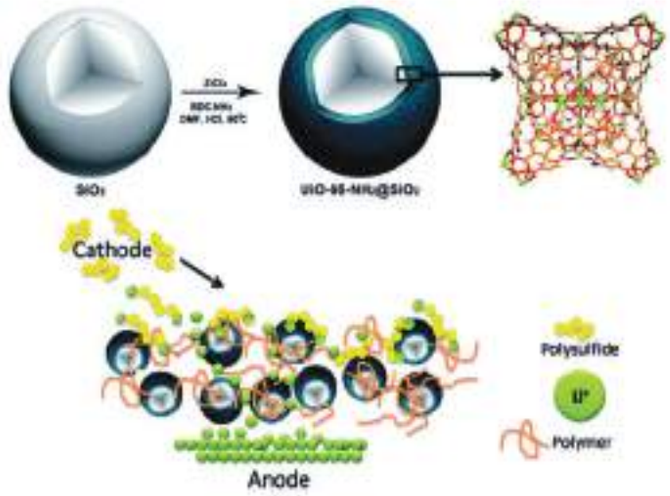


Fig. 8.9: UiO-66-NH_2@SiO_2 was successfully synthesized and coated on a commercial Celgard 2320 membrane.

CO_2 fixation and production of biodiesel by Chlorella vulgaris NIOCCV under mixotrophic cultivation

In this study by CSIR-NIO, Chlorella vulgaris NIOCCV was cultivated in seafood processing industry wastewater with continuous supply of 5%, 10%, and 20% CO_2. The optimum CO_2 fixation efficiency (RCO_2), biomass productivity, specific growth rate (SGR), and lipid content were recorded on dry weight basis at CO_2 supply of 10%. The fatty acid methyl ester-derived biodiesel properties determined at same condition were in compliance with national and international fuel standards. The synergistic environmental benefit of nutrients removal from wastewater is shown as an additional advantage of microalgal cultivation. Thus, integration of algae-based CO_2 fixation with wastewater treatment and biodiesel production may realize microalgal CO_2 capture technology as environmentally sustainable and economically more attractive.

Improvement in biomass, lipid production and biodiesel properties of a euryhaline Chlorella vulgaris NIOCCV on mixotrophic cultivation in wastewater from a fish processing plant

In this study, the changes in biomass productivity, wastewater treatment, lipid production and biodiesel properties from mixotrophic cultivation of Chlorella vulgaris NIOCCV in untreated wastewater from a fish processing plant over F/2 medium was reported by CSIR-NIO. A significant 6-fold increase in biomass productivity ((257.87- ± -1.27-mg·L_1·d_1) and 1.3-fold in lipid accumulation (48%) was recorded for C. vulgaris NIOCCV cultivated in wastewater enrichment of 15% (v/v) over F/2 medium. The biomass productivity was significantly higher in wastewater enrichment up to 50% (v/v) and salt concentration 5% (w/v) than in F/2 medium. The cultivation of C. vulgaris NIOCCV in wastewater resulted in significant decrease in nutrient levels is another advantage. Therefore, C. vulgaris NIOCCV can effectively be cultivated in untreated fish processing industry wastewater without addition of nutrients. Further, C. vulgaris NIOCCV can efficiently be utilized as bioresource for biodiesel production.

For the first time, explored the Leishmania species and stage-specific adaptive mechanisms

The hurdles in drug and vaccine development pipelines for leishmaniasis, a complex, multifaceted disease, are largely due to

the digenetic lifecycle, differential clinical manifestations of the parasite, and the incomplete understanding of its adaptations within its hosts. For the first time, CSIR-NCL reviewed the distinct computational and experimental techniques employed to identify the species and stage-specific adaptive mechanisms at different levels of biological organization, the progress made so far, and limitations in comprehending leishmaniasis as a systems biology disease. Based on the available perspectives, suggestions were made to tackle the growing challenges for bridging the genotype with the phenotype. A systems perspective can be instrumental in understanding the complexities of the disease and can provide insights for targeted control.

Artificial photosynthesis using sunlight to generate fuel

A quasi-artificial leaf (QuAL) device was developed by CSIR-NCL in a wireless configuration with TiO_2/Mn-CdS composite and NiCu as co-catalyst for solar hydrogen production in direct sunlight. The device works at no applied potential and generates 10.5mL/h of hydrogen, with power conversion efficiency of 4.8%. A good resemblance of NiCu alloy to Pt in terms of electrochemical activity makes the device economical. High lifetime of electrons in Mn-CdS helps to greatly improve charge utilization for H_2 production in QuAL device. In addition, re-absorption of emitted light is successfully utilized to enhance hydrogen yield in the present work.

Total synthesis of bioactive natural products

An enantioselective synthesis of cytotoxic indole alkaloid (+)-subincanadine F was accomplished starting from the corresponding (S)-acetoxy succinimide via aziridinium ring formation and its reductive ring expansions route. Regio- and stereoselective reductive aziridinium carbon–nitrogen bond cleavage comprising ring expansions was a key step. Simple and efficient collective total synthesis of five carbazole alkaloids have been reported; which also completes the formal synthesis of several other related carbazole alkaloids. Diastereoselective practical approaches to (±)-epi-subincanadine C have been developed via regioselective oxidative carbon–carbon double bond cleavage and an exceptional syn-stereoselection in Michael addition of cuprate to the unsaturated γ-lactam.

Nanobeads for detection of bilirubin in human blood serum

Amphiphilic polystyrene having pendant glucuronic acid was synthesized by CSIR-NCL covalently incorporating oligo(p-phenylenevinylene) (OPV) based fluorophore. The OPV fluorophore functioned as signal transducer and glucuronic acid on surface of PS nanobeads acted as interaction site for free bilirubin to facilitate non-covalent interaction via hydrogen bonding. Visual color change from blue to bluish green was observed under UV lamp after addition of bilirubin into polymer. The limit of detection was found to be as low as 20 nM which is far less than the clinical range for causing jaundice (< 25 to > 50 μmol/L). The developed sensor showed its effectiveness towards real time monitoring of free bilirubin in human serum.

Flexible supercapacitor electrode materials

Perylenediimide (PDI) and benzodithiophene (BDT) based donor-acceptor random and alternate p conjugated polymers were developed and explored as composite electrode materials in Type III supercapacitor device by CSIR-NCL. Results show that the donor-acceptor alternate design involving P(PDI-alt-BDT) is an excellent supercapacitor electrode material with specific capacitance of 113 F g-1with excellent stability up to 4000 cycles and almost 100% retention of the initial capacitance in single electrode setup in PC-LiClO4 organic electrolyte. Flexible

supercapacitor device were also fabricated which shows areal capacitance of 35 mF cm^{-2} at a current density of 0.5 mA cm^{-2}, which is promising for commercial application.

Crop protection: Understanding regulation of protease gene expression in cotton bollworm (Helicoverpaarmigera) and identification of peptides for growth inhibition

Insects cope up with plant defensive protease inhibitors (PIs) present in the ingested food by differentially regulating digestive proteases. Mechanisms regulating protease gene expression in insects are largely unknown. Multi-domain PI arrests growth and development of cotton bollworm. CSIR-NCL presented evidence supporting a dynamic transition in cotton bollworm protease expression upon PI-ingestion by identifying a distinct novel PI isoform of cotton bollworm in larvae feeding on PI. Based on present and earlier studies a potential mechanism of protease regulation in cotton bollworm and subsequent adaptation strategy to cope with anti-nutritional components of plants is proposed.

Photocatalytic synthesis of cyclic carbonates from CO_2 and epoxides using CoPc/TiO_2 hybrid under mild conditions

First report on the photocatalytic coupling of carbon dioxide with epoxides to give cyclic carbonates under extremely mild such as room temperature and atmospheric pressure conditions using a hybrid photocatalyst consisting of cobalt phthalocyanine grafted on titanium oxide (CoPc/TiO_2) under visible irradiation is described by CSIR-IIP. The developed protocol provided almost quantitative conversion of various epoxides to corresponding cyclic carbonates in excellent yields without any evidence for the formation of any by-product. At the end of the reaction, the photocatalyst was separated by centrifugation and reused for several subsequent recycling runs without any significant loss in activity, and no leaching had observed during the photocatalytic reactions.

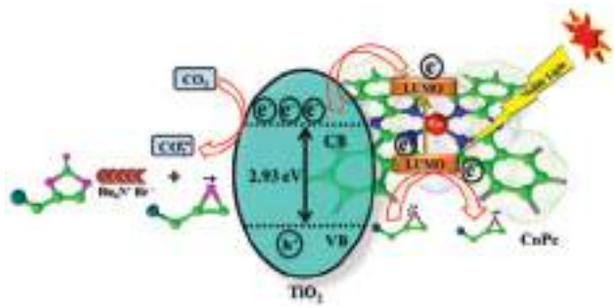


Fig. 8.10: Photocatalytic synthesis of cyclic carbonates from epoxides and CO_2

"Effect of Particle Size of Nanosilica on Microstructure of C-S-H and its Impact on Mechanical Strength"

In the present study, the effect of particle size of silica on its early age reactivity and its impact on C-S-H microstructure and mechanical strength at the early and later ages of hydration was investigated by CSIR-CBRI. Two different types of commercially available silica i.e. Elk-microsilica (Elk-Si) (100–300 nm) and colloidal nanosilica (CNS) (8–15 nm) were used for the study. The lime silica reaction was carried out with a C/S ratio 2.0 and the reaction was monitored in the first 24 h with a range of instrumentation techniques. The results showed that the CNS had ~60% higher reactivity than the Elk-nSi. Calorimetric results revealed that in the presence of CNS, the hydration rate and the formation of AFm phase were accelerated. Furthermore, FTIR and NMR results revealed that in the presence of the CNS, the structure of C-S-H gel was also affected. This acceleration and modification C-S-H gel led to the formation of a compact microstructure as the capillary porosity of cementitious system measured by MIP was found to reduce significantly. The formation of a compact microstructure at the early age of hydration improved the early age mechanical strength. However, it hindered the later age hydration and thus more unhydrated

cement was observed in the semi-quantitative XRD and BSE/IA analysis, especially in the presence of higher dosages of CNS, which was responsible for the lower long-term mechanical strength.

Durability Studies of Nano-Engineered Fly Ash Concrete

Mechanical and durability studies of nano-engineered fly ash concrete have been investigated by CSIR-CBRI using various concrete mixes containing 30–50% fly ash (FA), 3% silica nanoparticles (SNPs) and 6% silica fume (SF) at constant water/cement (w/c) ratio of 0.29. Durability parameters i.e. carbonation (2% CO_2, 20°C, 65% RH) and sulphate attack (5% magnesium sulphate) were used and the specimens were exposed up to 180 days. Long-term carbonation results revealed that SNPs incorporated mixes show a reduction of carbonation depth up to 73% with respect to control specimens containing 30% FA. Similarly, SNPs incorporated specimens show significant resistance towards the sulphate attack of about 39% as compared to control specimens. For the comparison purpose, SF containing specimens were also evaluated, however, higher resistance were observed for SNPs incorporated concrete specimens. Diffusion coefficient and service life of SNPs incorporated specimens were studied using Meta and Demis model, revealed exponential enhancement in the service life of SNPs incorporated concrete mixes.

The transcription factor Lef1 switches partners from β-catenin to Smad3 during muscle stem cell quiescence

Tissues undergo wear and tear all the time. But because stem cells replenish the lost ones, we hardly notice the wear and tear. The stem cell population in muscles stay dormant/quiescent until it receives a signal due to an injury. Once these cells get activated following an injury, they divide. Some of them form muscle cells and help heal the wound. Others stay as stem cells, and help in maintaining the stock of stem cells for body's later needs. This study by CSIR-CCMB showed gene switching molecules change partners to help maintain stock of stem cells in muscles. The study showed transcription factor Lef1 interacting with β-catenin in activated muscle stem cells. However, during the quiescent stages of the muscle stem cells, Lef1 interacts with Smad3. The study also shows that in absence of β-catenin in activated muscle stem cells, Lef1 interacts with Smad3, and induce quiescent stages of muscle stem cells, and help in replenishing the stock of muscle stem cells.

Aggregation of Respiratory Complex Subunits Marks the Onset of Proteotoxicity in Proteasome Inhibited Cells

Living cells have a robust protein quality control mechanisms to ensure their correct folding, functioning and degrading the proteins that are not required or damaged. With age, these control mechanisms are known to weaken, and cause proteins to misfold, aggregate and possibly cause toxicity in cells. This study by CSIR-CCMB investigates the players and mechanisms of early stages of protein aggregation. It shows that by inhibiting proteasomal machinery in cells, which helps in degrading proteins, Respiratory Chain Complex (RCC) proteins are one of the first ones to aggregate. It also shows that specific signatures in the protein sequence, called the Low Complexity Regions partially contribute to this aggregation. Aggregation of the RCC proteins could deregulate formation of functional protein complexes in mitochondria and lead to mitochondrial dysfunction.

Reconstructing the demographic history of the Himalayan and adjoining populations

The prehistoric human settlement in the Himalayas is poorly understood. The difficult terrain of the Himalayas has not favoured large-

scale human migrations, population admixture and assimilation in the region. Such conditions might have facilitated the existence of several small isolated communities in this region. In this study by CSIR-CCMB the authors have tried to reconstruct the demographic origins of the Himalayan and adjoining populations (HAAPs). Through genome analyses, this study shows higher similarities of HAAPs with those in East Asia than with the closer neighbours of South Asia. However, now the HAAPs form a distinct genetic cline due to different degrees of admixture with East and South Asians. The study also estimates a recent westward migration into Northeast India and Northern Nepal from the East Asia.

Controlled electrodeposition of iron oxide/nickel oxide@Ni for the investigation of the effects of stoichiometry and particle size on energy storage and water splitting applications

Controlled synthesis of nickel/iron multimetal oxides with different stoichiometry and particle sizes was carried out by CSIR-CMERI. Electrodeposited samples grown at different pH values showed a wide range of electrochemical properties such as dissimilar current response and potential window due to the formation of different stoichiometry and surface morphologies. Smaller particle size and higher content of NiO are advantageous due to the creation of a facile diffusion path. Moreover, electrical conductivity as well as series resistance increased for the samples with smaller particle size due to the quantum size effect. The quantum size effect was confirmed from the blue shift of the UV-vis absorbance spectrum. Finally, an asymmetric supercapacitor (ASC) cell was fabricated with electrodeposited samples, which showed a large potential window of ~1.6 V along with a high energy and power density of ~91 W h kg−1 and 7200 W kg−1, respectively. Furthermore, the ASC exhibited very low relaxation time constant (~1.3 ms) and long stability of ~83% after 10 000 CD cycles, ensuring the effectiveness of electrodeposited multimetal oxides for energy storage as well as water splitting applications.

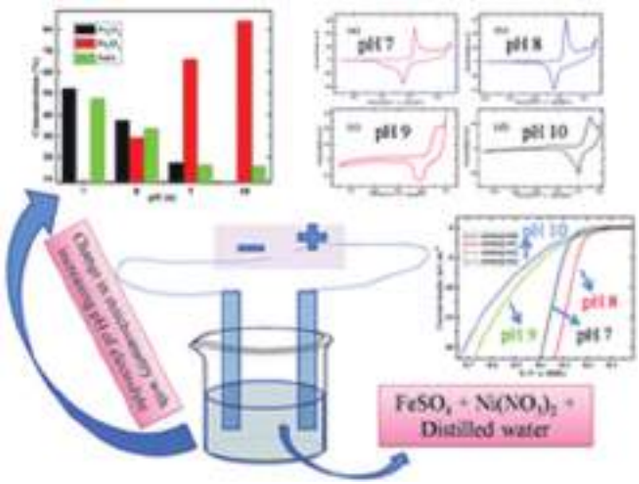


Fig. 8.II: Controlled synthesis of nickel/iron multimetal oxides with different stoichiometry and particle sizes

A novel non-enzymatic Zinc Oxide thin film based electrochemical recyclable strip with device interface for quantitative detection of catechol in water

Catechol, one of the major effluents released by various chemical and metal processing industries, causes severe pollution of groundwater. Monitoring of catechol in water using cost-effective, handheld sensor is demanding for the safety of the environment. In this work by CSIR-CMERI, non-enzymatic zinc oxide thin film based electrochemical strip sensor is developed on conducting glass substrate for detection of catechol. The preparation of strip without employing standard Pt or Ag/AgCl electrodes and simply depositing ZnO through wet chemical process represents a cost-effective innovative technique. The strip is integrated with readout meter and an algorithm is built based on the experimentally observed linear variation of amperometric current with catechol concentration. The quantitative detection performance is demonstrated by testing 0.1–12 ppm catechol solutions.

Facile synthesis of flower-like morphology Cu0.27Co2.73O4 for a high-performance supercapattery with extraordinary cycling stability

CSIR-CMERI has shown that the partial replacement of Co by Cu in cobaltite to give Cu0.27Co2.73O4 with unique flower-like morphology is found to be very beneficial for supercapacitor–battery hybrid applications. The 3D architecture of the material on a conductive substrate resulted in outstanding supercapattery performance. Asymmetric assembly of the material with activated carbon in a two-electrode system delivered high energy and power densities as well as a high specific capacity. The device also showed excellent cycling stability over 20 000 cycles, with a capacity retention value of 86.9%.

IMPORTANT SERVICES TO RURAL SECTOR

IMPORTANT SERVICES TO RURAL SECTOR

9.0 IMPORTANT SERVICES TO RURAL SECTOR

CSIR, during the 12th five-year plan, operated CSIR-800 program for rural sector and successfully implemented 55 projects of 1-2 years duration. Considering the diverse needs of the population and the geographical extent of challenges across the country that require effective technological interventions, need was felt for lot more to be done through focused investment into key areas of development.

Based on suggestions of CSIR schemes review committee under chairmanship of Dr. T. Ramasami (Former Secretary, DST), in 2018-19 the rural and societal oriented initiatives of CSIR-800 revamped into CSIR-HARIT (Harnessing Appropriate Rural Interventions &Technologies).

CSIR-HARIT aimed to enable deployment of CSIR offerings (technologies/ innovations/ products/ processes/ interventions/ services) in villages across the country for augmenting the incomes and improving the quality of lives of the targeted communities.

The key project activities implemented during 2018-19 under CSIR-HARIT are as follows:

1. Popularization of Improved Samba Mahsuri, a bacterial blight resistant and diabetic friendly rice to increase farmers' income (CSIR-CCMB)
2. Empowerment of Rural Women in Food Processing Sector through CSIR-CFTRI Intervention with Select Technologies (CSIR-CFTRI)
3. Dissemination of Nutrition, Food Safety, Food Research and Hygiene practices to general public through social media (CSIR-CFTRI)
4. Establishment of Common Facility Centre for Spice processing 150-200 kg / day (CSIR-CFTRI)
5. Improving quality of salt with simultaneous recovery of sodium sulphate through scientific intervention, in Nawa-Didwana region of Rajasthan (CSIR-CSMCRI)
6. Rural Penetration and Pilot Trials for Divya Nayan (CSIR-CSIO)
7. Increased crop productivity and enhanced income generation through smart micro irrigation system (More yield per Drop) (CSIR NISTADS)
    - A Post-Harvest Processing and Research Centre at CSIR-NEIST Branch, Itanagar is set up for Post-Harvest Processing and Research to Augment the Economy of Rural Tribal People of Arunachal Pradesh. The centre will immensely benefit rural tribal people of Arunachal Pradesh. The centre will also provide training to improve the knowledge and skill of farmers and entrepreneurs of Arunachal Pradesh through post-harvest handling, processing, water purification and renewable energy technologies. The centre would help the farmers of the state to fetch higher market prices for their produces and enhance their economic conditions. Another post-harvest processing unit along with waste management technology is being set up at Ziro in Lower Subansiri district, Arunachal Pradesh.

- CSIR-Aroma Mission for cultivation of aromatic plants has benefitted thousands of farmers. Biotechnological interventions have been introduced to improve soil fertility and biological health for high crop productivity. Over 5550-hectare area has been covered and 216 Distillation Units Installed. 24 Superior varieties and 25 Agro technologies were developed to enhance the income of the farmers. Further, 695 Training / Awareness Programs have been conducted and over 40,000 personnel have been trained in the domain under the mission.
- During 20119, few significant contributions of the mission are:
  - » Distribution of 300 quintals of Mentha suckers on the occasion of Kisan Mela (31st January 2019) to the Mentha growers at CSIR-CIMAP campus. The total yield of this planting material would generate gross return of about 15 crore in a span of 3 months.
  - » Development and demonstration of various agro-technologies like 'Saving Geranium Planting Material' and 'Early Mint Technology' for enhancing farmers' income.
  - » Cultivation and value-addition of aromatic crops for doubling the farmers' income and helping the country to emerge as a global leader in the production and supply of essential oils.
  - » Designing, fabrication, installation and commissioning of improved field distillation units of varying capacities & designs at farmers' field in several states of India.

Under CSIR-Aroma Mission Project, Cultivation: CSIR-NBRI turmeric variety 'Kesari' has been extended to Uttar Pradesh, Uttarakhand, Bihar, Odisha, Maharashtra and Haryana for extraction of essential oil from senescing waste leaves. About 30 q turmeric seed rhizomes were provided to 37 farmers during 2018-2019. These farmers will act as seed farmers for further seed production of 'Kesari'. The market linkage has been established for the leaf essential oil produced by farmers.

Under the CSIR Aroma mission, the crops viz., wild marigold, damask rose, Indian valerian and lemongrasswas extended by CSIR-IHBT to over 256 ha in the states of Himachal Pradesh, Jammu & Kashmir, Uttarakhand, Arunachal Pradesh, Manipur, Odisha, Punjab, Haryana, Uttar Pradesh, Madhya Pradesh, Chhattisgarh and Tamil Nadu. Revenue to the tune of ₹ 5.56 crores was generated, thereby, benefitting 728 farmer families. Nine field distillation units were also set up in the farmers' fields at various locations to empower the farmers for production of essential oils from aromatic crops.

CSIR-IIIM conducted field distillation trail runs at Jamnagar (Gujarat) and Jalna (Maharashtra) During the visit cum trail runs, interaction with the farmers and local individuals done and immobilized them for moving from traditional crops cultivation to medicinal/aromatic crops cultivation.

Fig. 9.1: Interaction with farmers

Fig. 9.2: Trial at Jalna (KVK)

Fig. 9.3: Oil recovery

Purification of ground and surface water for production of safe drinking water through deployment of water purification plants at schools, hostels and village hamlets

CSIR-IICT identified and analyzed the water samples of the places containing high TDS, Turbidity and fluoride concentration. Designed, installed and commissioned a 1000 L/h capacity RO based mineral water plant in Vattipally village located in Marriguda Mandal, Nalgonda,

the worst fluoride affected region with a high fluoride content of 5.5 ppm which is reduced to < 0.5 ppm and TDS from initial 1130 ppm to final 65 ppm. Successfully commissioned and demonstrated 12 defluoridation plants of capacity 50-150 L/h capacity in schools and village hamlets in fluoride affected villages in Nalgonda District, namely; Kasturba Gandhi Girls school, ZPHS Narayanpur, Thumbai Thanda, Survail School, IICT hostel, school and guest house etc. Cost effective scheme for treating reject water from RO process has been developed. So far, 20 such compact systems have been installed successfully in Sarvail school, ZPHS-Narayanpur, Kasturba Gandhi Girls' school, Bhongir, Zaheer Memorial school etc. Many of the installations were made in fluoride worst hit villages of Nalgonda District, Telangana; on charity basis funded by IICT for production of safe drinking water.

Fig. 9.4: Highly Compact Low Cost Water Purification System

Popularization of Pheromone Application Technology (PAT): An Upcoming Versatile Agro Practice for Pest Management.

For the benefit of the small farm holders, CSIR-IICT proposed village based demonstrations under farmers' participatory approach to create greater impact & awareness of PAT in the farming community of Telangana state for the management of the insect pests of vegetables & field crops. CSIR-IICT under farmers' participatory approach successfully demonstrated PAT through mass trapping technique & controlled the devastating pests - Rice yellow stem borer (100 acres) and Brinjal shoot & fruit borer (50 acres) Pink Bollworm on Cotton (400 acres) Fruit fly on vegetables (50 acres) Tomato/chilli pod borer (10 acres) Tobacco caterpillar (10 acres) . The pest damage was effectively brought down in all the demonstrations resulting in increased yields

Integrated approaches for control of Malaria in various parts of India

Malaria is a major public health problem in Arunachal Pradesh and Andhra Pradesh states of India. Several deaths of epidemic proportions are reported every year from different parts of these two states mostly due to the infection of P. falciparum which is a predominant parasite species followed by P.vivax. Among all Northeastern states the state Arunachal Pradesh is highly endemic for malaria. Very limited studies has been carried out to understand the transmission dynamics and epidemiology of malaria in Arunachal Pradesh. Similarly, not much studies has been carried out on malaria epidemiology and its transmission in tribal areas of Andhra Pradesh. CSIR-IICT studied the malaria epidemiology in endemic villages of these two states and to implement disease protection measures such as insecticide treated bed nets (ITNs) or Long-lasting insecticidal mosquito nets (LLINs) and conduct community based disease awareness programs.

Various Anopheles vectors are prevailing in endemic regions to transmit malaria parasite, hence to avoid vector - human contact the long-lasting insecticidal mosquito nets (LLINs) helps to protect people from mosquito bites and arrest the transmission of parasite. Long-lasting insecticidal mosquito nets (LLINs) are the most prominent malaria preventive measure for large-scale deployment in highly endemic areas. These LLINs helps to reduce the mortality and morbidity caused by malaria in endemic regions.

Based on epidemiological mapping studies the health authorities were directed to suppress the malaria prevalence, vector control interventions were implemented by spraying two rounds of indoor residual spray is conducted in high prevalence blocks of malaria. In addition to these efforts, health education camps and awareness programs were conducted to health authorities on modern integrated control approaches.

Contribution of CSIR-CRRI in PMGSY program of Ministry of Rural Department

CSIR-CRRI has been associated closely with Pradhan Mantri Gram Sadak Yojna (PMGSY) since its inception. CSIR-CRRI has been recognised as 'Principal Technical Agency' for PMGSY Program. Review of PMGSY Detailed Project Reports submitted by Andaman & Nicobar was carried out by CSIR-CRRI. CSIR-CRRI Scientists participated in the 'Regional Review Meeting' of PMGSY Program, organised by MORD at Chennai and Agra and made presentation about 'Use of Local Materials and Stabilisation Techniques' which will help towards conservation of good quality aggregate deposits.

Rural network for collecting oil seeds for biofuel

MOU signed between Chhattisgarh Biofuel Development Authority and CSIR-IIP for Feedstock supply chain establishment, titled "Creation of robust rural network for collection, storage & supply of Jatrophacurcas seed (Ratanjot) oil& other tree borne oil seeds to make biojet (Jet A-1) aviation fuel" which lead to incentives to farmers/tribal community for collection of seeds, which were used to produce raw oil as CBDA, which was further converted into Aviation Bio-fuel at CSIR-IIP leading to India' First Bio-Fuel flight by Spicejet on 27 August, 2018.

Supply and Installation of 51 numbers Iron & Arsenic Removal Plant at Border Outposts in North 24 Parganas District of West Bengal

CSIR-CGCRI has a long-standing expertise in deploying arsenic and iron purification plants in affected areas using its ceramic membrane technologies. In this context during 2018-19, 45 nos. iron and arsenic removal plant have been installed at 45 border outposts of North 24 Parganas district. The capacity of each plant is 5000 LPD and quality of product filter water is very satisfactory.

Up-Gradation of Bareilly Rural Terracotta Cluster through New Technology

Common facility centres were established with CSIR-CGCRI support from its Khurja Outreach Centre in two clusters at Bareilly that make terracotta wares. Basic equipment such as pug mill, jigger jolley, wood fired furnace and electric potters' wheel etc. were installed in the centres. Necessary training and demonstration in the operation of the machines were also provided to the handicraft artisans. The local potters will be benefitted by making their products using machineries and will be get more cost of the products. This will be helpful for the improvement in the livelihood of the family members. Skill development activities were carried out among various stakeholder groups by the institute's outreach centres in Khurja and Naroda.

Cotton Picking Head

CSIR-CMERI has developed a system for picking cotton directly using spindle type cotton picker head either using tractor or self-propelled machine.

Salient Technical Features:

- Spindle type, Two Inline Drums Mechanical Cotton Picker Head
- Picking efficiency: 85%-90%

- Trash content: 10%-12% seed cotton basis and 30%-35% lint basis
- Row spacing: 70-100 cm
- Productivity: 0.25 ha/hr (single row)
- Power requirement: up to 45 hp (single row)

Future plan: The mechanized cotton-picking head will be utilized for Maharashtra and Gujarat state.

Fig. 9.5: Cotton picking machine

Solar biomass hybrid dryer for drying of fish/spices

Drying of fish is mainly carried out traditionally under open sun. Solar thermal energy, which is conventionally used for drying is trapped through solar flat plate collectors. This gives higher drying temperature than the conventional method. Further, the solar assisted mechanical driers enhance the drying process through forced convection. Combustion of biomass in the presence of excess air in a combustor liberates heat energy, inert gases and ash. A cross counter flow heat exchanger removes the heat from the combustion gases and places it in the air which is circulated in the drying chamber for drying the material while the ash has other agricultural uses. Therefore, hybrid solar-biomass based fish dryer, utilizing both solar thermal and biomass as sources of thermal energy can be a better option for drying of fish.

Benefits to people:

- Enhancing income of over 100 fisherman families (Total coastal area of India: 5232km.)
- Providing direct employment to 50 people
- Growth of entrepreneurship and spread of microfinance

A 100 kg/batch capacity solar-biomass hybrid fish dryer is currently being developed at CSIR-CMERI for drying of fish. The dryer once developed will be installed in Mizoram for field level testing. Similar dryer can be utilized for drying of other important spice crops of North-east like ginger, turmeric etc. which are found in plenty in the North-east, thereby promoting the utilization of renewable energy in India which is in line with the mandate of Govt. of India.

Fig. 9.6: Solar biomass hybrid dryer for drying of fish/spices

Solar assisted cold storage

Most fruits and vegetables have a very limited life after harvesting at normal atmospheric conditions. Postharvest cooling rapidly removes

Fig. 9.7: Solar assisted cold storage

field heat, allowing longer storage periods. Cold storage is the one widely practiced method for bulk handling and preserving of the perishables between production and marketing. It is one of the methods of reserving perishable commodities in fresh for a longer period by controlling temperature and humidity within the storage system.

A 500 Litre Cold Storage Facility has been developed in CSIR-CMERI institute premises and it is presently under demonstration.

CENTRAL MANAGEMENT ACTIVITIES

CENTRAL MANAGEMENT ACTIVITIES

10.1 GOVERNING BODY

The 190th Governing Body (GB) meeting of CSIR was held on 20.12.2018. The Chairman, GB, CSIR, Dr Shehkar C Mande made a brief presented to the GB about mandate and mission of CSIR , its S & T strength and contributions to the society as well as the vision/ plan for the future.

The presentation highlighted the contributions of CSIR over the past decades i.e. Indelible Ink / Amul Milk Powder / Tractor / Streptokinase / Pesticides /Dhrishti / TEJAS aircraft etc., Also highlighted were CSIR's new technology initiatives and success stories such as Divya Nayan, Electronic Reading assistance for the visually impaired / Solar Power Tree / Paraffin Wax Plant at Numaligarh / Coal Quality Certification for Power Generation / Farmer Centric Aroma Mission / Blight Resistant Samba Mahsuri Rice. CSIR's contributions towards human resource development in the country was presented and he lighlighted that CSIR has supported scientific HR through its NET programme and offering 2500 fellowships in each cycle.DG, CSIR emphasized that in the Indian civil aviation sector there is a need for technology upgrade in small aircraft segment which will form the hub of future connectivity and SARAS which has been tested will be a game changer in meeting this need.

Creation of Theme Directorates, in eight new vertical themes, which are multidisciplinary and converge into the mandate of CSIR was elucidated. There are 15 mission programmes implemented the past two years. The Aroma Mission / Intelligent Systems / Nano Bio- sensors / Nutraceuticals / Smart Buildings / Catalysis for Sustainable Development / Sickle Cell Anemia Mission etc. The presentation also coved that CSIR has identified technologies which are ready for deployment. It was conveyed that CSIR will partner with industry / offer solutions to MSME and entrepreneurs and hand hold. Since the rate of transfer of technology to Industry is slow, marketing / information dissemination will be stepped up. He expressed that CSIR will explore, enable, evangelize and exploit. This activity will cover the entire span of scientific research from basic research to research for societal benefit and also include translational research.

Some of the significant items recommended / ratified by GB are as follows:

- Proceedings of the 189th meeting of GB have been noted by President, CSIR (as per Rule-41 of the CSIR Rules and Regulations and Bye- Laws) with the observations that the final record of discussions of 190th meeting of the GB, CSIR have been placed for consideration of the Hon'ble Prime Minister in the capacity of President, CSIR, after considerable lapse of time and that the Department should ensure that such delay is avoided in future.
- Consideration and Adoption of Annual Accounts of CSIR for the Financial Year 2016-17.
- Consideration and Recommendation of the CSIR Annual Report for the year 2016-17.
- CSIR Technology Awards – 2018.
- Award of Shanti Swarup Bhatnagar

Prizes for Science and Technology 2018.

- Award of CSIR Young Scientist Awards 2018 - information thereof.
- Award of G. N. Ramachandran Gold Medal for Excellence in Biological Sciences and Technology 2018 - information thereof.
- Award of CSIR Bhatnagar Fellows 2018 - information thereof.
- CSIR Bhatnagar Fellowship - Enhancement of Annual Grant - approval thereof. - This item was withdrawn.
- Demolition of 28 Nos. of Type- I Staff quarters in E (E-1 to E-16) and F (F-1 to F-12) rows at CMERI, Durgapur residential colony
- Amendment to Recruitment Rules 2008 for the post of Director of CSIR Laboratories/ Institutes/ Centre
- Amendment in the Recruitment Rules for the posts of (1) Technical Officer i.e. Group- III (3) [PB- 2; ₹ 9300- 34800 with GP ₹ 4600/-] and (2) Driver [PB-1; ₹ 5200- 20200 with GP ₹ 1900/-] (Isolated posts) as a consequence of discontinuation of interviews for various junior level posts in CSIR in line with the instructions of DoPT, Government of India - approval thereof.
- Amendment to Rule- 7 of Part- IV of Administrative Service (Recruitment and Promotion) Rules, 1982 - Recruitment Rules for the post of Junior Secretariat Assistant (F&A)
- Recommendations of the DoPT for the Restructuring and Review of the Administrative Cadres of CSIR .

10.2 CSIR'S 77TH FOUNDATION DAY CELEBRATION

The Council of Scientific and Industrial Research (CSIR) celebrated its 77th foundation day on 26 September 2018 in Vigyan Bhawan, New Delhi, with great fervour and enthusiasm in the presence of a large number of young innovators, school children, young scientists and members of the CSIR family.

Fig. 10.1: Dr. Harsh Vardhan, Hon'ble Minister for Science & Technology, Earth Sciences, and Environment, Forest & Climate Change and Vice President, CSIR, graced the occasion. Dr. Harsh Vardhan said, the laboratories under CSIR should proactively involve those scientists who were part of its family, as "scientists never retire". "CSIR ranked ninth in the world amongst 1207 public research institutions of the world," said Dr. Harsh Vardhan. He also said that Indian scientists were among the best in the world

Fig. 10.2: Dr. Harsh Vardhan, Minister for S&T, during his address

Fig.10.3: Dr. Harsh Vardhan with Indian Air Force team, which carried out the successful test flight of the indigenously developed SARAS aircraft

Dr. Harsh Vardhan further called on the CSIR community to take a resolve on this Foundation Day, to diagnose the problems that remained unresolved during these 70 years; define specific goals and targets; make a team; develop a management plan and finally a mechanism to monitor the implementation of the action on a year-to-year basis.

Prof. Ashutosh Sharma, Secretary Department of Science & Technology and DG, CSIR, in his welcome address said, "In ancient Indian tradition the 75 years indicate one 'Prashasan', but in case of an organisation like CSIR, it represents the maturity, stability and wisdom." CSIR is a driver, catalyst in the growth of socio-economic development, he added.

Fig. 10.4: Prof. Ashutosh Sharma, DG, CSIR, during the welcome address

"CSIR is a repositioned organisation fully aligned with the national vision, policies & initiatives. Relevant and target oriented R&D is the backbone of the re-energised CSIR," added Dr. Ashutosh Sharma.

He later announced the Shanti Swarup Bhatnagar (SSB) Awards 2018, the highest multidisciplinary science awards in India. Thirteen scientists were selected for the award, which carries a prize money of Rs. 5 lacs and a citation.

Dr. Vijay Kumar Saraswat, Member, NITI Aayog and Chancellor, Jawaharlal Nehru University, delivered the CSIR Foundation Day Lecture on "Artificial Intelligence (AI) and Humanity". He discussed various aspects of Artificial Intelligence and its effects on society and humanity as a whole.

Dr. Saraswat also presented the CSIR Annual Awards in various categories including

Innovation Awards for School Children, Young Scientists Awards, Technology Awards, Diamond Jubilee Technology Award, Award for S&T Innovation for Rural Development, GN Ramachandran Gold Medal for Excellence in Biological Sciences and Technology & Commendation Award to the Indian Air Force team that carried out the successful test flight of the indigenously developed SARAS aircraft on 24 January 2018.

The annual event recognised exceptional contributions of CSIR scientists as well as school children, who developed solutions to several issues being faced by the society. These included a device for load distribution for labourers; toilet with automatic cleaning and flush; smart bike with advanced features to prevent triple riding, drunken driving and speed driving; herbal liquid cleaning agent; multi-purpose water filtration technique; cell-phone modified as hearing aid, etc.

During the event, a short film on the journey of CSIR achievements was also screened. The film gave a message that CSIR always focuses on developing cutting-edge technologies for the industry and also that CSIR has committed itself to contribute to national development by making technologies affordable and available for the benefit of the masses.

Fig. I0.5: Dr. Sanjay Kumar, Head, HRDG, proposing the vote of thanks

Dr. Sanjay Kumar, Head, HRDG and Director, CSIR-IHBT, Palampur, proposed the vote thanks.

Foundation Day Lecture Dr. Vijay Kumar Saraswat, Member, NITI Aayog

Delivering the CSIR Foundation Day lecture on Artificial Intelligence and Humanity, Dr. Vijay Kumar Saraswat, Member, NITI Aayog and Chancellor, Jawaharlal Nehru University, congratulated the awardees for their outstanding contributions and CSIR for completing 76 glorious years in the field of science and technology. "Science has really benefitted by the efforts of CSIR and we are proud of what CSIR has done for the last 76 years," he said.

Fig.I0.6: Dr. Vijay Kumar Saraswat, Member, NITI Aayog, delivering his lecture

Dr. V.K. Saraswat is a scientist of international renown and an accomplished researcher with more than four decades of experience spanning over several fields and areas in both basic and applied sciences of defence research. Apart from being a scientist, he is a rare combination of an innovator, technologist and visionary. He is also leading the "Methanol Economy Mission" to meet India's requirement of alternative fuel for energy and transportation thereby reducing our crude oil imports.

Artificial Intelligence (AI) is a branch of computer science dealing with simulation of intelligent behaviour in computers as well the

capability of a machine to imitate intelligent human behaviour. Dr. Saraswat during his lecture discussed the various aspects of Artificial Intelligence as well as its effects and application.

He further explained how AI technologies mimic the human abilities to sense, think and act. He said that AI encompasses multiple technologies that can be combined to sense, think and act as well as to learn from experiences and adapt over time.

Dr. Saraswat also mentioned the various elements of AI which have been under research like machine learning, language processing, speech, etc. Besides this, he also explained the difference between Artificial Intelligence and Human Intelligence. He said AI is growing and enumerated a brief history of AI, taking it from the first step of "Reasoning" to the last step of "Strong AI" (a self-aware machine with ideal thoughts, feelings, concrescence and consciousness) which does not exist yet.

Dr. Saraswat also focussed on Artificial Intelligence technology challenges like requirement of large volume of data, especially for modern neural net AI approaches; AI programs typically can only do one task; AI programs can be difficult to understand and verify after programming; and cyber security which is one of the issues as far as AI is concerned.
Dr. Saraswat also mentioned some high profile examples of AI like autonomous vehicles such as drones and self-driving cars; Medical diagnosis; Creating art like poetry; Playing games, etc. He also shared some recent news items on AI to enumerate how society is being changed by Artificial Intelligence.

Dr. Sarawat further said that AI encourages a gradual evolution in the job market which, with the right preparation, will be positive. AI will enhance the efficiency, lifestyle and throughput and people will work better with the help of AI. The unparalleled combination of human and machine will become normal in the workforce in the future, he added.

Later he also discussed the advantages and disadvantages of AI in areas like autonomous weapon, autonomous industry, autonomous decision-making and artificial super-intelligence. He also talked about a few of the debatable ethical issues associated with AI including removing human responsibility, devaluing human skills, eroding human self-determination, etc.

CSIR Foundation Day Function 2018 Awards

- CSIR Young Scientist Awards 2018
- G N Ramachandran Gold Medal 2018
- CSIR Innovation Award for School Children 2018
- CSIR Technology Awards 2018
- SSB Awards 2018
- CSIR Award for S&T Innovations for Rural Development (CAIRD) 2016
- CSIR Diamond Jubilee Technology Awards (CDJTA) 2015 & 2016

CSIR Young Scientist Awards 2018

CSIR introduced, in 1987, a scheme of awards for Young Scientists in order to promote excellence in various fields of science and technology. The 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 fields:

- 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 award winners this year were:

- The CSIR Young Scientist Award for the year 2018 in Chemical Sciences was awarded to Dr. Naveen Kumar Chandrasekaran of CSIR-Central Electrochemical Research Institute (CECRI), Karaikudi, for his contributions in developing electro-catalysts for conversion of CO_2 to valuable products and superhydrophobic, smart coatings for detection and prevention of corrosion.
- The CSIR Young Scientist Award for the year 2018 in Engineering Sciences was awarded to Dr. Abhiram Hens of CSIR-Central Mechanical Engineering Research Institute (CMERI), Durgapur, for his outstanding contributions to classical molecular dynamics and computational fluid dynamics-based studies of boiling, evaporation and thin film dewetting.
- The CSIR Young Scientist Award for the year 2018 in Engineering Sciences was awarded to Dr. Niraj Kumar of CSIR-Central Electronics Engineering Research Institute (CEERI), Pilani, for his outstanding contributions in the development of pseudo-spark based high current density electron beam source and slow wave oscillator.

G N Ramachandran Gold Medal for Excellence in Biological Sciences & Technology 2018

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 recognising excellence in the interdisciplinary subject/field of Biological Sciences & Technology.

The G N Ramachandran Gold Medal for Excellence in Biological Science and Technology for the year 2018 was awarded to Prof. K. Muniyappa of Indian Institute of Science, Bengaluru, for elucidating homologous recombination pathway of M. tuberculosis, mechanism of genetic exchange and identification of drug targets for treating tuberculosis.

CSIR Innovation Award for School Children-2018

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 the '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 IPR. From the year 2011, the Award has been renamed as 'CSIR Innovation Award for School Children'. The award winners during the year 2018 were :

First Prize (₹ 1,00,000/-) for developing Sustainable Load Distributor for Labourers

Students of class V, VII AND VIII, Shivani Kumari, Puja Kumari, Kumari Nandini Singh, Gyan Mishra and Chandra Mohan, Prarambhika school, Ahemadpur, Maner, Patna have developed a device for labourers. The device improves the working condition of labourers at construction sites and factories preventing the workers from occupational hazards and minimizing high blood pressure.

Second Prize (₹ 50,000/-)

- Students of class of VIII and IX standard, Chandra Mohan, Aman Kumar, Abhishek Kumar, Rohit Raj and Vishal Kumar, Parambhika School, Ahemadpur, Maner, Patna have developed an innovative method for making homemade slab which is prepared by using coconut fibres or paddy or wheat straw mixed with calcium oxide or jaggery used as binding material and water.

- This innovation is dedicated to the Clean India Mission. Students of class IX standard, Rohan Gupta and Kushagra Kasturia, DAV Public School, Sreshtha Vihar, Delhi, have developed an innovative method for making a dream toilet with automatic cleaning and flush system.

Third Prize (₹ 30,000/-each)

- A student of class XI, Gyanig Kumar, DAV Public School Chandrasekharpur, Bhubaneswar, Odisha, devised a smart bike having advanced features to prevent triple riding, drunken driving and speedy riding. The smart bikes also have a GPS and a GSM module system, which transfer the location of the biker to the ambulance and police in case of medical or safety emergency.
- Students of class IX, Shashank Bewoor and Pavan S. Byahatti of Dr. G.V. Joshi Rotary English Medium High School, Hubali, Karnataka, have proposed a method for preparing herbal cleaning agent and sanitizer from Acacia pycnantha, commonly known as Golden Wattle tree.
- A student of class XI, Ravi Prakash, Guru Gobind Singh Public School, Bokaro steel city, Jharkhand, has proposed a multi-purpose water filtration technique in which hair, wool and microstructure cuticles used for water filtration.

Fourth Prize (₹ 20,000/-each)

- Students of class XI, Aditya Partap Singh and Anmol Rathi, Bharatiya Vidya Bhavan's R.K. Sarda Vidya Mandir, Raipur, Chhattisgarh, have proposed a device to overcome the problem of different diseases happening due to spit or saliva on road.
- Students of class XI, Swastik Prajapati, Gaurav Kumar Mehto and Yaman Kumar, Govt. Multipurpose Higher Secondary School, Bilaspur, Chhattisgarh, have proposed a method to overcome the river pollution problem due to cremation a ritual for Hindus. In this proposal body ash management is done through the filtration process. Moksha has been developed in such a manner that the body ash does not mix with the river water and deposits over the riverbed.
- A student of class XII, Ishnoor Singh, Delhi Public School, Gurgaon, has proposed a device that provides a complete solution for remote control of all electronic appliances. This device consists of easy to install nodes that can be used to control any switch.
- A student of class X, V. Dhanush Kumar, Govt. Hr. Sec. School, Kotagiri, Tamil Nadu, has proposed a hearing aid. The device is a simple modified cell phone.
-

Fifth Prize (₹ 10,000/- each)

- Students of class IX, S. Shareen, T. Vibishini and M. Ellakiya Lakshmi, of Kaligi Ranganathan Montfordmat Hr. Sec. School, Perambur, Chennai has provided uniform water to the field by using "Automatic tube well or dug well irrigation system''.
- Students of class IX, R. Yuvadarshini, G. Pavithra and S. Kuzhalini, Kaligi Ranganathan Montfordmat Hr. Sec. School, Perambur, Chennai, have proposed an innovation to overcome the problem of light wasted on highways at night.
- A student of class X, Shreya Raju, Om Shelat, Ira Sidhu and Soumya juneja, Shiv Nadar School, Gurugram, Haryana have proposed a smart traffic management system. By using various formulas and processes, "Canny Edge Detection'' is used to attain structural information from the image and convert it into black and white pixels of the traffic.

CSIR Technology Awards 2017

Given annually, the CSIR Technology awards were instituted in 1990 to encourage multi-disciplinary in-house team efforts and external interaction for technology development, transfer and commercialisation. Each award carries a cash prize of ₹ 2 lakh a plaque and a citation. The categories of awards are:

i. Life Sciences
ii. Physical Sciences including Engineering
iii. Innovation
iv. Business Development and Technology marketing
v. Most Significant CSIR Technology of the Five Year Plan Period

The last of these is awarded once in five years, previously coinciding with the erstwhile five-year plan periods, to a technology proven in the marketplace for at least five years. The award was last conferred in 2015 with a cash prize of Rs. 5 lakh, a plaque and a citation. The award winners this year were:

- CSIR Technology Award for Life Science-2018

  CSIR-Institute of Microbial Technology (CSIR-IMTECH), Chandigarh, won the technology award for 'Clot Busters for Thrombolytic Therapy'

- CSIR Technology Award for Innovation-2018

  CSIR-Central Glass & Ceramic Research Institute (CSIR-CGCRI), Kolkata, has won the technology award for 'An Innovative Technology for Manufacturing of Specialty Material for Immobilization of High-Level Radioactive Waste'

- CSIR Technology Award for Physical Science including Engineering-2018

  CSIR-Indian Institute of Chemical Technology (CSIR-IICT), Hyderabad, has won the technology award for 'Technology Transfer for Commercial Plants of 4000 MT per year of para-tert-butyltoluene and 3000 MT per year of para-tert-butylbenzoic acid'

- CSIR Technology Award for Business Development and Technology Marketing-2018

  CSIR-Central Institute of Mining and Fuel Research (CSIR-CIMFR) and CSIR-Indian Institute of Petroleum (CSIR-IIP) have jointly won the award for 'Significantly Enhancing the Business and Marketing of their respective Knowledgebase'

- Certificate of Merit CSIR Technology Award for Life Sciences-2018

  CSIR-Central Institute of Medicinal and Aromatic Plants (CIMAP), Lucknow, has won the technology award for 'Ocimum Based Technological Interventions to Facilitate Industrial Growth, Societal Health and Rural Prosperity'

- Certificate of Merit CSIR Technology Award for Innovation-2018

  CSIR-IICT (Indian Institute of Chemical Technology), Hyderabad, has won the technology award for 'Innovative, Low-Cost Membrane Systems as Import Substitutes for Production of Medical Grade Water and Resource Recovery'

- Certificate of Merit CSIR Technology Award for Physical Sciences including Engineering-2018

  CSIR-Central Institute of Mining and Fuel Research (CIMFR), Dhanbad, has won the technology award for 'Mine Transport Surveillance System'

- Certificate of Merit CSIR Technology Award for Physical Sciences-2018

  CSIR-Central Scientific Instruments Organisation (CSIO), Chandigarh, has won the technology award for 'Aviation Cockpit Display Validation Platform'

Shanti Swarup Bhatnagar Prize (SSB) for Science & Technology 2018

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.

Any citizen of India engaged in research in any field of science and technology up to the age of 45 years is eligible to be nominated. Overseas Citizen of India (OCI) and Persons of Indian Origin (PIO) working in India are also eligible. 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
- Engineering Sciences

The recipients of the Shanti Swarup Bhatnagar Prize for Science and Technology were:

Biological Sciences

- Dr. Ganesh Nagaraju, Department of Biochemistry, Indian Institute of Science, Bengaluru
- Dr. Thomas Pucadyil, Biology Division, Indian Institute of Science Education and Research, (IISER Pune), Pune

Chemical Sciences

- Dr. Rahul Banerjee, Department of Chemical Sciences, Indian Institute of Science Education and Research, (IISER Kolkata), Mohanpur
- Dr. Swadhin Kumar Mandal, Department of Chemical Sciences, Indian Institute of Science Education and Research, (IISER Kolkata), Mohanpur.

Earth, Atmosphere, Ocean and Planetary Sciences

- Dr. Madineni Venkat Ratnam, Aerosols, Radiation and Trace Gases Group, National Atmospheric Research Laboratory, Gadanki, Tirupati
- Dr. Parthasarathi Chakraborty, Geological Oceanography Division, CSIR National Institute of Oceanography, Dona Paula, Goa .

Engineering Sciences

- Dr. Amit Agrawal, Department of Mechanical Engineering, Indian Institute of Technology Bombay, Powai, Mumbai
- Dr. Ashwin Anil Gumaste, Department of Computer Science and Engineering, Indian Institute of Technology Bombay, Powai, Mumbai

Mathematical Sciences

- Dr. Amit Kumar, Department of Computer Science and Engineering, Indian Institute of Technology Delhi, Hauz Khas, New Delhi
- Dr. Nitin Saxena, Department of Computer Science and Engineering, Indian Institute of Technology Kanpur, Kanpur

Medical Sciences

- Dr. Ganesan Venkatasubramanian, Department of Psychiatry, National Institute of Mental Health and Neurosciences, Hosur Road, Bengaluru.

Physical Sciences

- Dr. Aditi Sen De, Physics Division, Harish-Chandra Research Institute, Chhatnag Road, Jhunsi, Allahabad
- Dr. Ambarish Ghosh, Centre for Nano Science and Engineering, Indian Institute of Science, Bengaluru

CSIR Award for S&T Innovations for Rural Development (CAIRD) 2016

CSIR instituted the CSIR Award for S&T Innovations for Rural Development (CAIRD) in the year 2006 to recognise and honour outstanding S&T innovations that have helped transform the lives of rural people or alleviated the drudgery of the rural people.

The award is given to an innovation that has created a paradigm shift in standards of quality of life of the rural people or demonstrated competitive advantage and positive user response or helped in generating of rural employment in the country and shown a new way of conducting business to achieve social and economic transformation in the rural areas. The award consists of a cash prize of ₹ 10 lakh a citation and a shield.

The award winner of the year 2016 was CSIR-Indian Institute of Petroleum (CSIR-IIP), Dehradun for Development and Wide Popularisation of Eco-Friendly & Efficient Jaggery Plant.

CSIR Diamond Jubilee Technology Awards (CDJTA) 2015 & 2016

CSIR launched an annual Diamond Jubilee Technology Award on 26 September 2002 in commemoration of its Diamond Jubilee celebrations to encourage scientists, engineers and technologists to develop innovative technologies and products that are amongst the best in the world and enhance India's image. 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 ₹ 10 lakh, a citation and a shield.

The winners of the year 2015 & 2016 respectively were:

- Jubilant Life Sciences Ltd., Noida for development of "A commercially viable process to prepare highly pure niacinamide via 3-cyanopyridine route by using in-house developed catalyst".
- CSIR-Central Leather Research Institute (CSIR-CLRI), Chennai for developing "Waterless Chrome Tanning Technology" while avoiding the conventionally used pickling process.

HEADQUARTER ACTIVITIES

HEADQUARTER ACTIVITIES

11.1 Research, Project Planning and Business Development Directorate (RPPBDD)

The Directorate is the nerve centre of CSIR Headquarters, which is mandated to support the overall R&D Planning for CSIR while pursuing strategic opportunities for business developments, with inputs from all divisions/ directorates.

The significant activities of RPPBDD 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 ; Appraisal 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 clients with their security and sensitivity clearances; Management of Innovation Fund; Parliament matters relating to the above activities; Policy matters pertaining to the above activities; and Supporting CSIR S&T Award Systems (CSIR Technology Awards, CSIR Diamond Jubilee Technology Award and CSIR Award for S&T Innovations for Rural Development) for scientific and technological achievements to spur innovation among CSIR scientists, stakeholder interactions and also recognize outstanding S&T innovations that have created a paradigm shift and significant impact, locally as well as globally.

11.1.1. Constitution of a Committee to review extant guidelines of Lab Reserve Fund (LRF)

CSIR has in place detailed guidelines for creation of Lab Reserve Fund (LRF) and its utilization under various heads of revenue and capital for R&D activities at CSIR Laboratories as a supplement to GOI Budgetary Grants. In light of the changing scenario, it was proposed to revisit the LRF guidelines and align them to pursue and deliver outcome driven R&D as per the present STI focus on one hand and in alignment with the present innovation investment ecosystem, on the other hand. A committee was constituted under the Chairmanship of Dr. R. Ramanan, Mission Director, Atal Innovation Mission, NITI Aayog to examine and review extant guidelines of Lab Reserve Fund (LRF) - maintained by CSIR laboratories; and Headquarters Reserve Fund. The main ToR of the Committee are:

a) Enabling measures for enlarging the scope of the extant LRF guidelines;

b) Innovative mechanisms for enhancing LRF at the Laboratory level; and

c) Newer methodology for optimum utilization of LRF at HQs and Laboratory level.

RPPBDD was involved in preparation of the background Note and made presentation of

various contours of LRF before the committee when it met twice.

11.1.2. Action Taken Note on 297th report of the Parliament Standing Committee

RPPBDD worked upon and prepared the draft statement to be made by the Hon'ble Minister of State for Science & technology and Earth Sciences in both Lok Sabha & Rajya Sabha regarding status of Action Taken Report Note on the recommendations contained in the 297th Report of the Department related Parliamentary Standing Committee On Science & Technology, Environment & Forests.

11.1.3. Constitution of Research Councils and Advisory Committees

The activity regarding formulation of Research Council (RC) and Advisory Committee (AC) for establishments/ laboratories of CSIR was reassigned to RPPBDD in February. The directorate constituted AC for URDIP, Pune & TKDL, New Delhi and also supported the Changes in Membership of RC for CSIR-CLRI and CSIR- CSIO.

11.1.4. CSIR Thematic directorates: Functionalization and implementation of thematic projects for sustaining the basic research, applied research and the niche of laboratories along with augmenting the TRL of CSIR technologies

RPPBDD continued the effort to implement 'New R&D Management Strategy' in CSIR for deriving synergy from complementary skills and expertise across CSIR laboratories for innovative technologies, improving their Technology Readiness Levels (TRL)and providng fast response to needs of stake holders, to bring in sector-specific industry focus, augmenting inter-ministerial / departmental interaction / coordination, and also to enhance business focus of CSIR. A wide ranging connectivity with CSIR laboratories, line ministries and other stake holders including consolidation of participation of CSIR laboratories were established under the eight sector-specific theme driven clusters.

To begin with and sustain thematic R&D programs, also to bring further translational values, the recommendation of sectorial monitoring committees along with leads of 'Twelveth Five Year Plan projects' were consolidated with their TRL and reclassified as per the eight themes. Grand Challenges (Problems to be Solved / Thrust Areas) under all theme were identified.

Extensive Nodal Theme Directorates meetings were completed in a timeframe for establishing varying subdomains under the themes, for collective planning and for unifying the available synergetic strengths. Thematic concept notes including smart goals and TRL records were invited for identifying new research projects from the participating laboratories in each theme directorate. Based on the accompanying TRL and thematic deliberation in coordination with respective theme directors, the short listed proposals in a recommended format were considered under four project categories namely, FTT (Fast-Track Translation Project), FTC (Fast-Track Commercialisation Project), NCP (Niche Creating High Science/ High Technology Projects) and FBR (Focused basic research project) where in due course RPPBDD coordinated only NCP and FBR proposals / projects. Focused basic research (FBR) projects support high end basic research where 'initial Proof of Concept' is already indicated while Niche Creating High Science/ High Technology Projects (NCP) are those where a 'niche' has already been created by a group in the laboratory at National level, and the project under consideration is focused on retaining the leadership achieved, aimed at enlightening global leadership.

Stakeholders meetings and further individual theme centric expert meetings were conducted for selecting the proposals which

were considered further and sanctioned by competent authority.

The thematic activities for all the eight themes by RPPBDD during FY208-19 are summarized as follows:

(i) CSIR Theme: Aerospace, Electronics, Instrumentation & Strategic Sectors (AEISS):

The work on finalization of project proposals under AEISS theme for next funding cycle at Theme Level, aligned to National Priorities for resource investment till April 2020 was undertaken. The recommended concepts notes were converted into project proposals with SMART (Specific, measurable, Agreed, Realistic, Time–Bound) objectives and Measurable outcomes as compulsory for to be considered for appraisal and approval by the Nodal Theme Directorate. During the reporting period, an Expert Committee under the Chairmanship of Dr. Kota Harinaryana along with Director CSIR-NAL as the AEISS theme Director, was constituted to review and grade the received NCP and FBR project proposals under the theme, to review and recommend for funding by CSIR. A summary of the projects was prepared and presented to the said Committee.

The Expert Committee recommended 24 projects out of 51 projects which were graded as A++ and A+, supported for funding.

(ii) CSIR Theme: Civil, Infrastructure & Engineering (CIE):

Under this theme six projects (3 Niche Creating and 3 Focused Basic Research projects) of two years' duration have been supported with budget cost of ₹ 8.26 crores. Efforts have been initiated on the following activities:

- Electrical Insulating Hybrid Composite Sheet using Industrial Inorganic Wastes;
- Robotic Intervention for Industrial and Strategic Applications;
- Cold Mix Technology for High Volume Roads;
- Development of Rejuvenating Agent (RA) for use in Recycling of Asphalt Pavements-RAP;
- Upgradation of Half Warm Mix Technology for Construction and Maintenance of Bituminous Surfacing; and
- Development of composite bridge deck systems for fast track construction.

(iii) CSIR Theme: Ecology, Environment Earth & Ocean Sciences and Water (E3OW):

Under this theme nine projects (5 Niche Creating and 4 Focused Basic Research projects) of two years duration have been supported with budget cost of ₹ 21.19 crores. Efforts have been initiated on the following activities:

- Synthesis of Earthquake Hazard scenario in NW Himalaya by Investigating the multiscale Variations in structural and seismotectonic Assemblages (SHIVA);
- Better understanding of Carbon and Nitrogen Cycling in the Earth System (CNCES);
- Electric Conversion of High Polluting Diesel/ Petrol 3W, 4W Vehicles in Electric Vehicles and Development of Solar Charging Station;
- Exploring the Indian coastal and marine biodiversity for discovery and production of industrially important microbial proteins;
- Estimation of Ecosystem Services and Environmental Damage Cost Due to Climate Change: Biodiversity Perspective;
- Understanding Critical Zone Structure;
- Conversion of Waste and Biomass to value added products for gainful utilization;
- Geodynamics and Metallogeny of parts of the East Indian Shield with specific reference to Diamond, Iron Ore and Chromitite-PGE occurrences; and
- Better understanding of Impact of climate change on the physics, biogeochemistry and ecology of the north Indian Ocean.

(iv) CSIR Theme: Mining, Minerals, Metals and Materials (4M)

With due diligence and approvals, RPPBDD

implemented 37 numbers of FBR/NCP projects, developed out of 184 numbers of concept note under the theme. The projects were implemented in 12 laboratories of CSIR.

The R&D projects are on Magnesium Alloys, Metallic foam, High performance metal matrix composites, Strain and Permeability changes in coal and shale, Magnetic graphene based ion-exchangers, Selenium detection, Photonic meta-surfaces, Coke from low ash non-coking coal, Recycling of spent battery,Solvatometallurgical extraction of Cu and Zn, Dephosphorization of iron ore, Ferro Manganese from lean source, Metallurgical Wastes, for value addition, Reduction roasting of low and lean grade iron ores, production of titania slag, Nano structured Electrolytic Manganese Dioxide, Utilization of North East clay minerals, Value addition of non-timber wood, Paper strip for detection of the fluoride and arsenic in drinking water, Ammonia from dinitrogen at ambient condition, Electroactive Polymers for Bionics, hybrid flocculants for adsorption of low grade iron ore slimes and fines, RE-free intermetallic permanent magnets, In-situ synthesis for Titanium metal powder, White Light Emitting single phased oxyfluoride phosphors, Self-healing Coatings, new 2D materials, Catalysts for hydroprocessing reactions, Remaining Life Assessment of Piping Systems, Multi-scale damage of laminated FRP composites, Multifunctional nanomaterials and nanocomposites, nano metal-oxide/graphene - for wearable electronics, Hydrophobic ceramic hollow fiber membrane, Chalcogenide glass and fibers; and Contaminants removal in water/ industrial wastewater.

Under the theme a list of promising technologies was also prepared for assessment of their 'Technology Readiness Level'.

(v) CSIR Theme: Chemicals (including leather) and Petrochemicals (CIP):

CSIR invited concept notes from 19 labs participating under Chemical Theme. 159 proposals in the form of concept notes along with SMART objectives were received. The spreadsheet/ data of all concept notes was prepared along with their alignment of national priority/ grand challenge identified under the theme. A matrix was developed for bringing objectivity in shortlisting of proposals. Based on the matrix, shortlisting of proposals became objective and easy. Out of 17 screened projects (FBR/NCP), 9 projects were shortlisted by the Expert Committee for implementation. These projects mainly on development of catalysts for petcoke gasification, oxidation of propylene oxide, gasoline from bionaphtha and carboxylation of naphtha grade olefins using CO_2. Besides, futuristic projects including chromogenic materials, polymers for 3D printing, design of corrosion inhibiting molecules, dyes/ materials for DSSC, and intermediates for APIs were also considered.

(vi) CSIR Theme: Energy (Conventional & Non-Conventional) and Energy Devices (EED):

Concept notes were invited from 21 labs participating under Energy Theme. 156 proposals in the form of concept notes along with SMART objectives were received. The spreadsheet/ data prepared for all concept notes along with their alignment of national priority/ grand challenge identified under the theme helped in objective screening of the proposals. Out of 27 FBR/NCP proposals, 7 were screened for consideration by Expert Committee. A total of 5 projects (FBR/NCP) were shortlisted in review by the Expert Committee for implementation. The project considered for implementation included methane transformation, hydrocracking of renewable oils, conducting coating material for SOFC, salinity gradient based power generation and solar hydrogen production.

(vii) CSIR Theme: Agri., Nutrition & Biotech (ANB):

In the reported year, the ANB Theme facilitated various actions which includes identifying potential technologies for undertaking the

required TRL assessment and Technology audit, project identification under the specified categories for funding in 2018 -19.

About 195 concept proposals were received under seven sub themes of the Agri Nutri Biotech Theme, whereas based on the ranking, total 70 project proposals with alignment to the identified Grand Challenges from 19 CSIR laboratories were selected in the first tier screening for review at 2nd tier. The activity was successfully conducted. Expert Committee reviewed and recommend 18 of NCP and 20 numbers of FBR project for funding under the theme.

As a part of TRL verification / review of technologies, a total of 29 technologies having TRL 6 or above from this theme were shortlisted for preparation of technology compendium.

(viii) CSIR Theme: Healthcare (HTC):

During the FY 2018 -19, RPPBDD implemented 29 projects under FBR and NCP category of the Healthcare Theme. NCP were created when there was potential to create leadership where a project entitled 'Non Alcoholic Steato-Hepatitis' emerged as a cross-lab project. The current national leadership of CSIR in population and disease genomics was also reinforced. These thrust areas were combined with the best focused basic research projects (FBR) since only deep understanding would lead to high quality translation.

11.1.5. Facility Creation Projects

Aimed at building state-of-the-art infrastructure in India including upgrading the existing one in order to meet new technological challenges and for generating revenues, CSIR has also initiated a new strategy for funding explicit 'Facility Creation' need from FY 2017-18. Some of the facilities so created earlier started catering to the stakeholder needs including serving to other R&D and academic institutions.

During the FY 2018 -19 period, 13 numbers of Facility Creation Projects (FCP) were supported. The supported eminent facility are : Geopolymeric Concrete facility for road building, Creation of Advanced Structural Engineering laboratory, Metallurgical product developments for Automotive Strategic and Aerospace Applications, Net Shape manufacturing facility for Precision Glass Optics, Pilot level (up to 20 kg) synthesis of ceramic powders, pigments and. coatings for industry feasibility and market sensitization trials of near ready technologies, Electromagnetic Interference and Electromagnetic Compatibility measurements system up to 40GHz, Establishing State-of-the Precision AG Laboratory with Technical and Industrial Services Centre, Composite pilot plant facility, XRD facility for protein and Small molecules, Centre Excellence for Water Quality Assessment ; and Calibration facility traceable to primary standards of NMI for Phasor Measurement Unit Calibration system.

11.1.6. Detailed Demand for Grants of CSIR for FY 2018-19

RPPBDD prepared the Detailed Demand of Grants (DDG) of CSIR for the year FY2019-20. As both the Plan and Non-Plan budget were merged from FY 2017-18, the document provides financial statements, major achievements, outputs and outcomes of Schemes and future targets. The directorate also prepared response to Parliamentary Standing Committee on Science & Technology, Environment & Forests, Questionnaire-I, II and III on the Detailed Demand of Grants (DDG) of CSIR and submitted a consolidated response of DSIR & CSIR to Rajya Sabha Secretariat.

11.1.7. CSIR S&T Awards

(i) 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;

Category	Award recipients
Life Sciences	Clot Busters for Thrombolytic Therapy (of CSIR-IMTECH)
Innovation	An Innovative Technology for Manufacturing of Specialty Material for Immobilization of High Level Radioactive Waste (of CSIR-CGCRI)
Physical Sciences including Engineering	Technology Transfer for Commercial Plants of 4000 MT Per Year of Para-Tert Butyl Toluene (PTBT) and 3000MT Per Year of Para-Tert Butyl Benzoic Acid (PTBBA) (of CSIR-IICT)
Business Development & Technology Marketing	CSIR-CIMFR and CSIR-IIP

(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 to the best technology which has proven in the marketplace, at least for 5 years). Each award carries a cash prize of ₹ 2 lakh (Rupees Two lakhs only), except the "Most Significant CSIR Technology of the Five Year Plan Period" which carries a cash prize of ₹ 5 lakh (Rupees Five lakhs only). Besides, a plaque and a citation are also given to the awardees.

The awardees for CSIR Technology Awards - 2018 were selected and four category of awards were distributed by Dr. Harsh Vardhan, Hon'ble Minister, Ministry of S&T, ES & EFCC and Vice President in a specially organized ceremony on September 26, 2018, the CSIR Foundation Day. The details of the disseminated awards are as follows:

(ii) 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 ₹ 10 lakh, a citation and a shield.

CDJTA for the years 2015 and 2016 were presented by the Hon'ble Minister for Science & Technology and Earth Sciences, Dr. Harsh Vardhan, Minister of State for Science & Technology and Earth Sciences during the CSIR Foundation day function held on 26th September 2018.

- CDJTA-2015 was awarded to Jubilant Life Sciences Ltd., Noida for development of a commercially viable eco-friendly process of highly pure niacinamide via 3-cyanopyridine route by using in-house developed catalyst. The innovative technology developed by Jubilant Life Sciences for manufacture of niacinamide – a human and animal dietary supplement of vitamin B3, not only gainfully utilizes an in-house developed raw material, 3-cyanopyridine, but also a novel highly carbon efficient, selective and in-house developed catalyst.
- CDJTA-2016 was awarded to CSIR-Central Leather Research Institute for the Waterless Chrome Tanning (WLCT) Technology; an environment friendly, game changing technology for the leather sector. The globally positioned WLCT technology developed by CSIR-CLRI does not require additional

use of water for chrome tanning while eliminating the need to carry out pickling process associated with the use of acid and salt. This technology being environment friendly, offers reduction of salinity an TDS in effluents by 20% and brings down the usage of chromium by 15-20%, resulting in significant material saving as well.

11.1.8. Theme Compendium

At present CSIR has several technologies under various themes which are in advance stage of development and also ready for commercialization. Ministry of Micro, Small and Medium Enterprises (MoMSME) expressed its interest in commercialization of such technologies. Later, NITI Aayog also desired DSIR/CSIR to identify 200 technologies (TRL 6 or above) which are ready for commercialization and sharing the same with MoMSME. In the same context, CSIR Laboratories were requested to forward information on at least 10 technologies (TRL 6 or above) which are ready for commercialization and suitable for MSME, in a given proforma.

Theme wise Committees of Experts were formed to assess and validate the TRL levels of technologies received from CSIR Labs in the first week of May, 2020. Theme wise guidelines were developed and used for assessment of TRL provided by Labs.

11.1.9. Audit Inspection of CSIR

28 projects implemented under XI Plan period by 10 CSIR laboratories were audited by PDA. RPPBDD prepared a factual statement based on many aspects/ statements related to projects implemented during XI Plan, including its monitoring and implementation. Subsequently, PDA forwarded Action Taken Notes/ Audit paras to be replied by CSIR. Based on the information gathered from CSIR labs and that available in CSIR, suitable replies to ATNs were prepared and forwarded. The first version replies submitted by RPPBDD was approved by FA, CSIR and was forwarded to PDA for consideration.

11.1.10. Parliament Questions

The Directorate has provided required responses to varying Parliament Questions in FY 2018 - 19 such as Patent of CSIR, Establishment of Innovation Complexes, Scheme for Indian Scientists residing abroad, Indian scientist returning to India, Research projects, Setting up of cancer Institutes, Women scientist in the country , Patent of Indian medicine, Research work on GM herbs, Attracting youngsters to S&T research, Energy Generation from waste plastic, Knowledge networks under NMSHE and NMSKCC, National Civil Aircraft Development Programme, BGR-34, Medicinal Plants, On flood control and disaster management in NE region, Herbal Drugs, S&T Cooperation Agreements with other countries, Low Cost Medical Innovations, Promotion of Science Technology, Lagging in Science and Technology, CSIR - 800 Scheme, Emission of name carbon Particles, Building aircrafts under "Make in India Programme", Medicine for Mosquito borne Diseases, Technology for Climate Change issues, Ayurvedic Medicines, New Medicines introduces in AYUSH, Testing of Traditional Drugs, Research on effectiveness of Marijuana in cancer treatment, Medicinal/ aromatic plants in the country, Oneer-a safe drinking water device, Bio Energy, Converting sea water to potable water, Patent of Ayurveda Formulation, Research on Air Purification and Prototype Lithium-ion Cells.

During the year, around 125 questions were replied including inputs to Department of Science and Technology, and other ministries.

11.1.11. CSIR Annual Report 2017-18

Based on the contributions received from all the constituent labs of CSIR and Divisions of Headquarters, the Division prepared draft

CSIR Annual Report for the year FY2017 - 18 . The report contains Executive summary with Scientific Excellence, Significant Events. Significant S&T Achievements, Scientific Excellence, Significant S&T Contributions, Contribution to GoI missions, Significant technological contributions against sustainable development goals, Significant Scientific and Technical Achievements, Central Management Activities, Headquarters Activities, Awards, Recognition, Patents data, Publications etc.

11.1.12. Security & Sensitivity clearance

The R&D proposals involving overseas scientists/ agencies were examined and deliberated in the Directorate from security and sensitivity angle. The proposals covered collaborations, agreements, MoUs. During the year twenty-five proposals were processed by the Division.

Some of the clientele covering these proposals were: UK consortium; Israel Aerospace Industries Ltd.; M/s Raockwellcollins; Sigma Aldrich Com. LLC ; Korean Aerospace Research institute ; Mauritius Oceanographic Institute ; Purdue Pharma Natreon Inc.; Lean Manufacturing & Assembly Technologies Ltd. ; Good Rich Aerospace services Pvt. Ltd.; United Nations Industrial Development Organization; Liebherr-Aerospace & Transportation SAS; Merck Life Sciences Pvt Ltd; Ecoinvent; Ergo Exergy Technology Inc.; ISU Exachem Co Ltd; Technical University of Munich; Institute for Global Environmental Strategies; United Nations Environment programme; JeonjinEntech Ltd.; Asia-Pacific Network for Global Change Research; Druk Green Power Corporation Limited; Sripath Technologies; and Musad Engineering and consultancy etc.

11.1.13. CSIR-HARIT (hitherto CSIR 800)

CSIR, during the 12th five-year plan, operated CSIR-800 program for rural sector and successfully implemented 55 projects with a duration spanning 1 to 2 years. The success of the implementation is agreed by the fact that CSIR benefitted more than 4.5 lakh people against envisaged 3 lakh people and generated revenue of about ₹ 50 crore against an investment of about ₹ 31 crore. Considering the diverse needs of the population and the geographical extent of challenges across India that require effective technological interventions, it was implicit that a lot more to be done through focused investment into key areas of rural development. Based on suggestions of 'CSIR Schemes Review Committee' under chairmanship of Dr. T Ramasami (Former Secretary, DST), in FY 2018 - 19 the rural and societal oriented initiatives of CSIR-800 were revamped into CSIR-HARIT (Harnessing Appropriate Rural Interventions &Technologies).

Considering the complexities involved in the implementation of such endeavors it was felt that large numbers of organizations/ agencies/ institutes are required to work as a team for addressing the rural societal needs. As a result, a conscious decision has been taken to involve all relevant CSIR labs/ units in CSIR-HARIT endeavors for carrying out activities of national priority in project mode for rural people, with clearly defined deliverables.

CSIR-HARIT aimed to enable deployment of needed CSIR offerings (technologies/ innovations/ products/ processes/ interventions/ services) in villages across the country for augmenting the incomes and improving the quality of lives of the targeted communities. In the process, CSIR-HARIT also targeted alignment itself towards fulfillment of Sustainable Development Goals (SDGs) and Objectives of various National Missions. Presently, under the guidance and leadership of United Nation (UN), governments across the globe are targeting measurable delivery of outcomes against SDGs for the period 2016 to 2030. These SDGs are meant to address aspects of extreme poverty and to seek more equitable development and environmental sustainability across the planet.

Fig. II.I.I3.I: Samba Mahsuri Cultivation

The key project activities implemented during FY 2018-19 under CSIR-HARIT are as follows:

(i) Popularization of Improved Samba Mahsuri, a bacterial blight resistant and diabetic friendly rice to increase farmers' income (CSIR-CCMB): Improved Samba Mahsuri (ISM) has been estimated to be cultivated in ~1 00,000 hectares in 2018-19. In total, between 2011-2018, ISM has been cultivated in ~3,00,000 hectares of farmers' fields cumulatively in Telangana, Andhra Pradesh, Tamil Nadu, Karnataka, Chhattisgarh, Uttar Pradesh, Bihar, etc. The total value of ISM produce is estimated to be ~₹ 2880 crores out of which the trait specific value (Benefit of growing ISM) is ₹ ~550 crores.

(ii) Dissemination of Nutrition, Food Safety, Food Research and Hygiene practices to general public through social media (CSIR-CFTRI): 9 English and 8 Kannada podcasts have been produced and disseminated. In addition to the proposed, 8 Hindi podcasts have also been produced. Thus, total of 25 podcasts with an average duration of 25 minutes have been produced during the period. At present the reach is about 1,00,000. The podcasts are directly sent to 1250 members through WhatsApp. 63 subscribers receive the same through a YouTube Channel. Visitors to the CFTRI Website also have access to Thali Tales. Janadhwani, a community radio based in Sargur has been broadcasting the Kannada podcast every fortnight. The radio has a population reach of 2,50,000 in HD Kote and Sargur Taluks and an audited listenership of 98,000. Radio FM 90.8 managed by the Maharaja Institute of Technology, Mysuru, is broadcasting both English and Kannada. The radio has a reach of around 8,000.

(iii) Establishment of Common Facility Centre for Spice processing 150-200 kg /day (CSIR-CFTRI): A training programme was conducted on "Opportunities in Spice Processing" for farmers of Wyanad at CSIR-CFTRI during March 2019. 3 identified technologies on value addition to spices viz., (a)Turmeric processing, (b) Ginger dehydration and (c) Ginger paste have been demonstrated to the farmers at CSIR-CFTRI. Training programme have also been conducted to impart knowledge on spice processing and value addition which will help in

Fig. II.I.I3.2: Training Programmesbeingconducted at CSIR-CFTRI

Fig. II.I.I3.3: Demonstration of process to M/s. Manoj Salt Suppliers, Didwana (Solar salt producer)

producing better quality products and in turn benefits farmers.

(iv) **Improving quality of salt with simultaneous recovery of sodium sulphate through scientific intervention, in Nawa-Didwana region of Rajasthan (CSIR-CSMCRI):** Pilot scale demonstration has been completed to the local solar salt producer of Didwana (Rajasthan).

(v) **Popularizing sustainable and alternative livelihood options for low income coastal communities through imparting training on cultivation of economically important seaweeds (CSIR-CSMCRI):** Focus of present activity is development of livelihood and betterment of life for a discrete population in Tsunami colony in Tuticorin, Tamil Nadu and Siyal Bet, Jafrabad, Gujarat. The estimated present income of targeted beneficiaries (mostly women screened out of 250 trained persons) to be inducted for commercial farming (30 beneficiaries) is approximately ₹ 27.00 lakhs (considering income of ₹ 5,000 per month) for project duration (18 months) and this will increase more than thrice i.e. ₹ 91.80 lakhs (considering additional income of ₹ 12,000 per month) for these beneficiaries

after project implementation. Further commitment for commercial seaweed farming by trained beneficiaries in addition to the targeted 30 beneficiaries would be an additional asset in this project. Being out-reach type of work, the project will improve knowledge on socio-economic status of targeted population and further improvement through generation of means for their livelihood. Project's measurable deliverable also include establishment of seed production facility at these localities which would cater the need of seedling material needed for imparting training to 250 beneficiaries on seaweed faming and also expansion of seaweed cultivation at other places. CSIR-CSMCRI would ascertain linking up cultivators with appropriate financial institutions and private sector entrepreneurs to have buy back agreement

(vi) Rural Penetration and Pilot Trials for DivyaNayan (CSIR-CSIO): Project aims at Rural Intervention of the technology to unprivileged visually impaired in aspirational districts of Uttar Pradesh, Rajasthan and Bihar. Towards this hands on session of the device usage for Visually Impaired held at: (i) Bundi, Rajasthan for State government employees of Rajasthan during 2nd Regional convention of Govt. Employees, (ii) SBI Learning Centre, Panchkula for SBI employees and (iii) Patiala school for Deaf and Blind, Patiala; Panjab University, Chandigarh; Punjabi University, Patiala; Navchetna A Charitable Institute for the Blind, Patiala; Visually Impaired of Rajasthan in blind convention at Udaipur, Visually Impaired of UP at Dr. Shakuntala Misra National Rehabilitation University, Lucknow, Blind School, Sector 26, Chandigarh; SevaKutir, New Delhi.

Enrolment/Registration of users for device training & trials, also device distribution (including End User Licence Agreement) has been initiated through online portal available at https://divyanayan.csio.res.in

(vii) Increased crop productivity and enhanced income generation through smart micro irrigation system (More yield per Drop) (CSIR-NISTADS): The draft technical specifications of WASIS Basic Variant have been formulated. This variant is to be incorporated with the farmer's existing micro irrigation system. For the purpose, a visit was made to Jagdalpur, the district Headquarters of Bastar District on 28 and 29 March 2019 for discussion with officials on project site identification/ selection. With the help of district concerned officials, about 18 farmers from various sites/ villages in Bastar District of Chhattisgarh have been identified for implementation of the project for retrofitting of the WASIS Basic Variant to their existing irrigation system.

(viii) Technologies and Products for Reduced Emissions Fireworks (CSIR-NEERI and others): CSIR has developed of new and improved formulations of firecrackers popularly known as green crackers which are providing 30% reduction in PM emissions. The technology and training have been provided to more than 150 manufacturers of firecrackers (after signing of Non-Disclosure Agreement). – NEERI has also set up state of art facility for testing emissions from firecrackers. However, to cater to the voluminous samples anticipated to be submitted by firecrackers manufacturers (about 5000 to begin with), CSIR-NEERI has also identified NABL approved labs for emissions testing to cater to the needs of expected submission of voluminous samples and is planning to set up one such emissions testing facility also at Sivakasi. CSIR has thus developed unique developed emission testing facilities and also training capability to cater to the needs of large set of end users.

11.1.14 Project proposal of CSIR-NPL on establishing a centre for testing of ballistic materials

CSIR-NPL has planned on establishing National Centre for Ballistic Material Testing Delhi under Make- in India project in Body Armour. The overall aim of this centre is to characterize the raw materials used for soft and hard body armours in highest possible accuracies by maintaining quality system. Realising its importance, an Empowered Committee has been constituted for 'Make-in-India' in Body Armour by the Cabinet Secretary, under the Chairmanship of Dr. V.K. Saraswat, Member, NITI Aayog. One of the recommendations of the committee was that "CSIR/DSIR should make specific provision of budget at revised estimate 2018-19 stage for setting of the proposed Centre of Excellence at CSIR-NPL. The Ministry of Finance will provide requisite funds at revised estimate stage for establishing the Centre of Excellence at CSIR-NPL. The said committee reiterated that CSIR should take necessary action for funding the Centre and make it operational by December, 2019. RPPBDD was instrumental for getting its approval from the Competent Authority.

11.1.15. Proposal of CSIR-NAL for seed funding towards SPV for Regional Transport Aircraft

CSIR-NAL advocated on formation of Special Purpose Vehicle (SPV) between HAL-NAL-ADA (DRDO) for Regional Transport Aircraft (RTA) Project. The total cost of the project is ₹ 10000.00 crore and project is divided into three phases: (i) Project definition phase: ₹ 0.80 cr; (ii) Development and Certification: ₹ 64.20 cr; and (iii) Establishing production and development facility to achieve production rate of 36 aircraft per year: ₹ 35.00 cr. The main objective of SPV is to complete the PDP (Preliminary Definition Phase). The feasibility Study and DPR was examined and in-principle was obtained from a seed funding of ₹ 10 crore by RPPBDD.

11.1.16. CSIR-CMERI Centre for post-harvest processing in Arunachal Pradesh- Facilitation by RPPBDD

Arunachal Pradesh produces good quality of ginger, turmeric, chilly and other spice crops. But due to lack of protection and post-harvest processing technology, farmers are forced to sell their produces at a low price

RPPBDD supported the administrative and establishments requirements of CSIR-CMERI for setting up a post-harvest processing near here to help farmers in Ziro of Arunachal Pradesh. The centre plans to cater to the needs of the farmers of the state through technological solutions and training to improve their knowledge and skills about post-harvest handling, processing, water purification and renewable energy technologies. The centre would help the farmers of the state to get proper value for their produce and also help in their economic upliftment.

11.1.17. Contribution to National farm machinery facility at CSIR-CMERI-CoEFM, Ludhiana

RPPBDD supported CSIR-CMERI in augmenting the Centre of Excellence for Farm Machinery (CoEFM) of CSIR-CMERI at Ludhiana by positioning funding for Establishing state-of-the art precision Agriculture laboratory and for Setting up of Technical and Industrial Services Centre (TISC) along with up-gradation of Manufacturing Facilities. This centre is likely enhance the local industries along with contributing the needs in domain of farm machineries.

11.1.18. CSIR Contribution for Aspirational Districts (Data for MoS&T)

The Aspirational District Programme, launched by Government of India, aims to swiftly transform the districts that have shown relatively lesser progress in vital social areas and have appeared as pockets of under-development,

thereby posing a challenge to ensure balanced regional development. RPPBDD prepared an S&T based details of 115 Aspirational Districts including MSME needs (Commercial activities and Potentials) along with mapping existing Industry Sector in the district with relevant CSIR Themes and also put up the possible CSIR plan for S&T Interventions for the 115 Aspirational Districts. The duly agreed data was provided to office of Ministry of Science and Technology.

11.1.19. Formulating a new Mob Control Vehicle (MCV) with advanced features

Globally the 'Riot Control System market' is projected to grow from USD 9.05 Billion in 2016 to USD 11.78 Billion by 2021. CSIR reviewed the national scenario regarding possibilities of developing an innovative system, constraints were deliberated. Further it was scheduled to design and develop Mob Control Vehicles (MCV) for utilization in the situation for both protecting the law-enforcement units as defensive device and controlling the situation whenever peace maintenance is required as offensive device. For the purpose a compact armored vehicle with expandable multiple shield system at front and back was proposed either operator controlling from vehicle cabin or developing tele-operated systems at later stages.

Design analysis and simulation are extremely critical for design validation and performance analysis such a vehicle and its mechanism, components.

RPPBDD in association with CSIR-CMERI coordinated the widespread needs, assisted in build-up and finalization of a laboratory centric proposal for 'Design and Development of Mob Control Vehicle (MCV)' with extensive involvement of all possible stake holders. The concept was initiated and developed into a full-fledged proposal in association with Ministry of Home Affairs and Rapid Action Force (RAF of the Indian Central Reserve Police Force as participants. CSIR-CMERI prepared and finalized it as an FTT project;

11.1.20. Monthly Summary of Progress Reports

Submission of Monthly Summary progress report of the CSIR laboratories, to Department of Scientific & Industrial Research (DSIR) for circulation among different Ministries was undertaken. The Hindi version of the report was prepared and submitted to DSIR.

Fig.II.1.19.1: Proposed four-wheeled-drive and three degrees-of-freedom compact armored vehicle with expandable provision

11.2 Human Resource Development Group (HRDG)

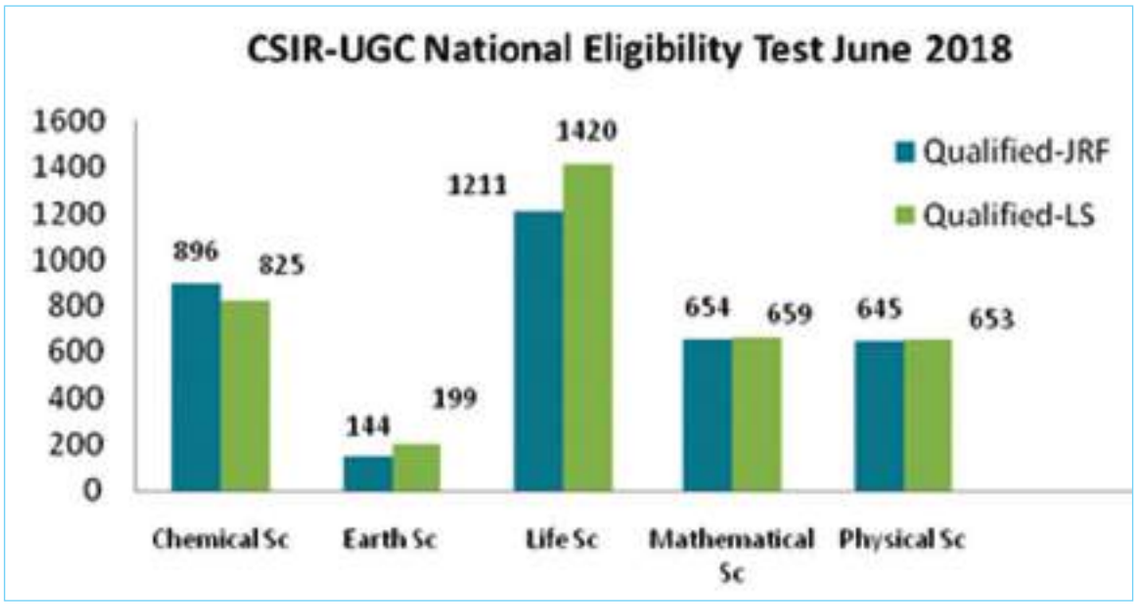
The Human Resource Development (HRD) Group of Council of Scientific & Industrial Research (CSIR) has a mandate to develop and nurture S&T manpower at the national level. It also promotes, guides and co-ordinates scientific & industrial research through research grants to scientists/professors working 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 for the period from April 2018 to March 2019 are as follows:

11.2.1. National S & T Manpower Development:

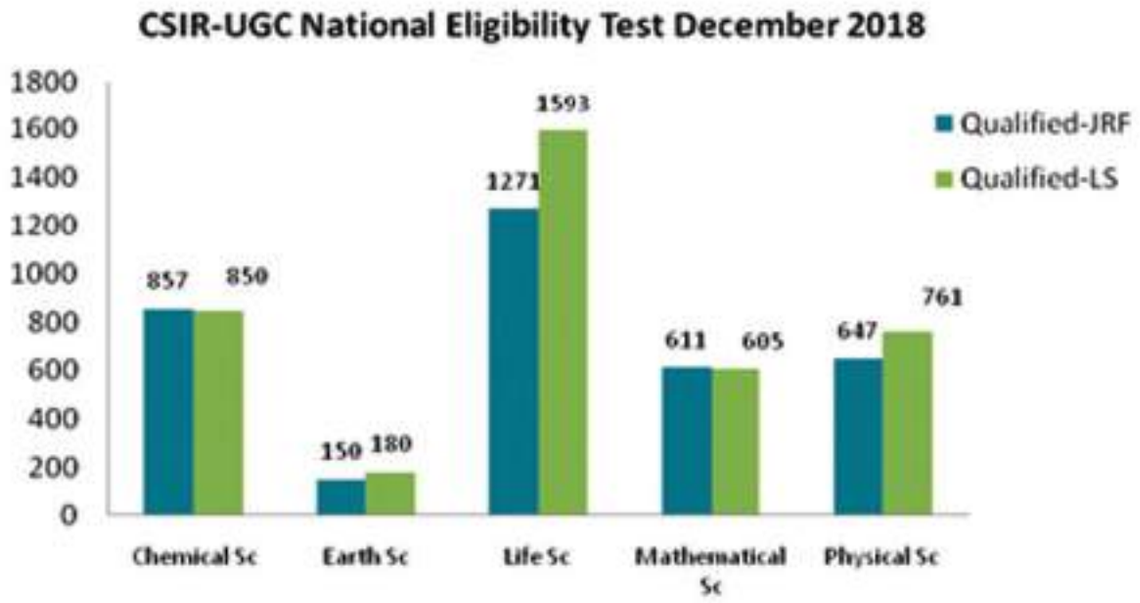
11.2.1.1. Junior Research Fellowship(NET)

CSIR-UGC National Eligibility Test (NET) June 2018 for Junior Research Fellowship and Eligibility for Lectureship was conducted on 17th June 2018 at 27 centres throughout the country. 2,16,426 candidates registered & 1,55,924 appeared for the examination. The result of CSIR-UGC NET June 2018 was declared on 27th November 2018. A total



Subject	Chemical Sciences	Earth Sciences	Life Sciences	Mathematical Sciences	Physical Sciences	Total
Qualified-JRF	896	144	1211	654	645	3550
Qualified-LS	825	199	1420	659	653	3756

Out of 3550 candidates qualified for JRF, 2050 are to be supported by CSIR and rest by UGC.



Subject	Chemical Sciences	Earth Sciences	Life Sciences	Mathematical Sciences	Physical Sciences	Total
Qualified-JRF	857	150	1271	611	647	3536
Qualified-LS	850	180	1593	605	761	3989

Out of 3536 candidates qualified for JRF, 2036 are to be supported by CSIR and rest by UGC.

number of 3550 candidates qualified for CSIR/ UGC Junior Research Fellowship & lectureship and 3756 qualified for lectureship only.

The CSIR-UGC NET December 2018 examination was held on 16th December 2018. 2,01,150 candidates registered and 1,59,084 appeared for the examination. The result was declared on 2nd April 2019. A total number of 3536 candidates qualified for CSIR/ UGC Junior Research Fellowship & lectureship and 3989 qualified for lectureship only.

11.2.1.2. Senior Research Fellowship (SRF) and Research Associate-ship (RA)

The expert committee meetings for the selections of SRFs and RAs in 19 disciplines were held during 2018-19. Out of total 2942 candidates called for interview, the candidates selected for SRF and RA were 550 and 230 respectively.

11.2.1.3. 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 2018-19, 79, Senior Research Associates were selected and their total number as on 31st March 2019 was 150.

11.2.1.4. 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 / 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 2018-19, thirtyeight (38) JRF-GATE fellowships were awarded and around 77JRF-GATE Fellows are working at present in different CSIR laboratories.

11.2.2. Promotion and Recognition of Excellence

11.2.2.1 CSIR Young Scientist Awards

The CSIR Young Scientist Awards (YSA) is 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 2018, three scientists were selected for Young Scientist Awards, one from Chemical Sciences and two from Engineering sciences. These awards were presented by Dr Harsh Vardhan, Hon'ble Minister for Science & Technology and Earth Sciences and Vice President, CSIR on the occasion of CSIR Foundation Day Function held on 26th September 2018 at Vigyan Bhawan, New Delhi.

Recipients of CSIR Young Scientist Awards 2018

Chemical Sciences

Dr Naveen Kumar Chandrasekaran

Electroplating Metal Finishing and Technology Division

CSIR-Central Electrochemical Research Institute

Karaikudi (Tamil Nadu)

Engineering Sciences

Dr Abhiram Hens

Micro System Technology Laboratory

CSIR-Central Mechanical Engineering Research Institute

Durgapur (West Bengal)

Dr Niraj Kumar

Microwave Devices Area

CSIR-Central Electronics Engineering Research Institute

Pilani (Rajasthan)

11.2.2.2 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 2016, 2017, and 2018 were presented by Shri Narendra Modi, Hon'ble Prime Minister of India and President, CSIR at presentation ceremony held on 28 February, 2019 at Vigyan Bhawan, New Delhi.

11.2.2.3 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 2018, GN Ramachandran Gold Medal was presented to Prof. K. Muniyappa, Indian Institute of

Award Year 2016

Fig. II.2.1: Recipients of Shanti Swarup Bhatnagar Prize 2016 with Shri Narendra Modi, Hon'ble Prime Minister of India and President, CSIR

Award Year 2017

Fig. II.2.2: Recipients of Shanti Swarup Bhatnagar Prize 2017 with Shri Narendra Modi, Hon'ble Prime Minister of India and President, CSIR

Award Year 2018

Fig. II.2.3: Recipients of Shanti Swarup Bhatnagar Prize 2018 with Shri Narendra Modi, Hon'ble Prime Minister of India and President, CSIR

Science, Bangalore by Dr Harsh Vardhan, Hon'ble Minister for Science & Technology and Earth Sciences and Vice President, CSIR on the occasion of CSIR Foundation Day Function held on 26th September 2018 at Vigyan Bhawan, New Delhi.

Recipient of G N Ramachandran Gold Medal for Excellence in Biological Sciences & Technology 2018

Prof. K Muniyappa
Department of Biochemistry
Indian Institute of Science
Bangalore (Karnataka)

11.2.3. Funding of Extra Mural Research Schemes to promote R & D

Schemes	No. of Proposals Considered	Proposals Recommended	Proposals Renewed
General	458	178	594
Emeritus Scientist	60	19	74
Sponsored	--	--	7

11.2.4. Travel / Conference Grants

Travel grant is provided by CSIR to young researchers for presenting research papers at International Conferences abroad. Total of 1656 travel grant applications from students were considered and 677 cases were recommended for support. Travel grant committee also considered 476 applications for travel support from regular employees and recommended 256 cases for support. For organizing national/international conferences/ symposia/ workshops etc., a total of 1939 proposals from universities/institutes/scientific societies etc were considered and 499 cases were recommended for

Schemes	Total Considered	Total Recommended
Travel Grant to students	1656	677
Travel Grant to regular employees	476	256
Symposia Grant	1939	499

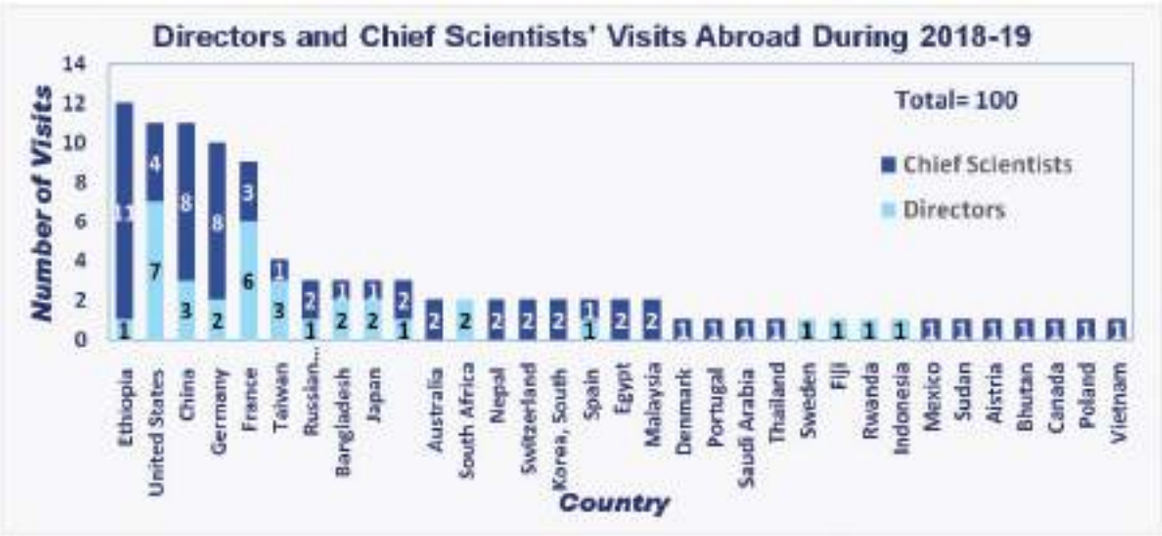
11.3 International S&T Affairs Directorate (ISTAD)

11.3.1. International S&T Networking

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

I. SCIENTIFIC INTERACTIONS THROUGH EXCHANGE VISITS

100 visits of CSIR Directors and Scientists 'G' were facilitated during FY 2018-19 as part of internalization strategy and for international benchmarking. These visits facilitated projecting CSIR globally. 198 scientists / research scholars from abroad visited CSIR institutes for collaborative projects, workshop / seminar participation, business meetings, training courses and research internship programmes that further provided S&T networking opportunities.



II. BILATERAL COOPERATION

a) Country Specific Bilateral Cooperation Programmes of CSIR

Germany

Germany continued to be one of the most active S&T partners of CSIR. CSIR's network with major research agencies of Germany including BMBF, DLR, DAAD, FhG progressed well in terms of joint research effort.

CSIR - BMBF Cooperative Science Programme:

Four (4) projects were implemented by CSIR-CEERI, and CSIR-CECRI, CSIR-NPL, CSIR-NAL under the CSIR-BMBF (German Ministry for Education and Research) programme. Six (6) CSIR scientists visited from India to Germany and One Researcher from Germany visited India. The outcome of the projects is given below.

Topic	CSIR Institute	German Institution	Outcome
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	CSIR-CECRI	University of Regensburg	Experience acquired in preparation of laser scribed graphene electrodes and their application in electroanalysis using microfluidic systems which will be implemented in CSIR-CECRI. Laser scribing of polymers to graphene offers material of high throughput at relatively low cost. Electrode design can be tuned to suit the requirement. Multi-analytes addressing system can be designed with less active material and without going through regular screen printing or lithography which in general require more active materials. One (1) joint research paper published a reputed journal.
AlGaN/GaN HEMTs based polar liquid sensor	CSIR-CEERI	Leibniz InstitutfürHöchstfrequenztechnik (FBH)	Novel design developed for Gallium Nitride HEMT based polar liquid sensor. Handheld circuit and system developed for laboratory use in polar liquids detection and Nano molar Hg detection (heavy metal ions detection). Project led to HE development; New knowledge generated disseminated through three (3) joint research papers in reputed journals
Vibration Energy Harvesting using Multi-Layered Piezoelectric Stacks / Devices: Comparative study on lead containing and lead free material systems	CSIR-NAL	University of Duisburg-Essen	i) Fabricated ML stacks, bimorphs, pellets of both PZT and lead free piezo materials and dispatched to Germany for their testing; ii) Piezo force microscopy (PFM), electrocaloric (EC) measurements, ferroelectric and dielectric measurements of the samples were carried out at University of Duisburg, Germany;

			iii) Energy harvesting characterization of PZT ML stacks were carried out using an energy harvesting unit fabricated at University of Duisburg, Germany; iv) Tape casting of barium titanate and cobalt ferrite powder (brought by German visitor) was done at CSIR-NAL using the tape casting facility; v) Energy harvesting characterization of PZT devices at CSIR NAL using energy harvesting equipment; vi) Magneto-electric characterization of piezoelectric and magnetic alternate multi-layered stack was carried out using the facility available in University of Duisburg, Essen, Germany. The ML stack showed ME coupling coefficient of 6.22E-5 V.Oe-1 Cm-1.
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	CSIR-NPL	German Aerospace Center, DLR	Process Technology for optimization of ohmic contact for making thermoelectric device for power generation and cooling applications developed. Development of prototype thermoelectric devices at CSIR-NPL will assist Indian automobile industries to utilize this concept at large scale to harness the waste heat of exhaust pipe into electricity to partly power the Heating, Ventilation and Air conditioning (HVAC) requirements of their automobile. This technology will help in reducing the fuel consumption in automobiles and thus lead to reduction in greenhouse gas emission. The knowledge generated will be used for developing thermoelectric technology that could be used for energy harvesting from waste heat (wood burning stoves in villages). There is perhaps no such renewable energy generating technology for harnessing waste heat (Nuclear reactors, Steel Plants) at high temperatures is worldwide available commercially. Two (2) joint research papers published.

Also, an Indo-German Workshop on "Waste Treatment Technologies: Sustainable Water Supply and Wastewater Management – Research for Sustainable, Affordable Solutions" co-piloted by CSIR-NEERI and Institute of Env. Engg. and Management (IEEM), Witten/ Herdecke University gGmbH, co-funded by CSIR and BMBF, was held at New Delhi on February 27-28, 2018 with an objective to identify specific research topics of mutual interest and develop pre-proposals to be reviewed and developed into full proposals. The Workshop focused on five themes, viz, (a) Treatment of wastewater and contaminated water resources to produce supply water, (b) Small scale solutions, especially septage management, (c) Industrial and hazardous wastewater prevention, treatment, reuse, (d) Wastewater monitoring, analyses and (e) Water and Energy. The deliberations resulted in development of 12 pre-proposals which were reviewed and merged into five (5) consortium proposals.

Italy

The CSIR-CNR Exchange Programme for the year 2015-2018 got concluded with completion of following joint research projects in December 2018:

Republic of Korea

A corporate level MoU was signed by CSIR with National Research Council of Science & Technology (NST), Republic of Korea on July 10, 2018 with an objective to promote, establish and expand scientific and technological research cooperation in fields of science and technology, including Affordable Water Purification; Bioscience and Biotechnology; Traditional and Oriental Medicines; Chemical S&T; Electronics and Telecommunication;

Fig. II.3.I: MoU signing between CSIR and National Research Council of Science & Technology (NST), Republic of Korea

S.No.	Title	Indian Partner
1.	Sonochemical synthesis of biobased composite materials for energy applications	CSIR-CECRI
2.	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
3.	Sonochemical synthesis of biobased composite materials for energy applications	CSIR-CECRI
4.	Design, Materials Development and Fabrication of Capacitive Micromachined Ultrasonic Transducer (CMUT)	CSIR-CEERI
5.	Improved safe management of arsenic rich waste generated from arsenic removal plant	CSIR-CMERI
6.	Development of catalytic renewable process by converting Indian origin non-edible oil to valuable chemicals	CSIR-NCL

Energy S&T; Geoscience and Technology; New / Alternate Materials; Robotics and Automation; Aerospace S&T.

Taiwan

For implementation of the MoU between CSIR and Industrial Technology Research Institute (ITRI), Taiwan signed on 12 Oct. 2017 for promoting Industrial R&D partnership, a Joint Seminar "CSIR-ITRI Seminar: Exploring Opportunities" was organized.at New Delhi on Oct 31, 2018 with participation of 10 experts from ITRI and 25 from CSIR. The seminar focused on three themes: IoT, Energy and Environment and Accelerator Ecosystem and Innovation Models. Several areas for joint collaboration were identified.

Fig. II.3.2: MoU between CSIR and Industrial Technology Research Institute (ITRI), Taiwan

DG, CSIR along with CSIR delegation met the 10-member ITRI delegation led by its Vice President. The deliberation recommended taking up technology oriented projects and supported ongoing technology partnership dialogues on

a) Development of miniaturized DivyaNayan (a personal reading machine for visually impaired to access printed or electronic textual information) [CSIR-CSIO]
b) Setting up Sensor Fabrication Facility in India though joint project on "Development of Low Cost Air Quality System for Indian Terrains [CSIR-CEERI]

Ethiopia

The Council of Scientific and Industrial Research (CSIR) has entered into an agreement with the Metal Industries Development Institute (MIDI), Ethiopia to implement a "Twinning Programme on Capacity Building to Transform Metal Industry Development Institute (MIDI)". The agreement was signed by the Director of NML, Jamshedpur on behalf of CSIR, India and the Director General of MIDI on 7th June 2017. The financial compensation to the twinning partners (CSIR laboratories) for the twinning program for three-year duration is US$ 6,806,000. The principal objective of this transformation program is to enhance the competitiveness of the metal and engineering industry through speeding up the transformation and development of the sector, through a transformation of MIDI into a globally competitive center of excellence in the field of metals and metals manufacturing. The benefit will have a great impact on Ethiopian metals industries.

The need for a Twinning arrangement for Capacity Building of Metals Industry Development Institute (MIDI) has been established through the TOR document prepared by MIDI and the GAP analysis carried out by the experts of the CSIR, India. Thereafter, a proposal for twinning program was made which included the activities plan and strategies to transform MIDI into a centre of excellence focusing on the technical skills development, soft skills development, management system enhancements, curriculum development, laboratory establishment activities, and industrial services activities of MIDI. The CSIR labs have started their respective activities as per activity schedule.

Czech Republic

AnMoU between Council of Scientific and Industrial Research (CSIR), India and the Czech Academy of Sciences, Czech Republic to promote and strengthen scientific and technological cooperation was signed on September 7, 2018 during the visit of Hon'ble President of India to the Czech Republic. The MoU would serve as a broad framework for implementation of cooperation particularly through joint R&D projects in mutually agreed S&T areas.

Japan

Three corporate level cooperation arrangements were concluded by CSIR with Japanese partners

1) MoU with Hiroshima University: signed on 29.10.2018 for promoting research partnership in areas of mutual interest to contribute to the advancement of knowledge partnership and technology development.
2) MoU with Institute of Innovative Research (IIR), Tokyo Institute of Technology: signed on 29.10.2018 to cooperate in areas of mutual interest.
3) Agreement with Research Center for Advanced Science and Technology (RCAST): signed on 28.10.2018 to undertake academic exchange to promote academic research and other activities.

b) CSIR's Participation in Inter Govern-mental S&T Cooperation Funding Programmes:

Thirtyeight (38) 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 ₹ 2210.389 lakhs.

S.No.	Country	CSIR Institutes	Topic	Funding Programme	Funding (Rs. in Lakhs)
1.	Australia	CSIR–IICB	Development of new drugs for Leishmania – An Australian–Indian Partnership Collaboration Agreement was approved	An Australian–Indian Partnership	143.88
2.	Austria	CSIR-NIIST	"Ultrafast Electron Transfer Dynamics and Anti-Proliferative Activity of Hybrid Transition Metal Nitrosyl Complexes	India-Austria S&T Cooperation Program (2018-20)	8.8
3.	Finland, Estonia	CSIR-NIIST	Holistic processes and practices for clean energy in strengthening bioeconomic strategies (INDONORDEN)	INNO INDIGO partnership programme on Biobased Energy	69.446
4.	France	CSIR-CGCRI	Development of an Affordable, Rapid and improved Multiphoton Maskless Lithography System for 3D Printing of Surface Texturing with Sub-Micron Structures using Amplified Microchip Lasers	IFCPAR Scientific Research Programme	148.00
5.	France	CSIR-NAL	A novel high temperature solar selective coating on Nimonic Substrate for solar thermal electricity receivers	CEFIPRA	23.27
6.	France	CSIR-IICB	Peptide-based Hydrogels for Sensing and Targeting CDK5 Kinase Biomarker Hyperactivity in Gliobastoma	IFCPAR	64.04
7.	France	CSIR-IICB	Mechanism of miRNA-dependent and independent targeting of mRNAs to P-bodies	IFCPAR	65.30
8.	France	CSIR-IIP	Enhanced CO2 adsorption and its photo-electrochemical conversion using semiconductor-metal complex hybrids	IFCPAR	50.00
9.	France	CSIR-NIIST	Nanowire white LEDs based on innovative nano-phosphors	DST-IFCPAR	71.44
10.	France	CSIR-NIO	Nutrient transfers through groundwater in India (NUNDERGROUND)	DST-IFCPAR	12.193

11.	Germany	CSIR-CCMB	Exploring the Structural and Functional Determinants of Neuronal Calcium Sensors	DST-DAAD PPP Programme	39.92
12.	Germany	CSIR-CMERI	Photovoltaic driven adsorption and electro-chlorination post-treatment coupled with riverbank filtration for sustainable drinking water production	DST-DAAD	13.80
13.	Germany	CSIR-CSIO	Optoacoustic Microscope on a fiber tip for endoscopic applications	DST-DAAD	14.28
14.	Germany	CSIR-CECRI	Advanced Li-Ion Transporting Solid-State Lithium Batteries	IGSTC	40.61
15.	Germany	CSIR-CLRI	Smart Cities integrated energy supply, carbon sequestration and urban organic waste treatment through combined solar sludge drying and pyrolysis (PYRASOL)	IGSTC	115.57
16.	Germany	CSIR-NEERI	Minimizing wastewater volume and treatment costs by utilizing ambient conditions (MAKARA)	IGSTC	120.01
17.	Germany	CSIR-NIIST	Design and development of near-net-shape manufacturing process for light weight high strength aluminum composite and engineering components by squeeze infiltration technique for automotive and aerospace applications (NearNetMac)	IGSTC	183.33
18.	Germany	CSIR-SERC	Modular Lightweight Wastewater Treatment Units made with TRC for Rural and Periurban Dwellings	Clean Water) (IGSTC	68.00
19.	Hungary	CSIR-CSIO	ICT Based Tools for Assessment and Improvement of Efficacy of Upper Limb Robotic Rehabilitation Using Thermographic Diagnostic Method	DST-NRDIO	37.60
20.	Japan	CSIR-IIP	Integrated Thin Films of Graphene-Ionic Liquids for Lubrication in MEMS Applications	DST & JSPS	7.95
21.	Japan	CSIR-NIIST	Construction of p/n Heterojunction through the Self-Assembly of Functional Dyes	DST-JSPS	7.09

22.	Japan	CSIR-NPL	Highly Conductive polymers and Nonmaterial for Structural Applications	DST-JSPS	10.75
23.	Malaysia, Vietnam	CSIR-CGCRI	"Fiber-optic sensor technology for the detection of chemical species in liquid / gas environment using side-polished Photonic Crystal Fiber	India- ASEAN Collaborative R&D Scheme	72.43
24.	Malaysia, Indonesia	CSIR-CSIO	Monitoring of blood oxygenation for diabetic foot ulceration detection by using diffuse reflectance spectroscopy	India- ASEAN Collaborative R&D Scheme	28.15
25.	Norway	CSIR-IICT	Structure-based target exploration for the discovery of new leads for antibiotics	ICMR - RCN	100.72
26.	Russian Federation	CSIR-4PI	Analysis of urban 'heat islands', air pollution dynamics and extreme weather phenomena in India and Russia	DST-RFBR	24.00
27.	Russian Federation	CSIR-CDRI	Understanding CTD-chromatin crosstalk during transcription through nucleosome	DST-RFBR	165.00
28.	Russian Federation	CSIR-CSMCRI	New Ion-conducting Hybrid Membranes for Electro-membrane Processes and Energy Applications	DST-RFBR	26.06
29.	Russian Federation	CSIR-IICT	High Mobility Organic Single Crystals for n-Channel Field-Effect Transistors	DST-RFBR	24.00
30.	Russian Federation	CSIR-NCL	Catalytic Transformation of Indian and Russian Origin Biomass Feedstocks to Biofuel via Levulinic Acid	DST-RFBR	24.00
31.	Russian Federation	CSIR-NGRI	Himalaya-Burma arc: Modeling of seismicity and recognition of earthquake-prone areas	DST-RFBR	24.00
32.	Russian Federation	CSIR-NIO	Irregular wave transformation over the submerged sand bars and mudbanks: role of dissipation and nonlinear processes	DST-RFBR	22.92
33.	UK	CSIR-CMERI	Robust Cyber Security Framework for Longitudinal	DST-UKERI	23.20

			Smart Energy Monitoring Device Data (CS-SED)		
34.	UK	CSIR-CSIO	Integration of Space Based SAR (BIG) Data with ground based Information for an Improved Near Real Time Assessment and Monitoring of Seismic Hazard	DST-UKERI	18.31
35.	UK	CSIR-NCL	Automated Continuous Manufacturing Platform for Functional Nanoscale Materials	DST-UKIERI	19.09
36.	UK	CSIR-IICB, CSIR-IMTECH, CSIR-CDRI	Global Network for Neglected Tropical Diseases	GCRF	78.00
37.	UK	CSIR-IICT	BIOREVIEW: Biorefining Value from Industrial Waste	DBT Newton Fund	1.75
38.	Switzer-land	CSIR-IMTECH	Higher Order Assembly of wag 31.	Indo-Swiss Joint Research Program of DBT	243.48

Also, CSIR institutes bagged funding from Inter-governmental programmes and successfully organized below listed joint workshops with partners from Germany and Japan. The workshops led to identification of new topics and proposals for collaborative R&D.

S.No.	Event	CSIR Institute	Dates and Venue
1.	Indo-German Workshop on "Waste to Wealth" to find solutions for effective waste management funded by Indo German science and Technology Centre (funded by IGSTC)	CSIR-AMPRI	February 25-26, 2019; Bhopal
2.	Indo-German Workshop on "Membranes for Water and Energy" to provide an opportunity for membrane technocrats/researchers to discuss stable membrane and sustainable membrane technologies, their potential applications & challenges (funded by IGSTC)	CSIR-CSMCRI	February 18-20, 2019; Bhavnagar
3.	Indo-German Workshop on "Additive manufacturing of metals: Current issues and way forward" funded by Indo German Science and Technology Centre (funded by IGSTC)	CSIR-NML	February 4-6, 2019; Jamshedpur
4.	India-Japan Workshop on Bio molecular Electronics and Organic Nanotechnology for Environment Preservation (IJEWBME 2018) (funded by DST-JSPS)	CSIR-NPL	December 6-9, 2018; New Delhi

c) Twinning of CSIR institutes with their partners abroad

With an objective to enhance mutually beneficial subject specific collaboration, Institute to Institute level research linkages were promoted. The following cooperation arrangements were signed/approved for signing:

1) **France:** Agreement was signed on 26.02.2019 at CSIR-NCL for Creation of an International Associated Laboratory (LIA): Indo-French Joint Laboratory For FunctionalisedMATerials for SUstainableCATalytic and related Applications (MATSUCAT) jointly between CSIR-National Chemical Laboratory (NCL), Pune and Centre National de la Recherche Scientifique (CNRS) on behalf of Universitéd'Artois (UA), Université de Lille Sciences et Technologies (UL1), Ecole Nationale Supérieure de Chimie de Lille (ENSCL), Ecole Centrale Lille (ECL), The Université de Strasbourg (UNISTRA).

2) **Germany:** Materials Transfer Agreement (MTA) between CSIR-IICT and Max Planck Institute (MPI) for Biology of Ageing, Cologne, Germany was concluded to provide know how and research substances - Mito-Esc (molecule: 6-7 dihydroxy coumarin (Esculetin) coupled with lipophilic triphenylphosphoniumcation tagged with octenyl carbon chain [TPP+]).

3) **Mexico:** MoU between CSIR-CSMCRI, Bhavanagar and Instituto Tecnologico De Sonora (ITSON), Mexico was signed on Nov. 27, 2018 to develop joint projects in teaching and research; organizing meetings and seminars as well as any other program of interest to both institutions; promoting exchange of students, researchers and personnel as well as the exchange of experiences in the fields of teaching, research and culture within the areas determined by mutual agreement; Encouraging reciprocal exchange on topics such as research, postgraduate courses, doctoral courses, books, publications and other teaching materials; and formulation and implementation of joint research programmes including in the areas of Energy efficient photovoltaic (PV) powered reverse osmosis (RO) desalination system.

4) **Rwanda:** MoU between CSIR-CLRI-NIRDA was signed on 14.07.2018 with the following objectives: (i) Preparation of Detailed Project Report for creation of a roadmap for the Leather Value Chain in Rwanda; (ii) Supporting NIRDA towards fulfilling the industrial requirements for a Leather Park in Bugesera, Rwanda; and (iii) Establishment of industrial hands-on training/testing/R&D centre for leather and leather products.

5) **Republic of Korea:** A MoU was signed in October 2018 between CSIR-CEERI and Pohang Accelerator Laboratory (PAL), Pohang University of Science and Technology, Republic of Korea to establish a framework of collaboration in the development of Microwaves Tubes, Vacuum Microelectronic THz Devices and related Pulse Power Systems and LIGA fabrication of mutual benefit to promote comprehensive cooperation between CSIR-CEERI and PAL.

6) **Republic of Korea:** Signing of "Expression of Interest" for partnership between CSIR-NPL and M/s EmCrafts Co. Ltd., Republic of Korea (ROK) on 09.07.2018 at New Delhi. It provides for developing a detailed partnership proposal to a) explore the possibility of developing and indigenizing Scanning Electron Microscopes (SEM) and b) develop new modules and modes of SEM for futuristic technical advancements in SEM.

7) **UK:** Consortium Agreement – CSIR labs (CSIR-IICB, CSIR- IMTECH & CSIR-CDRI) and Durham University, UK was signed on 06.07.2018. The participating agencies will co-operate in a research project entitled "A Global Network for Neglected Tropical Diseases".

III. MULTILATERAL COOPERATION

a) NAM S&T Centre

Networking with the member states of the NAM S&T Centre was encouraged by organizing participation of three (3) CSIR scientists in 3 relevant workshops organised by NAM S&T Centre in

b) Commonwealth Small Island Developing States (SIDS)

Hon'ble Prime Minister announced during the Executive Session of the Commonwealth Heads of Government Meeting (CHOGM), held in London on 19-20 April 2018, "India will champion capacity building programs through the Commonwealth, to help Commonwealth Small Island Developing States (SIDS) acquire the capacities to use modern technologies like remote sensing, or multi beam hydrography, to better manage their ocean based national wealth. For this, proposal of CSIR for offering Specialized Capacity Building in Blue Economy Sectorthrough below listed training programmes by CSIR-NIO, was approved for operating under ITEC Programme of the Ministry of External Affairs (MEA).

a) Remote sensing applications on the coastal zone management;

b) Port Environment and Engineering studies;

c) Multibeam Survey training (shallow multi beam) and

d) Ballast Water Management

IV. Human Resource Development

a) Capacity building of CSIR Scientists through Raman Research Fellowship (RRF) Scheme

As part of HR initiatives to give advanced exposure to CSIR scientists and to promote research networking, CSIR continued its Win-house fellowship programme. Following 9 promising CSIR scientists were selected for grant of Raman Research Fellowship for 2018-19:

S.No.	Name and Designation	CSIR Institute	Period	Host Institute
1.	Dr. Mukesh Kapoor Senior Scientist	CSIR-CFTRI	3 Months	Michael Smith Laboratories, University of British Columbia, Vancouver, Canada
2.	Dr. Akash Deep Scientist	CSIR-CSIO	4 Months	InstitutfürWerkstoffe der Elektrotechnik RWTH Aachen University, Aachen, Germany
3.	Dr. Raj Kumar Scientist	CSIR-CSIO	4 Months	Applied Electromagnetic Research Institute, National Institute of Information and Communications Technology (NICT), Tokyo, Japan
4.	Dr. Kausar M. Ansari Scientist	CSIR-IITR	6 Months	Department of Food Chemistry & Toxicology, University of Vienna, Austria
5.	Dr. P Nisha Scientist	CSIR-NIIST	3 Months	Institute of Agrochemistry and Food Technology (IATA), CSIC, Valencia, Spain
6.	Dr. Abhilash Scientist	CSIR-NML	6 Months	Federal Institute for GeoSciences & Natural Resources, Hannover, Germany
7.	Dr. SaptarshiSasmal Principal Scientist	CSIR-SERC	4 Months	Dept. of Civil Engg. and Engg. Mechanics, University of Arizona, Tucson, Arizona, USA

b) Capacity building of foreign researchers with CSIR-TWAS Fellowship

With an aim to provide training and advanced exposure / award higher educational degrees to researchers from developing countries, thereby enhancing CSIR brand, CSIR, in association with TWAS, offered 21 fellowships, 11 Postgraduate (leading to Ph.D.) and 10 Postdoctoral, to foreign nationals from Cameroon, Colombia, Egypt, Ethiopia, Ivory Coast, Nepal, Nigeria, Tanzania and Tunisia enabling them to carryout to carry out research at CSIR-CDRI, CSIR-CECRI, CSIR-CFTRI, CSIR-CLRI, CSIR-CMERI, CSIR-CSIO, CSIR-CSMCRI, CSIR-IICB, CSIR-IICT, CSIR-IIP, CSIR-IMMT, CSIR-NBRI, CSIR-NGRI, CSIR-NIIST, CSIR-NML and CSIR-NPL in different areas S&T (i.e. Biological Sciences, Chemical Sciences, Engineering Sciences, Food Sciences & Technology, Health Sciences, Materials Science & Engineering, Geophysical Sciences, Physical Sciences etc.). Details of the fellowships offered by CSIR are provided below:

Postdoctoral Fellowships

S.No.	Name	Nationality	CSIR Lab.	Research Area	Duration
1.	Dr. Luc Achille Ziem A Bidias	Cameroon	CSIR-NGRI	Physical Sciences – Volcanic history of famous Cameroon Volcanic Line	6-12 Months
2.	Dr. (Ms) Grace Andrea Montoya Rojas	Colombia	CSIR-NGRI	Physical Sciences – Impact assessment of soil pollution on groundwater quality	6-12 Months
3.	Dr. (Ms) Samar Sayad Ibrahim Mohamed	Egypt	CSIR-CFTRI	Biological Sciences – Biopesticides from essential oils to control Grain & pulse Beetle.	6-12 Months
4.	Dr. Rishi Ram Ghimire	Nepal	CSIR-NIIST	Chemical Sciences – Nanoscale materials for optoelectronic applications	6-12 Months
5.	Dr. Oluwagbenga Oluwasola Adeogun	Nigeria	CSIR-CFTRI	Biological Sciences – Natural food preservatives	6-12 Months
6.	Dr. Abdulrazaq Omotunde Ogunmoye	Nigeria	CSIR-IICT	Chemical Sciences – Synthesis of biologically active natural products from African medicinal plants	6-12 Months
7.	Dr. Adeyinka Sikiru Yusuff	Nigeria	CSIR-IIP	Chemical Sciences – Application of Heterogeneous catalyst in production of Biofuel from vegetable oils	6-12 Months
8.	Dr. (Ms) Oluwakemi Yemisi Adesanya	Nigeria	CSIR-NGRI	Physical Sciences – Seismic attributes analysis for hydrocarbon prospecting	6-12 Months
9.	Dr. Abideen Adejuwon Ibiyemi	Nigeria	CSIR-NPL	Physical Sciences – Nanocomposites for dye sensitized solar cell	6-12 Months
10.	Dr. Omar Rejeiba	Tunisia	CSIR-CSIO	Physical Sciences – Nanomaterials for sensors and devices	6-12 Months

Postgraduate Fellowships

S.No.	Name	Nationality	CSIR Lab.	Research Area	Duration
11.	Mr. Jean Marie Dangwang Dikdim	Cameroon	CSIR-NIIST	Chemical Sciences – Degradation of organochlorine pesticide by heterogeneous photocatalysis	6-12 Months
12.	Mr. Koffi Arnaud Kamenan	Côte d'Ivoire	CSIR-NIIST	Physical Sciences – Organic semiconductors based on latex for photovoltaic applications	6-12 Months
13.	Mr. Hailu DemissieTulu	Ethiopia	CSIR-CLRI	Chemical Sciences – Removal of Chlorophenolic compounds from aqueous media	Upto 4 Years*
14.	Mr. Adam Olaitan Abdulkareem	Nigeria	CSIR-CDRI	Biological Sciences – Role of estrogen metabolism in pulmonary hypertension	Upto 4 Years*
15.	Mr. Usman Lawal	Nigeria	CSIR-CECRI	Chemical Sciences – Polymer composites for high performance Zinc/Bromine Redox Flow Battery	Upto 4 Years*
16.	Mr. Simeon Ayodele Babalola	Nigeria	CSIR-CMERI	Engineering Sciences – Sensorial defect monitoring in friction stir welding	Upto 4 Years*
17.	Mr. DluyaThagriki	Nigeria	CSIR-IICB	Biological Sciences – Tropism and entry of Aedes based viruses (e.g. Dengue viruses)	Upto 4 Years*
18.	Mr. Godwin John	Nigeria	CSIR-IMMT	Engineering Sciences – Nanocomposites for removal of heavy metals and dyes from wastewater	6-12 Months
19.	Mr. Oluwatobi Adekunle Oso	Nigeria	CSIR-NBRI	Biological Sciences – Plant diversity, systematics and herbarium	6-12 Months
20.	Mr. Ibrahim Momoh Bello Omiogbemi	Nigeria	CSIR-NML	Engineering Sciences – Development of new electrode for duplex stainless steels (DSS) welding	6-18 Months
21.	Mr. Farid Mzee Mpatani	Tanzania	CSIR-CSMCRI	Chemical Sciences – Seaweeds and marine plants	Upto 4 Years*

CSIR-TWAS Fellows at CSIR Laboratories/Institutes

Mr. Muideen Opeyemi Mudasiru from Nigeria at CSIR-NBRI, Lucknow

Mr. Aaron Yissa Isaac from Nigeria at CSIR-NCL, Pune

Mr. Tome Sylvain from Cameroon at CSIR-NML, Jamshedpur

Mr. Nobosse Pierre from Cameroon at CSIR-IHBT

c) Capacity Building of foreign researchers through Training Programme

Following Training programmes were organized by CSIR for researches from developing countries:

S.No.	Training programme	Country / No. of	CSIR Institute participants	Dates
1.	Li-ion Battery	Nigeria (4)	CSIR-CECRI (Funded with Rs 3.55 lakh (approx.) By PRODA)	4 - 7 February 2019
2.	Library Management and Security Systems	Bhutan (10)	CSIR-NISCAIR	May 14-18, 2018

3.	Pavement Evaluation Techniques and their maintenance and rehabilitation; and Design of Bridge Structure and Foundation	Tanzania (7) Uganda (5)	CSIR-CRRI	Oct 29 – Nov 2, 2018
4.	Analytical Skills Development Course (ASDC)	20 researchers from 20 countries (Algeria, Bangladesh, Brazil, Chile, Costa Rica, Ethiopia, Mexico, Moldova, Morocco, Nigeria, Panama, Philippines, Serbia, Slovakia, Sri Lanka, Sudan, Tunisia, Uganda, Vietnam and Zimbabwe)	CSIR-IICT (Funded with ₹ 27.68 lakh (approx.) by OPCW	3-14 December 2018
5.	"Developing Key Parameters for Ensuring Sustainability of Leather Sector in Developing Countries"	17 from 12 countries; (Bhutan, Cambodia, Egypt, Indonesia (2), Mauritius, Nepal, Nigeria (5), Palestine, Sri Lanka, South Africa, Zambia and Zimbabwe)	CSIR-CLRI	28-31 January 2019

V. INTERNATIONAL CONFERENCES/ EVENTS ORGANIZED WITH PARTICIPATION OF INTERNATIONAL EXPERTS

Thirteen (13) international conferences/ workshops enhancing international recognition of CSIR, were organized by CSIR institutes with due approvals of the competent authorities. About 378 foreign delegates from all over the world (Algeria, Argentina, Australia, Austria, Bangladesh, Belgium, Bhutan, Bolivia, Botswana, Brazil, Burkina Faso, Cambodia, Canada, Chile, China, Colombia, Costa Rica, Cuba, Czech Republic, Denmark, Egypt, Ethiopia, Finland, France, Germany, Ghana, Hong Kong, Indonesia, Iran, Israel, Italy, Japan, Kenya, Malaysia, Mauritius, Mexico, Moldova, Morocco, Myanmar, Nepal, Netherlands, New Zealand, Oman, Panama, Philippines, Poland, Portugal, Russia, Saudi Arabia, Serbia, Singapore, Slovakia, Slovenia, Spain, Sri Lanka, South Africa, South Korea, Sudan, Sweden, Switzerland, Taiwan, Thailand, Togo, Tunisia, Turkey, UK, Uganda, USA, Venezuela, Vietnam, Yemen, Zimbabwe, Zambia) and about 4000 national participants attended these events that enabled them network with their international peers.

S.No.	Event	CSIR Institute	Dates and Venue
1.	International Conference on Sustainable Chemistry for Health, Environment & Materials (SuCHEM 2018)	CSIR-IICT	August 5-6, 2018; Hyderabad
2.	International Conference entitled Utkarsh 2018: Empowering & Enabling Women in Science	CSIR-NEERI New Delhi	October 30-31, 2018;
3.	International Workshop on Mid-Ocean Ridges and other Geological Features of the Indian Ocean (SCOR-InterRidge)	CSIR-NIO	November 14-16, 2018; Goa
4.	5th International Leh Symposium 2018 on Respiration under hypobaric hypoxia: Clinical and molecular portrayal	CSIR-IGIB	November 15-19, 2018; Gangtok
5.	International Conference on "Pavements and Computational Approaches (ICOPAC-2018)"	CSIR-CRRI	November 16-17, 2018; New Delhi
6.	International Conference on Biotechnological Research and Innovation for Sustainable Development – BioSD 2018	CSIR-IICT	November 22-25, 2018; Hyderabad
7.	4th International Plant Physiology Congress (IPPC-2018)	CSIR-NBRI	December 2-5, 2018; Lucknow
8.	International Training Course on Analytical Skills Development Course (ASDC)	CSIR-IICT	December 3-14, 2018; Hyderabad
9.	International Quaternary Union Research (INQUA) Meeting to have discussions on enhancing available knowledge by engaging with international dialogue and activities concerned with modern global environmental problems	CSIR-NIO	January 13, 2019; Goa
10.	International Training Workshop on Developing Key Parameters for Ensuring Sustainability of Leather Sector in Developing Countries	CSIR-CLRI	January 28-31, 2019; Chennai
11.	International Conference and Exhibition on Energy and Environment: Challenges and Opportunities (ENCO-2019)	CSIR_CIMFR	February 20-22, 2019; New Delhi
12.	7th International Symposium on Current Trends in Drug Discovery Research (CTDDR-2019)	CSIR-CDRI	February 20-23, 2019; Lucknow
13.	International Conference on New Age Opportunities and Challenges for Quality, Safety and GMPs in Herbal Drug Development	CSIR-NBRI	February 22-23, 2019; Lucknow

11.4 Human Resource Development Centre (HRDC)

Inputs of CSIR-HRDC for CSIR Annual Report 2018-2019:

CSIR-Human Resource Development Centre (CSIR-HRDC), Unit of CSIR, Headquarters, is situated at Ghaziabad and has Mission as "To promote a professional and holistic human resources management group both at headquarters and in each laboratory and evolve long term human resource development plan for professionalizing R&D management and support functions in CSIR". Since its establishment in 2002 the Centre is continuously working towards achieving its mission statement.

Continuing its endeavor, CSIR-HRDC conducted 35 different programmes having all-round coverage of various training requirements across CSIR HQ and labs. The programmes inter-alia covered skill upgradation & development, orientation, induction, capacity building, competency certification and sensitization etc. In between its planned programmes and need-based/demand-driven programmes, the Centre has struck an excellent balance in carrying out ad-hoc programmes also.

Following pie-chart indicates various target categories benefitted from the programmes.

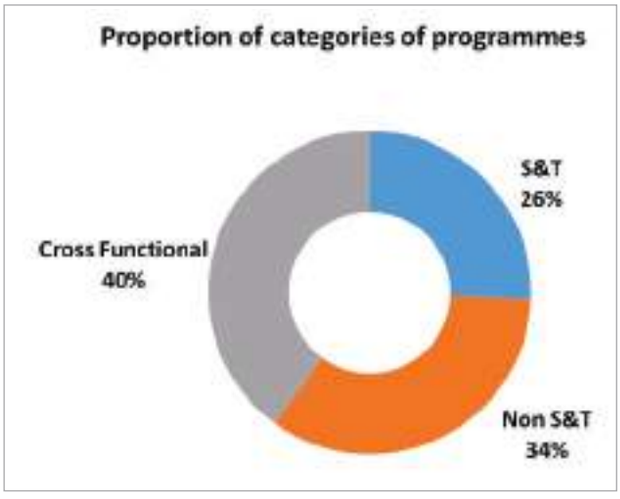


Fig. II.4.0: Different Target categories benefitted during 2018-2019

Programmes with strategic intent

The Impact of the programmes like "Leadership skills, nurturing of new or strategic knowledge/ skill, orientation and mid-career capacity building" are far reaching which will be visible after a couple of years from now. There were 5 exclusive programmes designed for scientist last year: Leadership development programme (twice), Technology & Innovation management, IPR Issues and Team building/motivation.

There were two programmes designed for a cross- team of scientists & technical personnel: One on technical consulting and the other on science communication. The former was a 4-day Certificate programme organized in collaboration with Consultancy Development Centre, New Delhi. The later was the first ever skill shop organized by the Centre focusing only on the development of "skills pivotal to science communication". For technical manpower, there were two programmes: One on mid-career capacity building and the other, an orientation programme, for newly joined personnel.

Under non-S&T category, two programmes were devoted for Engineering Services Units of all CSIR Labs and one programme exclusively designed for guest house officials of all CSIR guest houses. "Capacity building programme for Engineers and architects of ESUs" had two editions, the first centrally held at Ghaziabad and the second at Kolkata in quick succession bearing testimony to the usefulness of the programme. "Capacity Building Programme for Guest House Officials" was a well-received programme as it was particularly overdue for long.

Under cross-functional category, there were three planned programmes: "Workshop on Adoption of Ministry of Finance Manual on procurement of Consultancy and other Services – 2017", "Training Programme on Taxation Laws: Direct and Indirect Taxes" (Two editions). Also there was one women-centric programme "Training Programme on Work-life Balance" which is a regular in the Centre's calendar underlining its thrust on women empowerment.

Fig. II.4.1: CSIR - Leadership Development Programme, April 16-20, 2018

Fig. II.4.2: CSIR-Leadership Development Programme, February 18-22, 2019

Fig. II.4.3: CSIR-HRDC Certificate Programme in Technical Consulting, May, 28-31, 2018

Fig. II.4.4: Capacity Building Programme for Technical Officers, May 21-25, 2018

Fig. II.4.5: Capacity Building Programme for Guest House Officials, December 5-7, 2018

The participants were women scientists and officers.

Need-based/Demand-driven Programmes:

These programmes were opportunities for the Centre to rise to the occasion based on both internal calls and external stimuli to organize interventions fulfilling the imminent training needs. The main internal stimuli were RTI implementation/record management (1 programme), New Accounting Software implementation (led to 6 programmes), Vigilance and tendering process (led to 6 programmes) and Latest trends in Public Procurement (led to 3 programmes). Also, there were two women-centric programmes on Sexual Harassment of Women at Workplace & Gender Sensitization that were organized based on overwhelming demand from stakeholders.

Fig. II.4.6: Programme on Effective Implementation of RTI Act and Record Management, April 5-6, 2018

Fig. II.4.7: Training Programme on Vigilance and Tendering Process, April 24, 2018

Fig. II.4.8: Implementation of New Accounting Software in CSIR Labs, April 23-27, 2018

Fig. II.4.9: CSIR-HRDC Training Programme on Work-life Balance for Women Scientists and Officers, March 8, 2019

11.5. Information Technology Division (ITD)

(i) GIGW compliant CSIR website

The Division facilitated continued up-gradation and up-dating of CSIR website 'https://www.csir.res.in', in compliance with Govt of India Guidelines (GIGW). The CSIR website conforms, closely as possible, to the Minimum-Required-Content as per the guidelines laid down by several Nodal Ministries and Departments of Govt of India including Ministry of Electronics & IT(MeitY), Department of Administrative Reforms and Public Grievances (DARPG), Ministry of Personnel, Public Grievances and Pensions and DSIR.

(ii) PAN CSIR Video Conferencing System

The division facilitated the management and technical support for CSIR-wide, state-of- the -art High Definition Video conferencing facility for CSIR scientific groups and its laboratories. It includes VC sessions for monitoring of various R&D programs, projects and other monitoring activities. Besides the increased productivity and efficiency, significant cost on travel has been saved during the year by conducting more than 60 VC sessions per month (point to point and multiparty). The division regularly supported office of DG, CSIR for DG addressing all CSIR Laboratories through VC on key occasions such as Technology Day, New Year etc. This facility has been extended to all the CSIR Labs/ Institutes and its units including CSIR Science Centre.

The Division also facilitated monthly PRAGATI-VC sessions, for monitoring of various inter departmental projects by O/o Hon'ble Prime Minister of India with all Govt. of India Secretaries.

(iii) Webcasting

The division facilitated live webcasting of several central events, such as address by Hon'ble Prime Minister from Vigyan Bhawan on CSIR Foundation day function along with Video Conferencing with premium educational institutes. Webcasting is being supported every year from Vigyan Bhawan to facilitate all Scientific Community and Staffs of CSIR.

(iv) Implementation of e-procurement (C-PPP) portal for CSIR & its labs

For increased transparency and efficiency in procurement, the division contributed as nodal division for PAN CSIR including labs and coordinated with NIC for implementation of e-tendering through central procurement portal. The CSIR and its laboratories saved enormous budget and able to bring transparency in procurement process.

(v) ICT Infrastructure upgradation

To its continued endeavor to empower the scientists, officials and staff, the division facilitated replacement of aged hardware (computers/laptops/printers/Scanners etc. for many divisions.

(vi) Supporting IMPACT and other Legacy Software

The Division coordinated and facilitated Finance division of CSIR Hq for processing financial data for preparation of their balance sheet and various financial reports to be submitted by CSIR. The technical support for section specific legacy Application Software such as Recruitment, R&I, ISTADS, monitoring / follow up cases by O/o DG CSIR have been maintained by the division.

(vii) Implementation and management of Aadhaar Enabled Attendance system (AEBAS)

The Division contributed as nodal division for implementation and management of Aadhaar Enabled Attendance system (AEBAS) system in CSIR its labs along with implementation

of IP based surveillance system. To meet the surveillance requirement, the division implemented IP based surveillance system for CSIR Hqrs and in Science Centre also.

(viii) Coordination with CSIR Labs for IT/ Cyber policies Implementation

The Division coordinated with CSIR Labs to implement IT related policies and followed up for their compliance by all the CSIR Labs.

(ix) OASIS (Online Advanced Scientific Information System)

The Division coordinated and facilitated in implementation of OASIS in all CSIR laboratories / institutes. OASIS portal has provision of Comprehensive Searchable Database of Scientific & Technical Staff of CSIR, along with CSIR-UTube, CSIR-WWW (What Why Who), Scheduler / Planner, Sharing of various Meeting Documents / Presentations, etc. OASIS Portal is currently being explored for Updation / Upgradation.

(x) DARPAN (Dashboard for Analytical Review of Projects Across Nation)

The Division coordinated and facilitated in implementation of DARPAN, which is developed by NIC with a vision for "Analytical Monitoring of the Plans and Schemes of Government at various Level through one consolidated dashboard with anytime and anywhere access". The dashboard displays information in an objective and quantifiable way, helping to get a comprehensive view of the whole issue in a single window access for identified Programme/ Schemes.

11.6 Mission Directorate (MD)

Jet Fuel Derived from Biomass: A Step towards Green Aviation

Application of biofuels for aviation is an effective means for the aviation industry to reduce its carbon footprint. CSIR-Indian Institute of Petroleum (CSIR-IIP) has developed a process as well as a catalyst to produce jet fuel based on biomass-derived non-edible oils such as jatropha oil. The bio-jet fuel has been able to match all the major specifications for aviation fuels such as petroleum derived jet fuel. The process developed is very similar to refinery processes and hence can be integrated into the current refinery infrastructure. The technology was showcased at Republic Day 2019 through flight of an Air Force carrier aircraft. Earlier in August 2018, a test flight was conducted with Spicejet when a commercial

Fig. II.6.I: Flights with jet fuel based on biomass-derived non-edible oils such as jatropha oil

flight from Dehradun to Delhi was flown with the bioaviation fuel in one of its engines.

High yielding variety of *Artemisia annua*

Artemisia annua is a major source of natural artemisinin used in the treatment of cerebral/ drug resistant malaria in India. The best available variety of Artemisia so far was "CIM Arogya" having artemisinin content of around 1%. However, with the increasing availability of semi synthetic artemisinin (SSA) in the market and continuous falling international prices of artemisinin, the production cost of natural artemisinin (NA) needed to be brought down for it to remain sustainable / competitive in the international market.

Extensive breeding work carried out during last 12 years at CSIR-Central Institute of Medicinal and Aromatic plants (CSIR-CIMAP), Lucknow has resulted in development of a new variety having artemisinin content of 1.2% (an increase of at least 20% over existing variety CIM Arogya) with a yield potential of 43-45 quintal per hectare dry herb. The variety has been named "CIM Sanjeevani". It was developed from poly cross progenies between two existing varieties i.e. Jeevan Raksha and CIM Arogya.

The variety has been licensed to IPCA Lab, Ratlam. CSIR-CIMAP facilitates linkage between farmers and user industry to ensure buy-back of produce through its biovillage model. Farmers are earning net profit of ₹ 60,000-70,000 per hectare in four months' period from Artemisia cultivation. The variety is being cultivated in about 2000 hectare through contract farming. In addition, employment in artemisinin processing industry is also being generated. Potential benefit to the industry due to reduced cost of production is by a margin of 20%.

Fig. II.6.2: High yielding variety of *Artemisia annua*

Linalool rich cold tolerant Ocimum chemotype

Linalool is used in the aroma, cosmetic, perfumery, pharmaceutical and flavour industries for formulating value added novel industrial products. The estimated demand of linalool is about 700-900 tons annually by these industries. Presently, India sources linalool from China. The market rate of natural linalool is ₹ 1500-1700/kg while the synthetic linalool costs ₹ 600-700/kg.

Through intensive breeding and selection process undertaken at CSIR-Central Institute of Medicinal and Aromatic plants (CSIR-CIMAP), Lucknow, a linalool-rich variety of *Ocimum basilicum* has been developed. The variety has been named "CIM Surabhi". The (-) linalool in this variety has 99.14% purity and quality would be better than that obtained from lavender. The development of a basil variety having high linalool content is a novel.

The variety is expected to provide additional income to farmers as it would be a high herb and essential oil yielding variety with 70-75% (-)linalool. A farmer can get an income of ₹ 50,000/- to ₹ 55,000/ha per annum. The farmers may be benefited with 30-35% additional profit.

Fig. II.6.3: Field view of variety CIM Surabhi

The baine-rich Opium Poppy Lines through Narcotics Department

Thebaine has $500 to $600 million market in Canada and a multibillion-dollar market in the United States. The demand of opium alkaloids stands at 260 tons per annum in 2016. India produces 3 tons the baine annually. CSIR-NBRI has developed an improved line of opium poppy producing 10% thebaine, against 1-2% in normal variety.

Fig. II.6.4:

Calliterpenone for Enhancing Crop Yields

The widespread application of agrochemicals to intensify crop cultivation is known to severely affect the arable soils. CSIR-Central Institute of Medicinal and Aromatic plants (CSIR-CIMAP), Lucknow has developed a novel plant growth promoter "Calliterpenone" from an important medicinal plant Callicarpa macrophylla. Calliterpenone is about 6 times cheaper to GA3. It is estimated that the application of calliterpenone, which contributes to improved growth and yield of the plant, would reduce the application of fertilizers, growth hormones, etc and hence would reduce the cost of cultivation by 10% and simultaneously enhance the yields by at least 10%.

Calliterpenone is eco-friendly and promotes population of beneficial soil microorganisms like Rhizobium and Bacillus and retards the detrimental effects produced by allelochemicals. The process for isolation of the molecule and its activity as growth promoter has been patented

in many countries. The technology was released for commercial exploitation involving beneficiary farmers.

A Calliterpenone based natural formulation named CIM-UPAJ has also been developed and has been validated in the farmers' field.

Medicinal & Aromatic crops

Crop	Effective Concentration (mM)	Average increase in growth/Yields (%) (in field experiments)
Mint root growth	0.001 (0.32 ppm)	18. 50
Mint oil yield	0.001(0.32 ppm)	53.49
Pyrethrum flower yield	0.01 (3.2 ppm)	21.50

control

Spray of 3.2 ppm cal 2 times

Vegetable crops

Crop	Effective Concentration (mM)	Average increase in Yields (%) (in field experiments)
Tomato	0.001	36.41
Potato	0.001	26.55
Onion	0.01	24.38

Grain and Legume crops

Crop	Effective Concentration (mM)	Average increase in Yields (%) (in field experiments)	Farmer's field trials conducted
Wheat	0.01	23.11	yes
Rice	0.001	27.94	yes
Chickpea	0.001	26.98	no
Mungbean	0.001	22.52	no

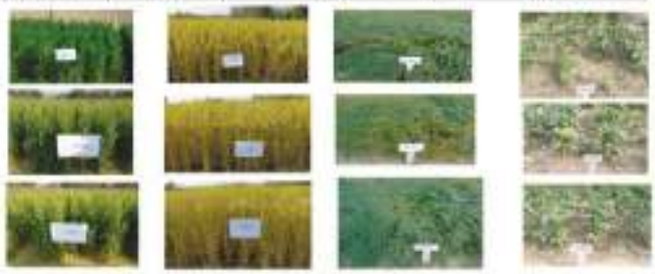


Fig. II.6.5: Performance evaluation trials on different crops

Agrotechnology Transfer and Thymol Crystal from Jammu Monarda

Jammu Monarda is an annual herbaceous plant. This plant species is suitable for subtropical climatic conditions of Jammu and temperate climatic conditions of Kashmir. It has potential for large-scale production of essential oil. The essential oil possesses high level of antifungal activity against common post-harvest fungal pathogens of a variety of crops both by direct contact and in the vapor phase. The essential oil contains high amount of thymol (70-85%) and carvacrol. The demand of thymol containing essential oils is increasing every year. Essential oil of Jammu Monarda has been accepted by pharmaceutical houses as an additional and alternative source of thymol. The prevailing price of the oil in Indian market is Rs.1500/kg.

CSIR-Indian Institute of Integrative Medicine (CSIR-IIIM), Jammu introduced Monarda citriodora in the country. The variety was named Jammu Monarda. The institute has developed agrotechnology and post-harvest processing technology of Jammu Monarda. The technology is expected to be used by farmers for cultivation of the crop in scientific manner as per crop requirement for higher yield and quality to get higher economic return. Large-scale cultivation of this crop will produce tonnage of thymol rich essential oil for fulfilling industrial demand of natural thymol crystals.

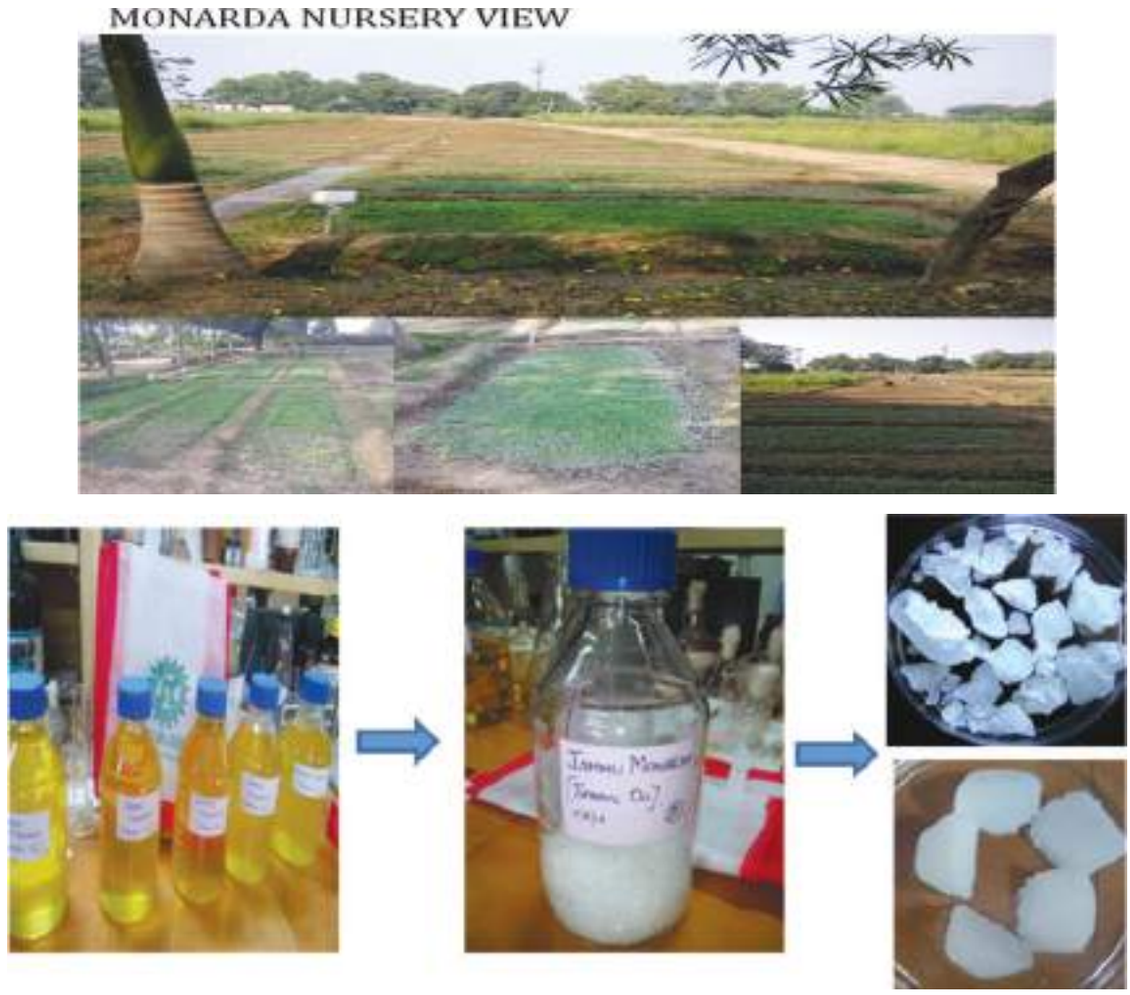


Fig. II.6.6: Essential oil crystal formation at lab scale

At laboratory scale, process for thymol extraction with more than 95% purity from Jammu Monarda has been carried out at 1L scale. Large-scale cultivation of Jammu monarda will be carried out at different locations of J&K & U.P.

Laboratory has also been working towards preparation of thymol as Certified Reference Material (CRM) and development of value added products from Jammu Monarda. The development shall contribute to socio-economic upliftment of farmers by providing high economic return crop and also fulfil the industrial demand of plant based natural thymol crystals.

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

Iron and iodine are essential elements for the human body. Iodine deficiency disorder (IDD) and iron deficiency anaemia (IDA) are caused by insufficient intake of iodine and iron, respectively. These have serious detrimental effects on human physiology and eventually adversely contribute to the economic and social development of entire populations. Globally 1.88 billion people are at risk of Iodine deficiency disorders (IDD) due to insufficient iodine intake and 2 billion people suffer from iron deficiency.

CSIR-Central Salt & Marine Chemicals Research Institute (CSIR-CSMCRI), Bhavnagar has developed an innovative and cost effective process for iodine and iron containing double fortified salt (DFS) exhibiting white colour and retaining micronutrient concentration for a prolonged period. The technology will help in improvement of nutrition and health status by employing cost effective, simple nutritional and technological solution especially those in the iron and iodine-deficient zones. A multicenter field survey for anemic and iodine deficient clusters was conducted. Large scale community-based comparative trial of CSIR-CSMCRI DFS for long term safety, and improvement in iron and iodine status in Bhavnagar and Vadodara district have been successfully competed. Process scale up has been done for production upto 0.5 ton/day DFS. Discussion is in progress for technology licensing.

Fig. II.6.7: Technology for double fortified salt composition containing iron and iodine to control both deficiencies

Novel cost effective process for high purity solar salt production with reduced contents of carbon, iodine, suspended solids and sulfate content directly in solar salt fields from high sulfate containing brines (particularly for Rajasthan inland/ lake brines

CSIR-Central Salt & Marine Chemicals Research Institute (CSIR-CSMCRI), Bhavnagar has patented a process for high purity salt production. The technology deals with improvement in salt purity and whiteness through chemical treatment of brine in Rajasthan, which typically contain high amounts of carbonates, bicarbonates, suspended impurities and micro algae. Thus, the salt is upgraded from edible to industrial grade and will meet the requirements of chlor-alkali industry in the adjacent areas.

The developed process has been validated at pilot scale in the solar salt works of a private salt manufacturer supplying salt to the chlor-alkali industries. The process has resulted in upgradation of solar salt quality as per the desired specifications of chlor-alkali industries.

Rajasthan is the 3rd largest salt producer state in India after Gujarat and Tamil Nadu and produces nearly 25 lakh tons of salt every year. The salt produced in Rajasthan is of edible grade due to unique composition of brine available in Rajasthan. This technology will be very helpful to the salt manufacturers in Rajasthan for selling their salt to chlor alkali industries.

Prototype salt unit for validation of results has been constructed and is ready for demonstration of process to user industries. Experiments at semi-pilot scale are validated and reproduced. The process has been perfected and implemented on large scale in Rajasthan at M/s. Bharat Salt Company, Nava. Industrial partners (M/s. Grasim Industries Ltd., Nagda& Sambhar Salts Limited, Nawa and DCM Shriram Consolidated Ltd. Kota), Lord Alkalies& Chemicals Ltd. have been involved for participation and validation of end product. Salt samples have been sent to different industries for testing, analysis and suitability. Feedbacks have been obtained from the user industries.

Membrane based process technology for commercial production of biomolecules

Bioactive molecules have great potential in world market of drug and pharmaceutical, cosmetics, food and textile industries. Oxyresveratrol is used as an anti-aging, cardio-protective, anti-cancerous, treatment of tape-worm infestation, neuro degradation in Alzheimer's disease and skin brightener. Natural dyes are used as food/ cloth colorant and in cosmetics. As per UPICO's survey report, in India the total requirement of raw materials of natural dye is 33730 tones and the quantity of natural dyes used is 675 tones.

CSIR-North East Institute of Science & Technology (CSIR-NEIST), Jorhat has developed knowhow for commercial production of oxyresveratrol and natural dyes. A low cost process has been developed for production of high purity biomolecules, which has great market potential. The developed process is membrane based process for separation and purification of biomolecules and is less energy intensive.

Pilot plant studies with a scale up capacity to 2kg of oxyresveratrol per day has been established and the technology for production

Fig. II.6.8: Process for high purity solar salt production

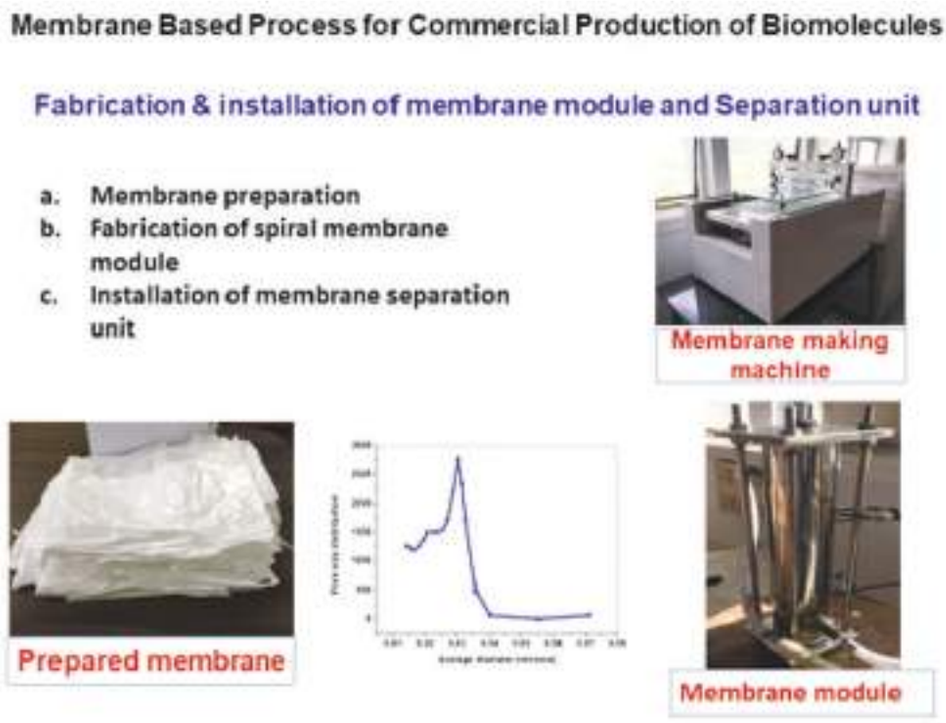


Fig. II.6.9: Membrane based process technology for commercial production of biomolecules

has also been demonstrated to entrepreneurs. After membrane treatment 98% pure product has been obtained. MOU has been signed with M/s Sira Naturals.

The laboratory has also successfully run the scaled-up model for production of one natural dye and is pursuing scaled-up production for two other dyes along with optimizing the scaled up process for obtaining pure natural dye.

1 TPD pilot plant for converting waste plastics to diesel

A 1 TPD plant is being set up at CSIR-Indian Institute of Petroleum (CSIR-IIP), Dehradun for converting waste plastics to automotive grade (Euro IV/VI diesel). The development requires pre-treatment facilities for validation of the bench-scale studies for production of diesel and establishment of various technological and process parameters that would facilitate successful commercialization / licensing of technology

Fig. II.6.10: 1 TPD pilot plant for converting waste plastics to diesel

The technology can provide various advantages viz. reduction of existing accumulated plastic waste from land and marine ecosystems; future segregation and disposal of waste plastics in an environment friendly manner; reutilization of waste plastics for production of diesel, gasoline and aromatics; economic benefit to ragpickers and village level entrepreneurs; and reduced mortality rates of cattle, wild animals, birds and aquatic organisms from ingestion of waste plastics.

Technology has been developed at bench scale. Site has been prepared for setting up of 1 TPD plant at the laboratory. The plant is to be commissioned.

Mission projects

1. Distillery Spent Wash Management Technology for recovery of Potash

Potassium is one of the three essential plant nutrients, along with Nitrogen & Phosphorus. More than 95% of world's total production of potassic chemicals is consumed as fertilizer. India does not produce any significant quantity of potash & relies on imports (4-5 million MT MOP per annum). As on date, there are no proven & viable land based Potash reserves in India.

Fig. II.6.II: Distillery Spent Wash Management Technology for recovery of Potash

Mission Directorate, CSIR has supported a Mission on Salt and Potash to CSIR-CSMCRI to facilitate development of large-scale domestic salt and potash manufacturing capacity in India. CSIR-CSMCRI explored the possibility for utilization of distillery effluent (spent wash) as a potential resource for potash fertilizer and developed process know-how for the production of fertilizer grade potash from spent wash along with recovery of residual organics. 1st commercial unit, based on CSIR-CSMCRI's Spent Wash Management (SWM) technology, is expected to be operational by August, 2019.

This waste to wealth technology is unique and unrivalled, as it not only achieves Zero Liquid Discharge (ZLD) for the distilleries (currently in red category of CPCB), but also generates valuable by-products which are import substitutes and earn high profits. This innovative solution also addresses the issues and limitations of the currently prevailing technologies viz., bio-composting, bio-methanation and incineration.

2. Development of Affordable Technologies for Quality Milk Assessment

Consumption of adulterated milk poses hazardous health effects. CSIR has launched a mission mode project aimed at developing state-of-the-art IR technology (both NIR and MIR) based instruments for milk analysis. It involves detection and quantification of all possible adulterants in milk besides the measurement of milk constituents. The mission also aims for development of systems for microbial contaminations like early mastitis detection in herds and somatic cell measuring systems in milk. In this context, the mission mode initiative in CSIR for delivering affordable yet state-of-the art technologies for meeting key industrial as well as societal needs is of utmost necessity. While conducting R&D work, an initial experimental setup for diffuse reflectance mode of measurement has been designed and is shown below. Various developments

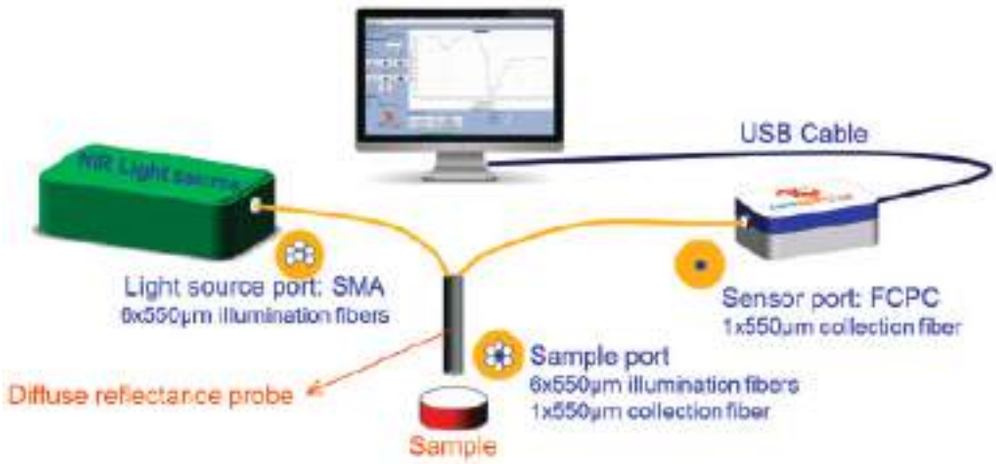


Fig. II.6.12: Process of testing milk quality

like design of experiments for detection of sugar, melamine, formalin, urea, edible oils and maltodextrin in homogenized raw milk with varying concentrations of adulterants (diffuse reflectance and trans reflectance mode of measurement), algorithm development and identification of specific spectral bands in reflection mode and first prototype of milk adulteration detection system are in progress.

3. Nano-Biosensors and Microfluidics for Healthcare

The CSIR Mission Project aims to use micro/nano-technologies in integration with micro-fluidics for the development of point-of-care, affordable and easy-to-use systems such as (i) Microfluidic based rapid test card for Typhoid detection, (ii) Label free, affordable and easy-to-use biosensor for detection of dengue virus infections in patient sample, (iii) Device for the detection of cardiac biomarkers and cardiac risk management, (iv) Devices for Breast & Lungs Cancer diagnosis, (v) Devices for pre-diabetic and diabetic condition detection using invasive and non-invasive techniques. To realize above devices/systems various inter-disciplinary expertise like micro and nano-fabrication to realize sensors; biomarkers identification, surface chemistries to capture biomarkers: electronic read-out interface, etc. are aligned. Apart from the existing facilities at various CSIR institutes, number of new facilities will be augmented at different institutes which will be utilized to realize platform devices like Nano-gap arrays for SERS active sensor chips, Nano-wire FET sensors, CNT FET, highly sensitive HEMT sensors chips and Photonic crystals based sensors.

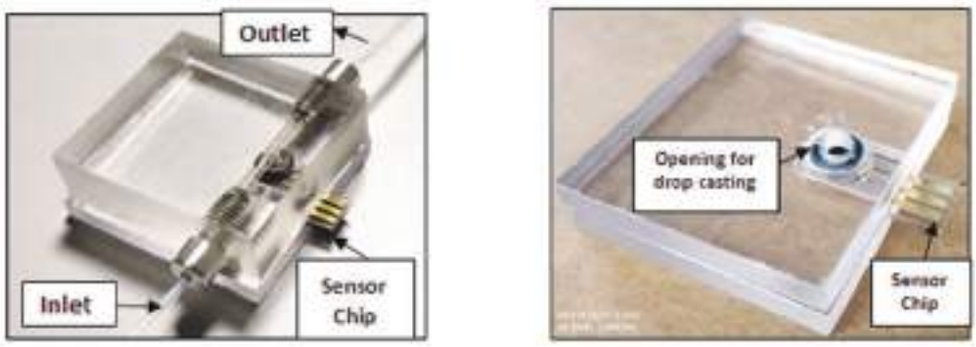


Fig. II.6.13: Different versions of Fluidic assemblies for sensor characterization

Fig. II.6.14:Test prototype capable of detecting 1 ppm, 2 ppm and 5 ppm acetone in air

Various electrochemical sensing platform are being designed and under characterization process. Few of them are shown below:

A prototype for detection of different concentrations of Acetone has been designed, developed and demonstrated.

4. CSIR Mission on Intelligent System (IS) - Intelligent Technologies and Solutions

Creating opportunities for technology development, the lines between the digital and physical world continue to blur - the intelligent systems are thus being designed with the cognitive abilities to sense, interpret, reason, act and learn. These systems can interact with the environment and are capable of taking decisions like a human being. The technological innovations in this domain are aimed to cater to different applications in the areas such as healthcare, transportation management, energy & water management, security & surveillance, speech recognition, computer vision and natural language processing. In this context and with the objective of developing desired technological interventions, CSIR has launched a project in Mission Mode with following objectives: (i) Development of Technology for Intelligent Electronic Devices / Systems; (ii) Development of Applications using Brain and Machine Interface; (iii) AI Techniques for Material Synthesis; (iv) Intelligent Cyber Physical Systems; (v) AI Techniques for Cyber Physical Security; and (vi) AI Techniques for Big Data Analytics in Healthcare. The project is being implemented by CSIR-CEERI, Pilani as Nodal lab and it involves other 6 CSIR laboratories viz. CSIR-NAL, Bengaluru; CSIR-CSIO,

Chandigarh; CSIR-NCL, Pune; CSIR-AMPRI, Bhopal; CSIR-4PI, Bengaluru; and CSIR-IGIB, New Delhi. The project is aligned to NITI Aayog's vision for "India Science and Technology 2032-33" which emphasizes the need for the deployment of Science & Technology interventions for ensuring various domains of interest. Some results on initial experiments like, Driver fatigue and drowsiness using various sensors to capture physiological and behavioural measures of the driver are being reported. An integrated embedded hardware and computing architecture is being developed to capture the Electrocardiogram (ECG) signals from seat back rest, Photoplethysmography (PPG) signals from the steering wheel and Video plethysmography (VPG) signals from the smart cameras.

5. CSIR Mission on "Development of Fast, Durable and Energy Efficient Mass Housing Scheme"

The mission is aimed at developing and deploying at a scale, prefab technology for construction of

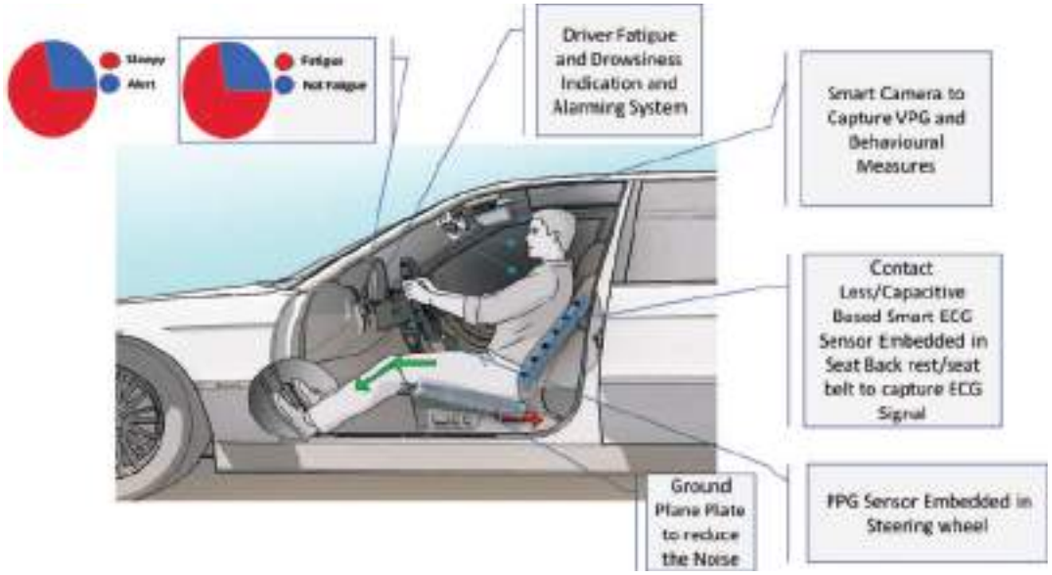


Fig. II.6.15. Human fatigue and drowsiness detection deployment architecture

fast, durable, energy efficient and affordable interventions for mass housing, in partnership of stakeholders the. Efficient design of precast structural panels using various materials will be developed to achieve desired performance such as light weight (50% reduction), improved fire rating (minimum 2hrs), durability (70-80years), cost effective (25% lesser compared to lowest available) with reduced cycle time of 5-7 days compared to existing 16-19 days. The mass housing schemes are planned to be developed suiting to socio-cultural requirements in different geo-climatic regions across the country. Design specifications/ standards for decentralized sewage treatment plant, treatment of domestic waste, air and water purification system for mass housing including cost effective management system for energy monitoring, control and optimization of individual and cluster of houses will also be developed and deployed in partnership of stakeholders. Easy to use guidelines for construction of mass housing using precast elements will also be developed which will be extremely useful for practicing engineers, policy makers and local bodies. The developed technology(ies)/ know-how(s) will be demonstrated by 3D virtual displays and by prototype demo units for the purpose of end to end training and needful deployment.

6. CSIR Mission on "Technologies for Robust Structural Health Monitoring of Critical Infrastructure & Conservation & Restoration of Heritage Structures"

The mission comprises of two verticals namely (i) Robust structural health monitoring technologies for critical infrastructure management; and (ii) Conservation and restoration of heritage structures. The first vertical is aimed at developing technologies for structural health monitoring of critical infrastructure using advanced signal processing, machine learning techniques combining with IOT and cloud-enabled technologies for early detection of damage in civil infrastructure. Robust health monitoring strategies for steel pipelines using distributed strain sensing, FBG sensors, MFC sensors and acoustic emission methods will also be developed. State-of-the-art indigenously developed sensors, sensing technologies and diagnostic software will be used for structural health monitoring of civil structures including

bridges, buildings, pipelines, and vessels.

The second vertical of the mission is aimed at developing state-of-the-art technologies for conservation and restoration of heritage structures. It includes different objectives beginning with classification and characterization of important heritage structures of India based on their architecture, structural systems and materials compositions. The developed technologies will then be applied to selected heritage structures and will be monitored for certain period of time for their performance evaluation. Guidelines for conservation and restoration of heritage structures in India will also be prepared.

7. CSIR Mission on Food and Consumer Safety Solutions (FOCUS)

Considering the national priority of safe food for all, a series of stakeholder dialogues were initiated by CSIR to provide safe and nutritious food. This had led to the identification of gaps where technological interventions are required. Thus a CSIR-Mission Mode Program on Food and Consumer Safety Solutions (FOCUS) was formulated and launched in July 2018 with an aim to provide "Technological Solutions for Food Safety". The mission is led by CSIR-IITR in collaboration with six other CSIR laboratories. The project will address the unmet needs of various stakeholders in the food value chain such as farmers (producers), industry, regulator and the consumer with the following objectives:

- Sensors and systems for food safety
- Methods and techniques for food safety
- Extension and outreach for food safety

Food and Consumer Safety Solutions (FOCUS) aims to deliver the following interventions under different theme areas that has strong relevance to Make in India, Swasth Bharat, Swachh Bharat, Innovate in India, Skill India and Startup India.

- Milk and Milk Products: Multisensor detection platform for qualitative and quantitative assessment of adulteration in skimmed milk and milk products like khoa and paneer.
- Beverages and packaged foods: Multi-analyte sensors for detection of degradation by-products/spoilage indicator in fruit juices and packaged foods (e.g. meat).
- Ghee and Edible oil: Systems for detection of rancidity/adulteration/polyaromatic hydrocarbons in ghee and edible oils.
- Safety solutions for post-harvest produce: Electrostatic coating system and storage chamber to enhance the shelf life and freshness of farmers' produce i.e. fruits and vegetables.
- Development of multi-analyte detection methods: Cost effective analytic methods, multiplex platforms and devices for detection of food toxins/contaminants such as mycotoxins, pesticides, bisphenols, acrylamide etc.
- Digital Food Safety Portal System: Development of a Digital Food Safety Portal which will collate all the R&D developments in the area of food safety in the mission and would focus on Dissemination of knowledge, street-vendor's awareness, Stakeholders workshops.

8. CSIR Mission on Nutraceuticals and Nutritionals

Nutraceuticals are poised to provide holistic solutions to the younger Indian middle class to keep chronic ailments at bay and also address the rising incidence of lifestyle diseases including cardiovascular ailments, diabetes, obesity and various forms of allergies. The national food regulator, FSSAI has issued strict compliance norms through its guidelines issued in December 2016. These standard have come into force from January 1, 2018. The need of the hour is to develop affordable food supplements and nutraceuticals so that it also caters 43 % malnourished children across

India along with middle and upper-middle class consumers. Further there is a dire need to develop nutraceuticals for the prophylaxis of common chronic diseases and general health indications which can fulfil the health care need of large population.

CSIR with its wide range of scientific expertise in the area of nutrition as well as exploiting vast plant resources available within India has leads that can be taken forward to develop nutraceuticals and nutrifoods with international scope which would have far reaching effects. This fact has unanimously supported the development of this mission with identified themes and specific objectives around those themes.

Thus, a CSIR-Mission Mode Program on Nutraceuticals and Nutritionals was formulated and launched in July 2018 with an aim to provide "Nutritional solutions for all". The mission is being led by CSIR-IHBT as nodal centre in collaboration with nine other CSIR laboratories. With a good number of affordable technologies on the shelves which can meet both nutritious and regulatory requirements in the Industrial scale, CSIR will be able to kick-start the proposed mission in a fast pace with clear objectives and vision. The project will address the unmet needs of various stakeholders in the food value chain such as farmers (producers of raw material), industry (final product), regulator (FSSAI) and the consumer with the following broad objectives:

- Development of region specific and pan Indian nutritious first meal of the day for children that meets the RDA requirement of nutrients;
- Development of nutraceutical formulations/ products for bone health, cognition, immunity and sleep disorders; and
- Establishing proof of studies for developing nutraceuticals for NCDs and CNS indications.

The mission "Nutrition and Nutraceuticals" has been strategically defined including seven themes dealing with specific issues:

- Enhancing Nutrition: The work package focuses on developing nutraceutical formulation using targeted plants for enhanced bioavailability of micronutrients especially Vitamin B12 and Selenium and Nutritive products for breakfast for the children suffering from malnutrition problem by utilizing the best possible combinations of active ingredients from herbs; ethnic and complementary foods from cereal and pulses from different regions of India
- Bone Health: The work package envisages developing plant based nutraceutical product useful for maintaining bone health of post-menopausal women as well as developing formulation for bone and cartilage health
- NCDs: Achebulinic acid enriched nutraceutical for management of Benign prostatic hyperplasia (BPH) is being developed. Further, attempt is being made for developing Nutraceutical products for cardio protection from antioxidant rich fraction from peel and other parts of pomegranate.
- Cognition: R&D is in progress for development of Scientifically validated alpha linolenic acid and virgin coconut oil based nutraceutical formulations for cognition and blended formulation of active extract/fraction of the selected plants (Ashwagandha, Bacopa, Mucuna) for cognitive impairments in elderly population.
- Immunity: Focus is on developing standard for the quality monitoring of the 'Triphala' formulation for adoption by the regulatory agencies involved in certifying the product for export and marketing;
- Sleep Disorder: A plant (Theanine and TEG fractions) based nutraceutical formulation for REM sleep enhancement is envisaged under the theme.
- CNS: Research attempts are being made to find leads for developing scientifically validated spice based oleoresin nutraceuticals from chilli, ginger, turmeric

and black pepper (individual and in combination) that will target disorders of central nervous system.

The proposed nutritional interventions in CSIR-Nutraceutical Mission will strengthen the government efforts to achieve the Sustainable Development Goals (especially SDG 2 (zero hunger) & 3 (Good Health 7 and Well-Being) as being addressed through National Health Mission and Nutritional Strategy Policy.

9. CSIR Aroma Mission

The CSIR Aroma Mission is envisaged to bring transformative change in the aroma sector through development of superior aroma crop varieties and their agro-technologies and assessment of their suitability for the large scale cultivation in specific agro-climatic regions; promotion of cultivation and processing of aromatic crops, enhancing area under selected aromatic crops along with enabling interventions including setting up of distillation units and catalyzing setting up of cooperatives for marketing of the produce; value-addition of aromatic crops in the form of high-end aroma chemicals and products; and skill & entrepreneurship activities and facilitating the creation of spin-offs.

In 20 months since the project was launched, an area of about 3000 hectare has been brought under cultivation of aromatic plants across the country. Significantly, Tagetesminutahas been introduced in tribal areas of Odisha and Manipur, Lavender in higher altitudes and disturbed areas of Jammu and Kashmir, Lemongrass &Palmarosa in rain-fed areas of Vidarbha, Bundelkhand and Odisha, high-yielding varieties of Vetiver in tsunami and cyclone affected areas of Tamil Nadu and flood-affected areas of UP and Bihar, and Lemongrass and Mints in Naxalite-affected Bastar and tribal area of Dudhwa, UP.

Twelve improved varieties of aromatic plants have been developed along with 9 agrotechnologies around the aroma plants. In the 343 training / workshops conducted throughout the country, about 22,000 persons were trained in different aspects of cultivation and processing technologies. Processing of the harvest in 100 distillation units installed under the project, has yielded over 1,00,000 kg essential oil worth ₹ 20 crore for the farmers. Eleven products have been developed

10. CSIR Phytopharmaceuticals Mission

The CSIR Phytopharmaceutical Mission is envisaged to bring transformative change in the medicinal plants sector through captive cultivation of selected medicinal plants, including rare, engendered and threatened species, production of quality planting material and development of region specific agrotechnologies; technology packages for production of GMP grade medicinal plant extracts; and phytopharmaceutical development from important medicinal plants.

In the first year of project implementation, mass multiplication of quality planting material and captive cultivation of target plant species has been achieved in an area of 120 hectare in different states/districts. Further, plants of 25 Rare, Engendered and Threatened (RET) species have been collected for gene bank. On site demonstration of cultivation technology has been imparted to farmers.

NMITLI project on Dental Implants-Transfer of technology to industry

An indigenous dental implant has been designed on the basis of scientific rationale and experimentally optimized to serve the treatment needs of an edentulous or partially edentulous Indian patient. The innovations include the use of same prosthetic platform for all implant diameters (3.5, 4.0, 4.5, 5.0), integrated platform switching and the developing a single component which serves as implant mount, implant impression transfer coping, implant impression pickup coping (with

Fig. II.6.16: Technology transfer of Dental implants to M/s Innvolution Healthcare Pvt Ltd, Delhi

long screw) and as the final straight abutment. The design of the screw is a tapered root form with a combination of reverse buttress thread and microthreads and was validated with Finite element analysis to provide ideal stress distribution to bone. The material chosen for the Implant fixture and the prosthetic components is Ti-6Al-4 V (titanium alloy) and the surface treatment for the implant was developed with a combination of grit blasting and acid etching. In addition, various other components including the surgical and prosthetic ancillaries were developed. The implants were duly tested for biocompatibility studies (as per ISO 10993) norms and engineering tests for fatigue. A trial in rabbit model was also done to prove the safety and efficacy of the implants as per CPSCEA guidelines and Good Laboratory Practices (GLP). Based on this success initial usage in human subjects was carried out in comparison with an International Implant. An initial clinical use of the implant was done at MAIDS with the registration at CTRI being - CTRI/2011/11/002149. The implants are now being manufactured, sterile packaged by IIT Delhi at the facility developed under the project at IIT Delhi premises. The implants are now undergoing phase II clinical trial at MAIDS after receiving the permission from DCGI. More than 100 implants have been placed in the patients till date. The technology for Dental implants was transferred to M/s Innvolution Healthcare Pvt Ltd, Delhi on May 8, 2017. The industry is now setting up the manufacturing plant at Faridabad and the process for regulatory approvals has been initiated.

Novel Therapy for Management of Sepsis: Phase IIb clinical trials completed

In the partnership of Cadila Pharmaceuticals and PGI Chandigarh under CSIR-NMITLI project, a randomized, double blind, two arms, active comparator controlled, phase IIb clinical trial to study the safety and efficacy of Mycobacterium w in combination with standard therapy versus standard therapy alone in sepsis due to gram negative infection was undertaken. The primary objective of the study was to evaluate efficacy of Mw in reducing 28-day mortality of patients with sepsis while primary study endpoint was to observe 28-day mortality (death) in Mw arm compared to standard therapy alone. The patients in test group were administered 0.3 ml/ day of Mw, for 3 consecutive days intra-dermal injected as 0.1ml x 3 injections. While those in control group were administered 0.3 ml/day of placebo, for 3 consecutive days intra-dermal injected as 0.1ml x 3 injections.

The primary efficacy of the test drug was analyzed to be successful. Out of 202 patients randomized in the study, total 27 (26.73%)

deaths have been reported. Out of these 27 deaths, 8 deaths (7.92%) were observed in Treatment Group, while 19 deaths (18.81%) were observed in Control Group. Thus, there was 10.89% absolute reduction and 55.56% relative reduction in mortality in Treatment Group compared to Control Group which is clinically relevant and statistically significant ($p = 0.0229$). The survival data of died patient's shows that there is significant difference between two arms for the days of death. Death was delayed in the treatment group compared to control group. [p-value: 0.0001, Hazard Ratio: 0.448 (95% CI: 0.311-0.646)].

With respect to secondary efficacy of the study, the survival data of all patient's showed significant difference between two arms for the days of discharge. Time to discharge was also earlier in treatment group for alive patients. Hospitalization days for died patients were considered as 28 days. [p-value: 0.0001, Hazard Ratio: 0.964 (95% CI: 0.948-0.981)]. The clinical trial report has been submitted to DCGI on February 2019 for additional indication for use in gram negative sepsis along with standard care.

CSIR-NMITLI Project on 'Automation of Ghani Operation through Vacuum Conveying System'

Advanced technologies are contributing significantly in every sphere. However, there is hardly any change over hundred years old kachighani processing of mustard oil. The manual operations of initial seed feeding, water addition and removal of ghani cake makes oil extraction very unhygienic with inhuman working conditions due to high temperature coupled with humidity and pungent atmosphere. In summer season from industry point of view, labour supply is highly erratic due to difficult working conditions and workers are not ready to work even for more than 1.5 times wages. This leads to huge production losses to the industry. To addressed the issue, full scale automated ghani plant designed, developed, fabricated & installed for production of mustered oil by converting traditional ghani plant under CSIR-NMITLI Project. The fully automated pilot

Fig. II.6.17: Automation of Ghani Operation through Vacuum Conveying System'

plant would help oil industry in maintaining high hygiene standards, improving quality of the product, increasing productivity, reducing labour dependence and harsh working conditions. Further, the endeavor through this project is also in line with the "Make in India", "Swachh Bharat" and "Swasth Bharat" Missions of Government of India.

11.7 CSIR-Traditional Knowledge Digital Library

The Traditional Knowledge Digital Library (TKDL) initiative preserves the country's traditional knowledge through digitalization and aims to prevent the misappropriation of India's traditional medicine knowledge through patenting worldwide. The TKDL database comprises knowledge from over 270 texts of Ayurveda, Unani, Siddha, Yoga and more recently Sowa Rigpa.

In the year 2018-2019, about 20,370 medicinal formulations from different Indian systems of medicine and Yoga were transcribed into the TKDL database. With this, the TKDL database contains over 3.5 lakh formulations out of which around 2,23,400 formulations that have been validated are available to patent offices as prior art as on 31 March 2019.

In August 2018, a MoU was signed between the National Research Institute of Sowa Rigpa (Min of AYUSH), Leh and CSIR-TKDL to carry out documentation and digitisation of Sowa Rigpa texts. The infrastructure was established at this difficult and remote location and transcription activity initiated in October 2018.

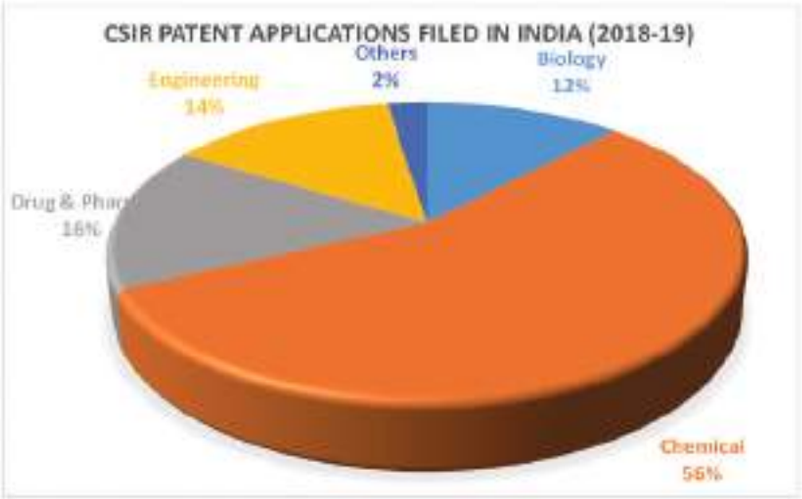
During this period, eight third party or pre-grant submissions were made to different patent offices wherein TKDL evidences were submitted against grant of patent applications based on Indian systems of medicine on grounds of lack of novelty or inventive step.

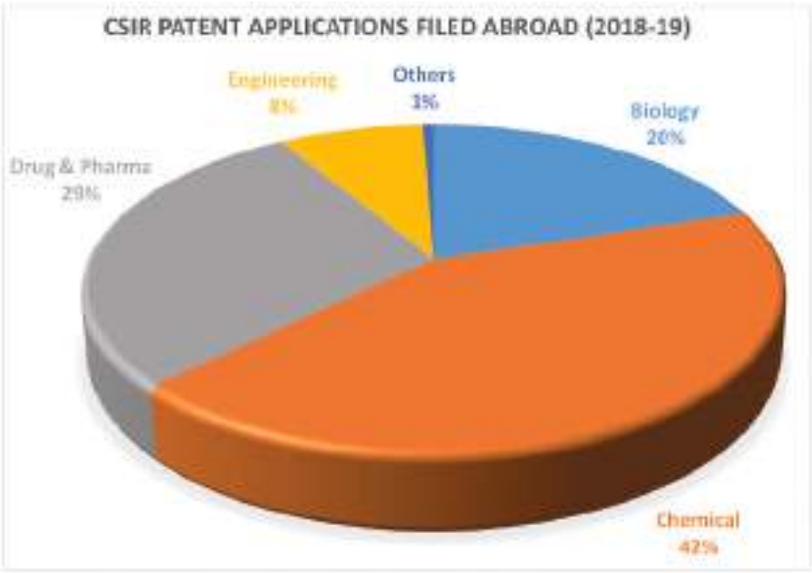
In 2018-2019, 75 project staff were actively engaged in the TDKL activities. Among these, 54 were newly engaged project staff and were trained extensively in transcription work and related IT techniques to contribute to the objectives of TKDL projects. In addition, trainings/ workshops were also conducted on three occasions for Ayurveda, Yoga and Siddha eminent experts to introduce them to TKDL and explain their role in validating traditional medicine formulations and yoga practices to be incorporated into the TKDL database.

11.8 Intellectual Protection Unit (IPU)

(I) CSIR's Patent Filing:

CSIR has filed 174 patent applications in foreign countries and 209 patent applications in India in various technical fields during 2018-19.

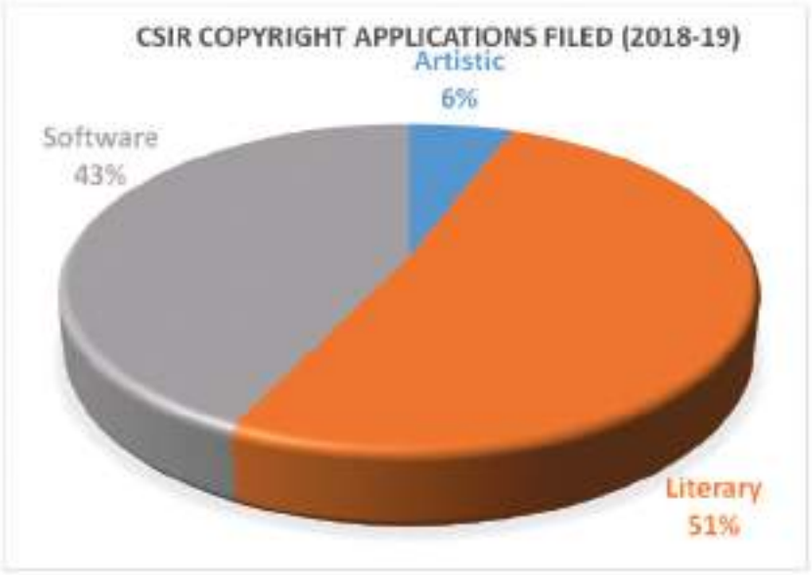




(II) CSIR's Copyright Filing:

CSIR has filed 35 Copyright applications during 2018-19.

The Copyright applications filed by CSIR subsist in different categories such as literary work, software and artistic work.



The copyright applications were filed for various classes of works generated by various laboratories of CSIR.

CSIR Copyright Applications filed durWing 2018-19

CBRI	1
CDRI	1
CIMFR	3
CMERI	13
IICB	1
IITR	3
IMT	1
NAL	1
NIO	2
NML	6
NPL	3
Total	**35**

(III) Vetting of intellectual property aspects in MoU/Agreements:

CSIR-IPU has examined Intellectual Property aspects of more than 72MoU/Agreements/ Proposals executed by CSIR during 2018-19.

(IV) Handling issues relating to Biological Diversity Act 2002 and Biological Diversity Rules, 2004

CSIR-IPU assessed the requirement of taking permission from the NBA in respect of patent applications of CSIR based on use of Biological Recourses from India. The applications for permission were filed in respect of 117 patent applications with the competent authority i.e. the National Biodiversity Authority.

Consequently, CSIR-IPU has obtained permissions from National Biodiversity Authority under the Biological Diversity Act, 2002 and the Biological Diversity Rules, 2004 by way of entering into Agreements on Access and Benefit Sharing.

CSIR-IPU is also in continuous negotiation with the NBA over the various clauses detailed in the Agreement on Access and Benefit Sharing offered by the NBA after the publication of the Benefit Sharing Regulations 2014.

(V) CSIR Innovation Award for School Children-2018:

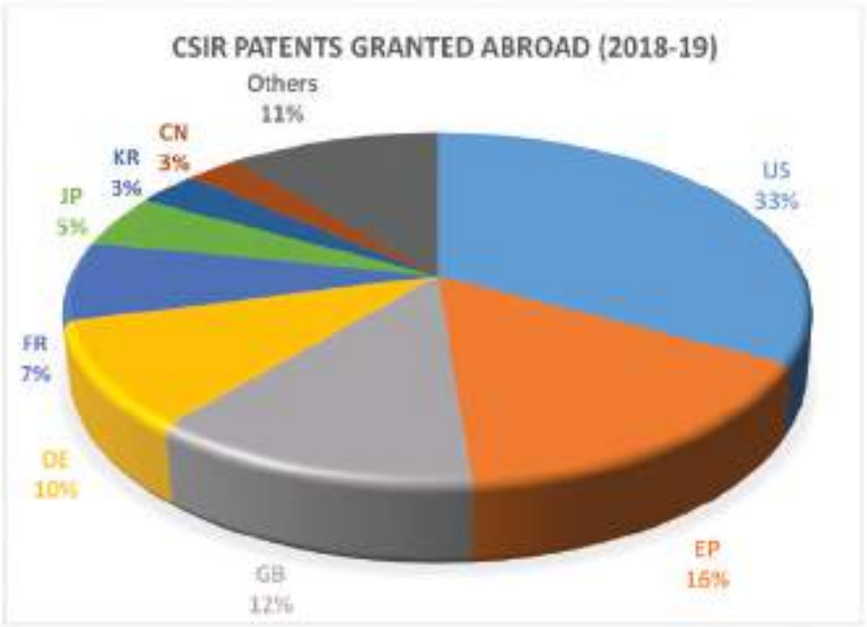
Thirteen innovations were selected out of 647 applications received for'CSIR Innovation Award for School Children-2018'.The selected innovations are (1) Sustainable load distributor, (2) Re-enforcement of roofs and road by home-made slab, (3) Dream toilet with automatic cleaning & flush, (4) V-bikes, (5) Acacia pycnantha'sripen pod as a nature's friendly liquid cleaning agent for stain removal, (6) Multi-purpose water filtration technique, (7) A Scientific Approach to Clean and Prevent Salivary Ejections, (8) Moksha, (9) Ignis home automation system, (10) Ears have failed still rejoice hearing, (11) Automatic Dug/bore well Irrigation System, (12) Automatic Electric Power Saving - On/Off Highways' Street Light, (13) Esplanade.

The winners of the CSIR Innovation Award for School Children-2018 were given prizes by the Vice President of CSIR and Minister of Science & Technology at Vigyan Bhavan on CSIR Foundation Day 26th September, 2018. The presentation includes cash prize, Memento and certificates to the winners.

(VI) CSIR Patent Applications Filing and Grant of Patents:

CSIR has been actively involved in filing, prosecuting and obtaining patents in India and abroad. Data on CSIR patent applications filed and granted in India and abroad during 2018-19 is given in Annexure II.

(VII) CSIR Patents Granted in major Jurisdictions:



(VIII) IP Awareness Programmes organized / lectures delivered:

Seminars organized:

1. CSIR-IPU has organised "One day workshop on European Patent Drafting and Prosecution Practices" in association with LexOrbis, AA Thornton, Dompatent, Mewburn Ellis on 22nd Nov 2018 at CSIR-Institute of Genomics & Integrative Biology, New Delhi 110025.

Lectures delivered:

Dr. Indra Dwivedy

1. Lecture delivered on "An Overview of Patent system: Drafting a Patent Specification and Patent Office Examination Practice" in the "23rd National Convention of Society of Pharmacognosy and an International Conference on New age opportunities and challenges for quality, safety and GMPs in herbal drug development", organised jointly with the Society of Pharmacognosy, India and Indian Pharmacopoeia Commission (IPC) on February 23, 2019 at CSIR-NBRI, Lucknow, India.

Dr. Shikha Rastogi

1. Invited as a panelistin the Capacity Building Workshop on Access and Benefit Sharing (ABS) provisions of the Biological Diversity Act and E-Filing Process of ABS Applications on 14th September, 2018at NBA Conference Hall, 5th Floor, TICEL BIOPARK, Taramani, Chennai - 600 113.

Dr. Lipika Patnaik

1. Delivered lecture on "Advanced Search Features – TKDL" in the "TKDL AND PATENT SEARCH" training programme for Rospatent-Russian Federation examiners and EAPO (Eurasian Patent Office) Patent examiners at the Indian Patent Office, New Delhi on 4-5th February, 2019.
2. Invited as External Member in the interview committee of Viva Voice of Patent Agent Examination held from 7th to 9th January 2019 at The Patent Office, BoudhikSampada Bhawan, Plot No. 32, Sector -14, Dwarka, New Delhi 110078.

Dr. Kapil Arya

1. Delivered lectures on Searching Prior Art document, Introduction of IPR & Drafting of patent document in the IPR awareness cum interaction Session organised by IICT, Hyderabad on 23-24th April 2018.
2. Delivered lectures on Patent Search, Drafting the Patent Claims, Introduction of IPR and inventor ship issues in the IPR awareness workshop organised by NEERI, Nagpur on 1st June 2018.
3. Delivered lectures on Patent Search, Drafting the Patent Claims, Introduction of IPR and inventor ship issues in the IPR awareness lecture on CSIR Innovation award for School Children organised by IPU-CSIR and NPL, New Delhi on 25th September 2018.

11.9 Unit for Science Dissemination (USD)

The Unit for Science Dissemination plays a critical role 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 Fostered by USD

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.

Advertisment

- Advt. in Newsletter of CSIR Pensioners Welfare Association, Lucknow News Letter No.- 25
- Advt. on S&T and Innovation for Socio-Economic Development-Transforming Global Leadership "Namumkin ab Mumkinhai" on 7th March 2019

Doordarshan/All India Radio

- Telecast of CSIR film on Doordarshan on the occasion of Independence Day 2018
- Telecast of CSIR film on Doordarshan on the occasion of Republic Day 2019
- Radio jingle on CSIR technologies aired on All India Radio during 29th May 2018 to 27th June 2018
- 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 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 Information Dissemination Services

The Unit provides press-clipping service to the office of the Minister of Science & Technology, DG CSIR 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.

Value-addition to the regular Newspaper Clipping Service of this Unit

Exhibitions organized/participated during this year include:

S.No.	Name of the Exhibition	Place	Duration
1.	Bio International Convention	Boston, MA, USA	4-7 June 2018
2.	Completion of 4 years of NDA Govt.	National Media Centre, New Delhi	7 June 2018
3.	Women Empowerment-2018	Jammu (J&K)	22-24 June 2018
4.	Industry Meet for Dissemination of CSIR Technologies and products in North East Region	Guwahati	27-28 June 2018
5.	Alluring Rajasthan 2018	Udaipur	18-20 July 2018
6.	6th Indian National Exhibition cum Fair 2018	Kolkata	26-29 July 2018
7.	Govt. Achievements & Schemes Expo	Pragati Maidan, New Delhi	27-29 July 2018
8.	10th Agri Tech India 2018	BIEC, Bangaluru	31 Aug-2 Sep 2018
9.	Shining Maharashtra-2018	Sholapur	26-28 Sep 2018
10.	MET+HTS- 2018	CIDCO, Navi Mumbai	27-29 Sep 2018
11.	IISF-2018	Lucknow	5-8 Oct. 2018
12.	19th IUFost World Congress 2018	CIDCO ,Navi Mumbai	23-27 Oct.2018
13.	Bihar Scientific Literacy Festival	Buxer, Bihar	29-31 Oct.2018
14.	Vibrant India &Sansad Utsav 2018	DilliHaat, Pitampura	2-4 Nov. 2018
15.	10th Agrovision 2018	Nagpur	23-26 Nov 2018
16.	ParyavaranKumbh Expo 2018	Kashi, Varanasi	1-3 Dec 2018
17.	Ujwal Himachal Pradesh 2018	Dharamshala	14-16 Dec 2018
18.	Swedeshi Mela 2018	Balia	22-31 Dec 2018
19.	106th Indian Science Congress 2019	LPU, Jalandhar,	03-07 Jan 2019
20.	Vibrant Gujarat -2019	Gandhi Nagar, Gujarat	18-22 Jan 2019
21.	Emerging North East 2019	Guwahati	6-8 Feb 2019
22.	Mharo Rajasthan-2019	Jalore	13-15 Feb 2019
23.	Chemtech+Bio Pharma World Expo 2019	BEC, Goregaon, Mumbai	20-23 Feb 2019
24.	Global R&D Summit 2019	Marriot, Hyderabad	21-22 Feb 2019
25.	Gromoday Mela 2019	Chitrakut(MP)	24-27 Feb 2019
26.	Women Empowerment-2019	Shimla(HP)	12-14 March 2019

Special compilations were brought on the coverage by media (of important CSIR events) for perusal of MOS(S&T), DG,CSIR and the concerned departments.

Daily News Bulletin services: Soft copy of the news clippings on CSIR matters published in national media being forwarded to all CSIR colleagues. Social Media Handles: USD handles social media like Facebook (CSIR India), Twitter (CSIR IND) and You tube (CSIR INDIA).

11.10 Director General Technical Cell (DGTC)

AnalytiCSIR

AnalytiCSIR, an online web portal, has been developed by CSIR, which provides access to its state-of-the-art analytical facilities and services of CSIR laboratories across the country. The CSIR's constructive move, will be a great asset to students and researchers of all facets of science and engineering in the country, who do not have access to sophisticated scientific equipment to carry out research of global impact.

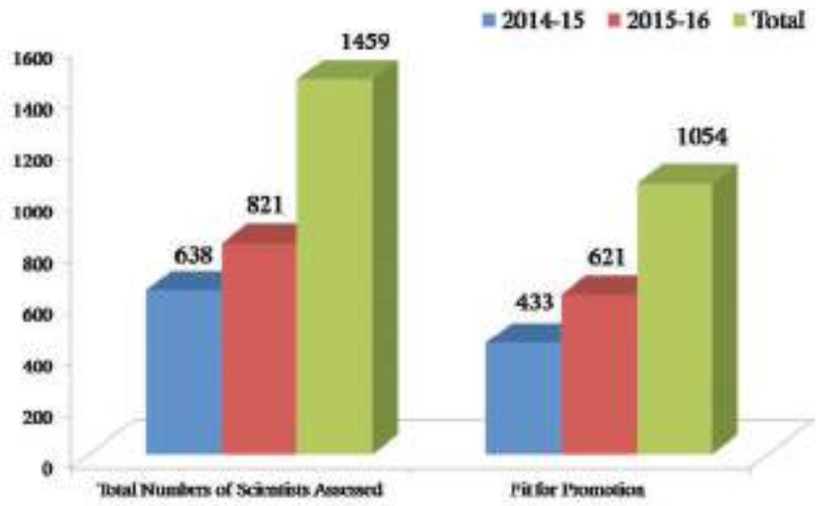
AnalytiCSIR v1.0 (first version), has been featured with the details of the available scientific equipment and research facilities at various research laboratories under the umbrella of CSIR and provides access to book the services of these facilities. The AnalytiCSIR e-portal was pre launched by DGCSIR on 9th February 2019, during the Director's Conference in Dhanbad, which initially limited for the intra and inter-lab usage. This internal exercise will enable to assess and streamline the performance of the portal, before it is extended to all the institutions Accordingly, soon the process is streamlined and found robust, it will be extended to all students/ academia/ industries/other public sector laboratories within the country. CSIR-IICT, Hyderabad has carried out the design, development and execution of the AnalytiCSIR Web portal.

Presently the facility includes 1281 equipments at 35 CSIR labs across India offering 1828 tests. The portal contains dashboards covering sample & test management, payment confirmation and test reporting, monitoring of lab-wise test bookings and earnings.

11.11 Recruitment and Assessment Board(RAB)

1. Recruitment process completed during 2018-19:

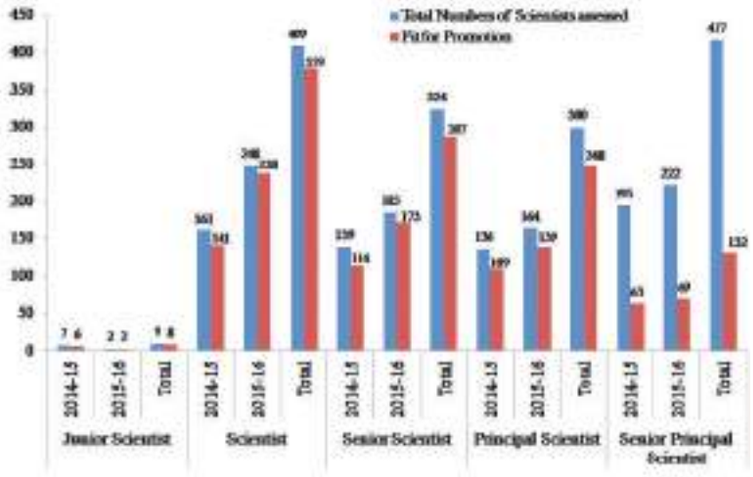
A total of 24 advertisements were made for new recruitments at lab/ institute level. Total 279 posts of Group IV scientists have been advertised at lab/ institute level including 208 posts at the entry level and 71 posts at the lateral level.



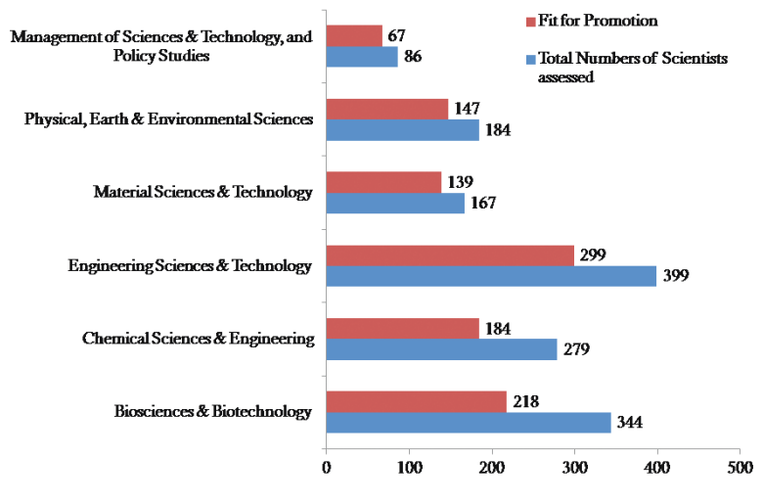
Assessment Results of Group IV Scientists of CSIR during 2018-19

2. Assessments done by RAB during 2018-19:

i. A Total of 1459 Scientists were assessed for the assessment cycles for the year "2014-15" and "2015-16". 72.24% scientists were promoted to their next higher grades.



Post/ Grade-wise Assessment Results of Group IV Scientists of CSIR during 2018-19

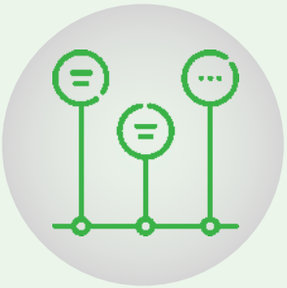


Cluster-wise Assessment Results of Group IV Scientists of CSIR during 2018-19

ii. Regarding different levels of Group IV Scientists for the assessment cycles for the year "2014-15" and "2015-16", 88.9% junior scientists, 92.7% scientists, 88.6% senior scientists, 82.7% principal scientists, and 31.7% senior principal scientists were successfully promoted to their next higher grades.

iii. For all six clusters of CSIR; 63.37% in Biosciences & Biotechnology, 65.94% in Chemical Sciences & Engineering, 74.93% in Engineering Sciences & Technology, 83.23% in Material Sciences & Technology, 79.89% in Physical, Earth & Environmental Sciences, and 77.90% in Management of Sciences & Technology, and Policy Studies were successfully promoted to their next higher grades for the assessment cycles of the year "2014-15 and 2015-16".

iv. Initiation of New Assessment Cycles for the year 2016-17 and 2018-19 has been made.



DATE LINE

12.0 DATE LINE

Date	Salient Details
April, 2018	
6th	CSIR-IMMT: One-Day Workshop on Utilisation of National Information System for Climate and Environmental Studies (NICES)
10th	CSIR-IICT: Indo-UK Consortium-Global Challenge Research Fund Meeting"
10th	CSIR-CSMCRI: 64th Foundation Day
12th - 13th	CSIR-CRRI: International Conference on Safe Riding Initiative (SRI-2018) jointly with Trax Society
23th	CSIR-CEERI: Technology Portfolio Workshop for MSMEs/Start-ups and Technology Transfer of Mercury-free Plasma UV
23th -24th	CSIR-IICT: A two day program on "IPR Awareness cum Interactive Session and Workshop"
24th	CSIR-IIP: 59th Foundation day celebrations
24th	CSIR-CLRI: 71st CLRI Foundation
28th	CSIR-CIMFR: A National Conference on "Recent Challenges in Mining Industry" was organized
30th	CSIR-IHBT: Hon'ble Minister of State (Independent charge) Micro, Small & Medium Enterprises, Shri Giriraj Singh visited
May, 2018	
3rd	CSIR-CEERI: Jigyasa-2018: A one-day summer science-research-workshop for students-scientists interaction
4th	CSIR-CDRI: Mini Symposium of the Global Challenges Research Fund Network for Neglected Tropical Diseases
6th	CSIR-IHBT: Hon'ble Chief Minister of Himachal Pradesh Shri Jai Ram Thakur visited
11th -12th	2nd National Technology Day symposium on `Shaping the energy future: Challenges and opportunities (SEFCO-2018)
15th -16th	CSIR-CFTRI: Indo-Finnish Joint Workshop - Innovative food concepts and technologies for global nutrition and business (Nutri-Concept)
15th	CSIR-CBRI: National Technology Day
21st	CSIR-CECRI: National Technology Day-2018 celebrated

28th	CSIR-IIIM: Visit of Hon'ble Vice-President Shri M. Venkaiah Naidu
31st June - 2nd	CSIR-IIP: Study visit of the Department-related Parliamentary Standing Committee (PSC) on Science & Technology, Environment & Forests
June, 2018	
5th	CSIR-NML: World Environment Day
5th -6th	CSIR-NISTADS: Workshop Technology Enablement in Water, Energy and Communication sector in North East, Guwahati
5th -6th	CSIR-CGCRI: National Conference on Engineering and Technology for Rebuilding India
8th	CSIR-NGRI: NGRI Foundation Day Lecture-2018
11th -13th	CSIR-NIO: India-USA Colloquium "Earth Observations and Sciences for Society and Economy"
July, 2018	
2nd	CSIR-IHBT: Celebrated Foundation Day
18th -20th	CSIR-IMMT: One Day Workshop on Application of Electron Probe Micro-Analyzer (EPMA)
25th	CSIR-CECRI: 71st Foundation Day celebrated
30th	CSIR-IICT: Two day National Seminar entitled "Emerging Trends in Analytical Sciences (ETAS-2018)"
August, 2018	
2nd -3rd	CSIR-NIO: Organized an International 2-day workshop on INDIA-ONR ARABIAN SEA SCIENCE
2nd	CSIR-IMMT: Workshop on R&D Opportunities in Defence Sector
3rd -4th	CSIR-CGCRI: National Seminar on Waste Management in Metallurgical Activities,
13th	CSIR-NAL: Hon'ble Minister for Science & Technology, Dr Harsh Vardhan visit to CCFP, Inauguration of UAV Design and Integration Facility
12th	CSIR-CCMB: Dr. Harsh Vardhan, Union Minister of Science and Technology, Earth Sciences and Environment, Forest and Climate Change inaugurated the National Wildlife Genetic Resource Bank at LaCONES-CCMB -_National Wildlife Genetic Resource Centre dedicated to the Nation
13th -14th	CSIR-SERC: National Hindi Technical Seminar on "Technology Vision 2035 – Challenges & Opportunities"

27th	CSIR-IIP: First Bio-Jet fuel powered flight from Dehradun to Delhi by 'SpiceJet' A galaxy of Hon'ble Union Ministers, Govt. of India, Dr Harsh Vardhan, Ministry of Science and Technology, Ministry of Environment, Forest and Climate Change and Ministry of Earth Sciences; Mr Nitin Gadkari, Minister for Road Transport & Highways, Shipping and Water Resources, River Development and Ganga Rejuvenation in the Government of India; Mr Dharmendra Pradhan, Minister of Petroleum and Natural Gas and Skill Development and Entrepreneurship; Mr Suresh Prabhu, Minister of Commerce and Industry and Civil Aviation and Mr Jayant Sinha, Minister of State for Civil Aviation, received the flight at the Delhi airport.
September, 2018	
12th	CSIR-SERC: Industry Meet on "Emergency Retrieval System for Power Lines"
13th -14th	CSIR-IIIM: National Conference-cum-Industry-Academia Meet
18th -19th	CSIR-CBRI: National Training-Cum-Workshops on Utilization of Bamboo as Building Material in North Eastern Region
19th	CSIR-NML: A Workshop on Cyber Security was held at CSIR-NML
21st	CSIR-CEERI: Foundation Day Function
22nd	CSIR-IMMT: workshop on Rare Earth Extraction Technology from Waste and Industrial By-products
25th	CSIR-NIO: India International Science Festival (IISF-GOA), 2018 for showcasing India's Scientific Achievements in Ocean Science & Technology
25th	CSIR-CSMCRI: Prelude to India International Science Festival-2018 (IIFS-2018)
27th -28th	CSIR-CBRI: India International Science Festival-2018: Precursor Events
October, 2018	
5th -8th	CSIR-CDRI: India International Science Festival (IISF-2018),
5th -8th	CSIR-NBRI: India International Science Festival- Science Village
6th -8th	CSIR-NISCAIR: "International Science Literature and Film Festival (ISLFF- 2018)" as a part of IISF 2018, along with Vigyan Prasar and VIBHA
12th	CSIR-NAL: CSIR Foundation Day Celebrations
25th	CSIR-IMTECH: New administrative block being inaugurated by Shri V P Badnore Ji, Hon'ble Governor of Panjab & Administrator Chandigarh in the presence of Dr. Anil Koul, Director, CSIR-IMTech, Chandigarh
November, 2018	
26th	CSIR-NML: 69th CSIR-NML Foundation Day Celebrations

11th -15th	CSIR-NPL: 13th International Western Pacific Conference on Acoustics (WESPAC-2018)
16th -17th	CSIR-CRRI: First International Conference on Pavements and Computational Approaches (ICOPAC)
19th –22nd	CSIR-NIIST: Seventh International Conference on Solidification Science and Processing (ICSSP7)
22nd	CSIR-NGRI: Dr. Shekhar C. Mande, Director General, CSIR and Secretary, DSIR, Govt. of India visited CSIR-NGRI
23rd -24th	CSIR-CIMFR: National Seminar on "Rock Blasting Techniques"
26th -28th	CSIR-NPL: Indo-Japan Workshop – 2018 on "Highly Conductive CFRP using Conductive Polymers and Nanomaterials for Structural Applications"
26th -29th	CSIR-CDRI: Golden Jubilee Shanti Swarup Bhatnagar Memorial Tournament-2018
27th -30th	CSIR-NBRI: Sixth International Conference on Plants and Environmental Pollution
December, 2018	
3rd	CSIR-CDRI: Study-Visit of the Departmental-related Parliamentary Standing Committee on Science & Technology, Environment & Forests
3rd	CSIR-CIMAP: Parliamentary Standing Committee (PSC) on Science & Technology, Environment & Forests visited CSIR-CIMAP
4th	CSIR-CSIO: 26th State Level Children's Science Congress -2018 at Indo-Swiss Training Centre, CSIR-CSIO, Chandigarh
5th -7th	CSIR-CECRI organized the Nineteenth National Conference on Corrosion Control (19th NCCC) in collaboration with National Corrosion Council of India (NCCI), Karaikudi and Indian Oil Corporation Limited, Noida and CSIR-CECRI
6th -9th	CSIR-NPL: Indo-Japan international workshop in collaboration with Nagoya University, Japan on Biomolecular Electronics and Organic nanotechnology for Environment Preservation (IJWBME-2018)
19th – 21st	CSIR-NIIST: National Conference on Emerging Trends in Science, Technology & Application of Electron Microscope (STAEM-2018) & 5th Annual Meeting of the Academy of Microscope Science & Technology (AMST)
24th	CSIR-CBRI: Dr. Shekhar C. Mande, DG CSIR visits - reviewed the R&D activities of CSIR-CBRI and encouraged the scientists, staff and students to generate global-level technologies and transfer them to the society
26th	CSIR-CFTRI: National conference for "Virgin coconut oil (VCO) manufacturers" jointly organized by CSIR- Central Food Technological Research Institute, Mysore and Coconut Development Board(CDB)
28th	CSIR-CSIO: Celebration of Opening Ceremony of CSIO Diamond Jubilee Year. The event was inaugurated by Dr. Shekhar C Mande, DG-CSIR.

28th	CSIR-CSIO: Dr. Shekhar C. Mande, Director General, CSIR & Secretary DSIR, Govt. of India inaugurated a new facility for design, fabrication and metrology of Optical Thin Films for strategic & defence, industry, medical and public safety applications set up in CSIR-CSIO on December 28, 2018
January, 2019	
1st	CSIR-IMTECH: Shekhar C. Mande, Secretary, DSIR and Director General, CSIR addressed CSIR-IMTech scientists/staff
18th -19th	CSIR-NML: National Seminar on "Advances in Engineering Materials for Sustainable Development (AEMSD 2019)"
28th Jan - 9th Feb.	CSIR-NGRI: Ongoing Training Course on Ground Water Exploration and Management
28th	CSIR-IMMT: Workshop on Treatment and Utilization of Industrial and Mining Wastes for Sustainable Environment
February, 2019	
4th -6th	CSIR-NML: Indo-German Bilateral Workshop on Additive Manufacturing of Metals (AMM-2019)
4th	CSIR-IMTECH: Indian Pharmacopoeia Commission (IPC) Interactive Meet on Pharmacopoeia Standards Regulatory and Quality Considerations
6th -7th	CSIR-IMMT: Workshop cum Brainstorming Session on Sustainable Approaches to Mitigate Environmental Issues in Eastern India
7th	CSIR-IICT: American Chemical Society's flagship outreach program "ACS on Campus"
18th -22nd	CSIR-NPL: 10th International Conference on Advances in Metrology (AdMet-2019)
18th -20th	CSIR-CSMCRI: Three days Indo-German Joint Scientific Workshop on "Membranes for Water and Energy"
18th	CSIR-IICT: A 10 days duration Skill Development Training programme on Basic Cheminformatics under CSIR Integrated Skill Initiative
20th -22nd	CSIR-CIMFR: International Conference and Exhibition on "Energy and Environment: Challenges and Opportunities" was organized at Vigyan Bhawan, New Delhi
22nd -23rd	CSIR-NBRI: International conference on "New Age opportunities and challenges for quality, safety and GMPs in herbal drug development"
25th -27th	CSIR-NIIST: 8th Annual Meeting of Indian Academy of Biomedical Sciences and Conference on "Deliberation on Translation of Basic Scientific Insights into Affordable Healthcare Products"

25th Feb – 1st March 2019	CSIR-IMTECH: Workshop on Ethical Contemplation of Animal Resources for Experimentation (WeCARE-2019)
25th -26th	CSIR-AMPRI: The "Indo-German Workshop on Waste to Wealth" was jointly organised by CSIR-Advanced Materials and Processes Research Institute (CSIR-AMPRI), India and Martin-Luther-Universität Halle-Wittenberg, Germany and BauMineral GmbH, Germany
26th	CSIR-CMERI: 61st Foundation Day Celebrated
26th to 1st March	CSIR-NCL: 5th Indo-French Symposium in NCL on "Functionalised Materials for Sustainable Catalytic and Related Applications MATSUCAT-2019"
27th Feb – 2nd March	CSIR-IICT: International conference "Advances in Chemical Biology and Biologics (ICACB-2019)"
March, 2019	
4th -13th	CSIR-NGRI: Advance training program on Analytic Geochemistry
6th	CSIR-IICT: "IPR Awareness cum Interactive Session and Workshop"
8th	CSIR-SERC: International Women's Day
14th	CSIR-IMTECH: Nobel Laureate Prof. Bernard Lucas Feringa (NOBEL PRIZE IN CHEMISTRY 2016) from University of Groningen, The Netherlands visited CSIR-IMTECH, Chandigarh and delivered a Nobel Laureate distinguished lecture
14th	CSIR-CECRI: International Year of Periodic Table for Chemical Elements (IYPT-2019)

ANNEXURES

ANNEXURE - I

Awards/Recognition

During the year numerous awards and recognitions have been received by CSIR staff, as under:

Awards/ recognition	Name of the awardees	Lab Name
Haryana Yuva Vigyan Ratna Award – 2017	Dr. Sanjeev Kumar	CSIR-CSIO
National Award for the Empowerment of Persons with Disabilities (DIVYANGJAN) -2018	Sh. Amit Laddi	CSIR-CSIO
NRDC National Societal Innovation Award 2017	Dr. Manoj K Patel	CSIR-CSIO
National Level Competition on Prototype Development: Techspardha 2018	Mr. Amarendra Goap	CSIR-CSIO
CSIR-CSIO Team awarded Certificate of Merit Technology Award for Physical Sciences including Engineering – 2018"	CSIR-CSIO Team	CSIR-CSIO
ISCA Young Scientist Award in Material Science Category for the year 2019.	Dr. Pooja Devi	CSIR-CSIO
ISEES Young Scientist Award	Dr. Pooja Devi	CSIR-CSIO
CSIR Raman Research Fellowship 2018-19	Dr. Abhilash	CSIR-NML
Scientist Elected as Fellow National Academy of Sciences (NASI)India in the year 2018	Dr. Suman Kumari Mishra	CSIR-NML
'Bharat Jyoti Award' New Delhi	Dr. Suman Ray	CSIR-NISTADS
Dr. J.G. Negi Young Scientist Award - IGU-2018	Dr. Rajesh Rekapalli	CSIR-NGRI
CSIR Technology Award for Business Development and Technology Marketing 2018	CSIR-IIP & CSIR-CIMFR Team	
National Bioscience Award 2018	Dr. Beena Pillai	CSIR-IGIB
"ISCA Young Scientist Award 2019" of the Indian Science Congress Association under "Engineering Sciences" section	Dr. Prosenjit Das	CSIR-CMERI
CSIR Diamond Jubilee Technology Award (CDJTA)	Dr J Raghava Rao	CSIR-CLRI
CSIR Technology Award (CTA)	CSIR-CIMFR Team	CSIR-CIMFR
CSIR Young Scientist Award-2018	Dr. Naveen Kumar Chandrasekaran,	CSIR-CECRI

Fellow of the National Academy of Sciences (FNASc), National Academy of Sciences, Allahabad	Dr. Ritu Trivedi	CSIR-CDRI
Selected member, Global Young Academy, GNAS, Germany Elected as a member of Indian National Young Academy of Sciences, INSA	Dr. Wahajuddin	CSIR-CDRI
Raman Research Fellowship- 2017-18	Dr. M.B. Anoop	CSIR-SERC
J.C. Bose National Fellowship by DST	Prof. Santosh Kapuria	CSIR-SERC
Raman Research Fellowship - year 2018-19	Dr. Ing. Saptarshi Sasmal	CSIR-SERC
ICI-UltraTech Award -2018	Dr. Prabhat Ranjan Prem	CSIR-SERC
Asia-Pacific Academy of Materials Fellow/ Academician Awarded in the International Conference of Asia Pacific Academy of Materials 2018 MRSI Medal-2018	Dr. Bipin Gupta	CSIR-NPL
Haryana Yuva Scientist Award-2018	Dr. Poonam Arora	CSIR-NPL
NRDC National Meritorious Innovation Award 2018	CSIR-NPL TEAM	CSIR-NPL
URSI Young Scientist Award	Dr. S.K Dubey	CSIR-NPL
"Rajbhasha Gaurav Samman" (National Award by Dept of Official Language)	Dr. Rakesh Sharma	CSIR-NIO
Shanti Swarup Bhatnagar Prize -2018 (under the category of Earth, Atmosphere, Ocean and Planetary Sciences)	Dr Parthasarathi Chakraborty	CSIR-NIO
ISCA Young Scientist Award 2019	Ms. Rupal Dubey	CSIR-NIO
Bronze Medal, Chemical Research Society of India, (2018)	Dr. C. H. Suresh	CSIR-NIIST
Kerala State Young Scientist Award for the Year 2018	Dr. Suraj Soman	CSIR-NIIST
NIGIS Award for Excellence in Corrosion Science and Technology for 2018 by the NACE International Gateway Indian Section (NIGIS), Mumbai	Dr. T.P.D. Rajan	CSIR-NIIST
Raman Research Fellowship	Dr. P. Nisha	CSIR-NIIST

A Fellow of the National Academy of Sciences (NASI), India	Dr. A. P. Giri	CSIR-NCL
INSA Young Scientist Award 2018	Dr. Sakya Singha Sen	CSIR-NCL
Fellow of the Royal Aeronautical Society, UK.	Dr L Venkatakrishnan	CSIR-NAL
Significant Women Contribution Award" by Computer Society of India, Bangalore	Dr. Manju Nanda	CSIR-NAL
CSIR Young Scientist award	Dr. Niraj Kumar	CSIR-CEERI
Raman Research Fellowship (RRF) award for the Year 2017-18	Dr. Mahanth Prasad	CSIR-CEERI
Innovative Young Biotechnologist Award (IYBA)-2018	Dr. Umakanta Subudhi	CSIR-IMMT
Odisha Bigyan Academy Award-2017'	Dr Srabani Mishra	CSIR-IMMT
Society of Geoscientists and Allied Technologists (SGAT) Excellence Award- 2018	Dr. D. S. Rao	CSIR-IMMT
Aroma Mission team received the "Ultra International Team Award" at the International Congress & Expo-2018	CSIR-IIIM team	CSIR-IIIM
CSIR Tech Awards-2018	Dr. T Prathap Kumar, Dr. B Satyavathi, Dr. Pravin Likhar, Dr. M Lakshmi Kantam, Mr. M Ramulu, Mr. S Anand Kumar, Mr. K Ravindranath, Mr. K Vijay Murty	CSIR-IICT
VASVIK Award' for the year 2018	Dr. S Venkata Mohan	CSIR-IICT
C. V. Raman Birth Centenary Award 2019	Dr. Hemanta K. Majumder	CSIR-IICB
Shanti Swarup Bhatnagar Prize	Dr. Suvendra Nath Bhattacharyya	CSIR-IICB
National Bioscience Award	Dr. Dipyaman Ganguly	CSIR-IICB
Fellowship of National Academy of Science (FNASc) 2018	Dr. Arun Bandyopadhyay	CSIR-IICB
National Women Bioscientist Award	Dr. Nahid Ali	CSIR-IICB
Chemical Society of Japan Lectureship Award-2019	Dr Kamlesh Prasad	CSIR-CSMCRI

CRSI Bronze Medal by Chemical Research Society of India	Dr. Kannan Srinivasan	CSIR-CSMCRI
the CSIR Certificate of Merit (Technology award for Life Science 2018)	CSIR-CIMAP Team	CSIR-CIMAP
"Indo-U.S. Genome Engineering/Editing Technology Initiative (GETin) Overseas Fellowship"	Dr. DA Nagegowda	CSIR-CIMAP
CSIR Technology Award for Innovation 2018	CSIR-CGCRI Team	CSIR-CGCRI
Raman Research Fellowship	Dr. Mukesh Kapoor	CSIR-CFTRI
Vigyan Bharti Delhi Samman 2018 by Swadeshi Science Movement of India (Vigyan Bharti, New Delhi)	Dr. Atul Kumar Agarwal	CSIR-CBRI
• Sun Pharma Research Award for the year 2018 in the field of 'Medical Sciences - Basic Research" • Elected Fellow, National Academy Sciences – India, Allahabad • Dr. Palle Rama Rao Award, by Government of Andhra Pradesh, at Andhra Pradesh Science Congress, Kadapa	Shri K Thangaraj	CSIR-CCMB
Fellow at National Academy of Medical Sciences	Shri G R Chandak	CSIR-CCMB
• Awarded SERB Distinguished Fellowship • Elected as Fellow of TWAS	Shri Amitabha Chattopadhyay	CSIR-CCMB
• Elected Fellow, Indian National Science Academy • Awarded J C Bose Fellowship	Shri Yogendra Sharma	CSIR-CCMB
Indian National Science Academy - INSA MEDAL for Young Scientists 2018	Shri Satya Brata Routh	CSIR-CCMB
Ratna Phadke Award of Indian Biophysical Society (IBS), Annual Meeting at IISER, Mohali Selected as Fulbright-Nehru Fellow to work in USA (August 2018)	Shri Shanti Swaroop Srivastava	CSIR-CCMB

ANNEXURE - II

Patents data

CSIR Patent Applications Filed and Patents Granted in India and abroad during 2018-19

	India		Abroad*	
	Filed	**Granted**	**Filed**	**Granted**
AMPRI	4	3	1	5
CBRI	2	2	0	0
CCMB	3	0	6	2
CDRI	3	3	2	6
CECRI	2	0	0	6
CEERI	2	1	0	0
CFTRI	2	3	0	0
CGCRI	3	9	2	4
CIMAP	2	0	0	0
CIMFR	10	6	0	0
CLRI	11	4	14	4
CMERI	17	0	0	0
CRRI	1	0	0	0
CSIO	3	0	5	0
CSIR(SCH)	1	1	0	5
CSMCRI	15	17	5	10
FPI	0	0	0	1
IGIB	0	0	0	2
IHBT	6	2	4	4
IICB	3	2	6	2
IICT	6	18	14	29
IIIM	3	2	12	25
IIP	1	10	1	5

IITR	3	1	0	0
IMMT	3	3	1	2
IMT	9	1	17	19
NAL	4	2	0	6
NBRI	5	0	0	5
NCL	50	56	76	124
NEERI	4	3	0	0
NEIST	1	4	0	1
NGRI	0	0	0	1
NIIST	4	3	4	5
NIO	0	0	0	0
NMITLI	1	1	0	3
NML	24	6	0	0
NPL	0	4	4	9
SERC(M)	1	0	0	0
	209	**167**	**174**	**285**
*** Data may increase later during national phase entries**				

ANNEXURE - III

Details of Foreign Patents Granted to CSIR

Details of Foreign Patents Granted to CSIR during 2018-19

CSIR-AMPRI				
S.No	**Country**	**Patent No**	**Title of Invention**	**Inventors**
1.	United States of America	10060833	An apparatus for testing shape memory effects in liquid bath	Hashmi Syed Azhar Rasheed, Bhargaw Hari Narayan, Ajay Naik, Pandey Jagdish Prasad, Yadav Mulayam Singh, Navin Chand
2.	United States of America	10023497	A novel multifunctional material for workability of geopolymeric system and its process thereof.	Sudhir Sitaram Amritphale, Ramesh Kumar Chouhan, Manish Mudgal, Sarika Verma, Satyabrata Das
3.	United States of America	10165713	Advanced non-toxic radiation shielding materials from tailored brine sludge and a process for the preparation thereof	Sudhir Sitaram Amritphale, Avneesh Anshul, Sarika Verma, Mohammed Akram Khan, Satyabrata Das
4.	United States of America	9938414	a novel process for making advanced nano phosphatic hybrid inorganic - organic geopolymeric corrosion resistant coating material for mild steel substrate	Sudhir Sitaram Amritphale, Deepti Mishra, Archana Singh, Avneesh Anshul, Satyabrata Das
5.	United States of America	10214453	A novel process for making "advanced cement free concrete and panels" by utilizing sea sand and sea water.	Sudhir Sitaram Amritphale, Sarika Verma, Mohammed Akram Khan, Prabha Padmakaran, Avneesh Anshul, Satyabrata Das
CSIR-CCMB				
S.No	**Country**	**Patent No**	**Title of Invention**	**Inventors**
6.	United States of America	10208353	Biomarkers useful for detection of grades of human breast cancer	Dinesh Kumar Lekha, Verma Vinod Kumar, Appukuttan Nair Rekha, Jem Prabhakar, Katoor Jayasree

7.	United States of America	10208098	Recombinant protein-based method for the delivery of silencer RNA to target the brain	Gopal Vijaya, Ghulam Hassan Dar
CSIR-CDRI				
S.No	**Country**	**Patent No**	**Title of Invention**	**Inventors**
8.	China	ZL2014800198858	Carbodithioates and process for preparation thereof	Vishanu Lal Sharma, Nand Lal, Amit Sarswat, Santosh Jangir, Veenu Bala, Lalit Kumar, Tara Rawat, Ashish Jain, Lokesh Kumar, Jagdamba Prasad Maikhuri, Gopal Gupta
9.	Germany	3154943	Cationic lipid cordiarimide hybrid compounds and a process for preparation thereof	Bathula Surendar Reddy, Vkk Durga Rao, Komal Sharma, M Prathap Reddy, Dibyendu Banerjee, Deependra Kumar Singh
10.	European Patent Office	3154943	Cationic lipid cordiarimide hybrid compounds and a process for preparation thereof	Bathula Surendar Reddy, Vkk Durga Rao, Komal Sharma, M Prathap Reddy, Dibyendu Banerjee, Deependra Kumar Singh
11.	France	3154943	Cationic lipid cordiarimide hybrid compounds and a process for preparation thereof	Bathula Surendar Reddy, Vkk Durga Rao, Komal Sharma, M Prathap Reddy, Dibyendu Banerjee, Deependra Kumar Singh
12.	United Kingdom	3154943	Cationic lipid cordiarimide hybrid compounds and a process for preparation thereof	Bathula Surendar Reddy, VKK Durga Rao, Komal Sharma, M Prathap Reddy, Dibyendu Banerjee, Deependra Kumar Singh
13.	United States Of America	9,994,515	Novel aryl naphthyl methanone oxime derivatives for the treatment of hematological malignancies and solid tumors	Sabyasachi Sanyal, Atul Kumar, Naibedya Chattopadhyay, Jawahar Lal, Arun Kumar Trivedi, Dipak Datta, Srikanta Kumar Rath, Tahseen Akhtar, Shailendra Kumar Dhar Dwivedi, Manisha Yadav, Bandana Chakravarti, Abhishek Kumar Singh, Jay Sharan Mishra, Nidhi Singh, Anil Kumar Tripathi

CSIR-CECRI				
S.No	**Country**	**Patent No**	**Title of Invention**	**Inventors**
14.	Germany	3164902	In Situ Humidification Technique in LT-PEMFC	Ramendra Pandey, Harshal Agarwal, Ram Kumar, Sridhar Parthasarathi, Santoshkumar Bhat
15.	European Patent Office	3164902	In Situ Humidification Technique in LT-PEMFC	Ramendra Pandey, Harshal Agarwal, Ram Kumar, Sridhar Parthasarathi, Santoshkumar Bhat
16.	United Kingdom	3164902	In Situ Humidification Technique in LT-PEMFC	Ramendra Pandey, Harshal Agarwal, Ram Kumar, Sridhar Parthasarathi, Santoshkumar Bhat
17.	South Korea	10-1895641	A high voltage, high performance layered cathode material for lithium ion batteries	Gopukumar Sukumaran, Nithya Chandrasekaran, Thirunakaran Ramasamy, Sivashanmugam Arumugam
18.	United States of America	9,985,277	Process for the preparation of high voltage nano composite cathode (4.9v) for lithium ion batteries	Gopukumar Sukumaran, Nithya Chandrasekaran, Thirunakaran Ramasamy, Sivashanmugam Arumugam
19.	United States of America	10224539	Improved lithium intercalation behavior of LiNi0.4Mn0.4Co0.2O2 cathode with novel surface modifiers	Kalaiselvi Nallathamby, Bhuvaneswari Dharmarajan, Babu Ganguli
CSIR-CGCRI				
S.No	**Country**	**Patent No**	**Title of Invention**	**Inventors**
20.	China	105050972	Energy efficient soda lime silicate glass compositions using borax pentahydrate	Basudeb Karmakar, Atiar Rahaman Molla, Anal Tarafder, Ranjan Sen
21.	China	ZL201380077091.2	Novel soda lime silicate glass composition comprising colemanite and a process for the preparation thereof	Annapurna Kalyandurg, Kaushik Biswas, Atul Dnyaneshwar Sontakke, Ranjan Sen

22.	Japan	6393314	A process for fabrication of rare earth doped optical fiber through vapor phase doping technique	Ranjan Sen, Maitreyee Saha
23.	United States of America	10040714	A process for fabrication of rare earth doped optical fiber through vapor phase doping technique	Ranjan Sen, Maitreyee Saha
CSIR-CLRI				
S.No	**Country**	**Patent No**	**Title of Invention**	**Inventors**
24.	Bangladesh	1005951	A zero water chrome tanning process	Rathinam Aravindhan, Palanisamy Thanikaivelan, Gladstone Christopher Jayakumar, Palanivel Saravanan, Jonnalagadda Raghava Rao
25.	China	CN106414777	A novel composition for water free, pickle free chrome tanning without medium and a chrome tanning process thereof	Chellappa Muralidharan
26.	Spain	ES2632994	A zero water chrome tanning process	Rathinam Aravindhan, Palanisamy Thanikaivelan, Gladstone Christopher Jayakumar, Palanivel Saravanan, Jonnalagadda Raghava Rao
27.	Nigeria	RP NG/ PT/C/2015/934	A novel fluidized bed reactor for treatment of waste water	Ganesan Sekaran, Sekar Karthikeyan, Ramasamy Boopathy, Asit Baran Mandal
CSIR-CSIR(SCH)				
S.No	**Country**	**Patent No**	**Title of Invention**	**Inventors**
28.	Germany	2941420	(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

29.	European Patent Office	2552444	Novel nicotinamide phosphoribosyltransferase (nmprtase) inhibitor for glioma therapy	Kumaravel Somasundaram, Nagasuma Chandra
30.	European Patent Office	2941420	(4Ee)-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
31.	United Kingdom	2941420	(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
32.	United States of America	10053718	An optimized economic process for Microbial cellulose production from a novel species of Gluconacetobacter	Rajendra Kumar Saxena, Firdaus Jahan
CSIR-CSMCRI				
S.No	**Country**	**Patent No**	**Title of Invention**	**Inventors**
33.	Germany	2411418	Improved process for the preparation of agarose polymer from seaweed extractive	Ramavatar Meena, Kamalesh Prasad, Arup Kumar Siddhanta, Pushpito Kumar Ghosh, Gauravkumar Kishor Mehta, Bharatkumar Kalidas Ramavat, Meenakshi Sundaram Ganesan, Bhavanath Jha, Avinash Mishra, Mahesh Ramniklal Gandhi, Pradeep Kumar Agarwal, Karuppanan Eswaran
34.	European Patent Office	2411418	Improved process for the preparation of agarose polymer from seaweed extractive	Ramavatar Meena, Kamalesh Prasad, Arup Kumar Siddhanta, Pushpito Kumar Ghosh, Gauravkumar Kishor Mehta, Bharatkumar Kalidas Ramavat, Meenakshi Sundaram Ganesan, Bhavanath Jha, Avinash Mishra, Mahesh Ramniklal Gandhi, Pradeep Kumar Agarwal, Karuppanan Eswaran

35.	European Patent Office	3089999	An integrated process to valorize seaweed biomass for a spectrum of bioproducts	Chennur Radhakrishna Reddy, Ravi Singh Baghel, Nitin Trivedi, Puja Kumari, Vishal Gupta, Kamlesh Prasad, Ramavatar Meena
36.	France	3089999	An integrated process to valorize seaweed biomass for a spectrum of bioproducts	Chennur Radhakrishna Reddy, Ravi Singh Baghel, Nitin Trivedi, Puja Kumari, Vishal Gupta, Kamlesh Prasad, Ramavatar Meena
37.	United Kingdom	2411418	Improved process for the preparation of agarose polymer from seaweed extractive	Ramavatar Meena, Kamalesh Prasad, Arup Kumar Siddhanta, Pushpito Kumar Ghosh, Gauravkumar Kishor Mehta, Bharatkumar Kalidas Ramavat, Meenakshi Sundaram Ganesan, Bhavanath Jha, Avinash Mishra, Mahesh Ramniklal Gandhi, Pradeep Kumar Agarwal, Karuppanan Eswaran
38.	Japan	6336457	Biodegradable hydrophobic composite materials and process for the preparation thereof	Ramavatar Meena, Pushpito Kumar Ghosh, Dharmesh Chejara, Karuppanan Eswaran, Arup Kumar Siddhanta, Kamalesh Prasad, Jai Prakash Chaudhary
39.	South Korea	10-1847027	ZN(ii) based colorimetric sensors and process for the preparation thereof	Prasenjit Mahato, Amrita Ghosh, Sanjiv Kumar Mishra, Anupama Shrivastava, Sandhya Mishra, Amitava Das
40.	Malaysia	MY-165640-A	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
41.	United States of America	10221149	An improved fast and selective process for the preparation of ?-valerolactone by catalytic hydrogenation of levulinic acid using ru-based catalysts	Kannan Srinivasan, Sreedhar Gundekari

42.	United States of America	10,000,579	An integrated process to valorize seaweed biomass for a spectrum of bioproducts	Chennur Radhakrishna Reddy, Ravi Singh Baghel, Nitin Trivedi, Puja Kumari, Vishal Gupta, Kamlesh Prasad, Ramavatar Meena
CSIR-FPI				
S.No	**Country**	**Patent No**	**Title of Invention**	**Inventors**
43.	United States of America	10129294	Method and system for detection and elimination of optimistic sack spoofing based denial-of-service attacks on SCTP through data enriched sack	Vengalil Anil Kumar, Debabrata Das
CSIR-IGIB				
S.No	**Country**	**Patent No**	**Title of Invention**	**Inventors**
44.	European Patent Office	2916874	Nanocomplex containing cationic peptide for biomolecule delivery	Munia Ganguli, Anita Mann, Vasundhara Shukla, Manika Vij
45.	United Kingdom	2916874	Nanocomplex containing cationic peptide for biomolecule delivery	Munia Ganguli, Anita Mann, Vasundhara Shukla, Manika Vij
CSIR-IHBT				
S.No	**Country**	**Patent No**	**Title of Invention**	**Inventors**
46.	Germany	2690969	Process for the modification of curcuma aromatic essential oil	Vijai Kant Agnihotri, Bikram Singh, Garikapati Dyva Kiran Babu, Gopi Chand, Rakesh Deosharan Singh, Paramvir Singh Ahuja
47.	European Patent Office	2690969	Process for the modification of curcuma aromatic essential oil	Vijai Kant Agnihotri, Bikram Singh, Garikapati Dyva Kiran Babu, Gopi Chand, Rakesh Deosharan Singh, Paramvir Singh Ahuja

48.	France	2690969	Process for the modification of curcuma aromatic essential oil	Vijai Kant Agnihotri, Bikram Singh, Garikapati Dyva Kiran Babu, Gopi Chand, Rakesh Deosharan Singh, Paramvir Singh Ahuja
49.	United States of America	10131727	A process for the development of highly efficient solid state matrix for immobilizing tea polyphenol oxidase enzyme for continuous batch production and total conversion of tea substrates to the aflavins	Harsh Pratap Singh, Kapil Sharma
CSIR-IICB				
S.No	**Country**	**Patent No**	**Title of Invention**	**Inventors**
50.	African Regional Intellectual Property Organization	AP 4731	Biomarker for valvular heart disease	Arun Bandyopadhyay, Tanima Banerjee, Somaditya Mukherjee, Santanu Dutta
51.	United States of America	10100082	A hexapeptide interacts with tubulin/microtubule and exhibits significant neuroprotection against ab toxicity thereof	Surajit Ghosh, Atanu Biswas, Batakrishna Jana, Saswat Mohapatra, Subhas Chandra Biswas, Suraiya Saleem, Prasenjit Mondal, Anindyasundar Adak, Subhajit Ghosh, Abhijit Saha, Debmalya Bhunia
CSIR-IICT				
S.No	**Country**	**Patent No**	**Title of Invention**	**Inventors**
52.	Germany	2947153	A process for the preparation of polymeric biosurfactants	Ganesh Kumar Chityal, Sujitha Pombala
53.	Germany	3039013	Pyrazolochalcones as potential anticancer agents	Kamal Ahmed, Anver Basha Shaik, Gajjela Bharath Kumar, Vangala Santhosh Reddy, Chityal Ganesh Kumar

54.	Germany	2748303	A highly enantioselective epoxide hydrolase from achromobacter sp. And a process for the preparation thereof	Ahmed Kamal, Rohini Khanna, Chityal Ganesh Kumar, Anver Basha Shaik, Matam Shiva Kumar
55.	Germany	EP3183230	N-((3,4,5-trimethoxystyryl) aryl) cinnamamide compounds as potential anticancer agents and process for the preparation thereof	Ahmed Kamal, Shaik Bajee, Challa Ratna Reddy, Mohammed Shaheer Malik, Vadithe Lakshma Nayak
56.	European Patent Office	EP3183230	N-((3,4,5-trimethoxystyryl) aryl) cinnamamide compounds as potential anticancer agents and process for the preparation thereof	Ahmed Kamal, Shaik Bajee, Challa Ratna Reddy, Mohammed Shaheer Malik, Vadithe Lakshma Nayak
57.	European Patent Office	2748303	A highly enantioselective epoxide hydrolase from achromobacter sp. And a process for the preparation thereof	Ahmed Kamal, Rohini Khanna, Chityal Ganesh Kumar, Anver Basha Shaik, Matam Shiva Kumar
58.	European Patent Office	2947153	A process for the preparation of polymeric biosurfactants	Chityal Ganesh Kumar, Pombala Sujitha
59.	European Patent Office	3039013	Pyrazolochalcones as potential anticancer agents	Ahmed Kamal, Shaik Anver Basha, Gajjela Bharath Kumar, Vangala Santhosh Reddy, Chityal Ganesh Kumar
60.	France	2947153	A process for the preparation of polymeric biosurfactants	Chityal Ganesh Kumar, Pombala Sujitha
61.	France	3039013	Pyrazolochalcones as potential anticancer agents	Ahmed Kamal, Shaik Anver Basha, Gajjela Bharath Kumar, Vangala Santhosh Reddy, Chityal Ganesh Kumar
62.	France	2748303	A highly enantioselective epoxide hydrolase from achromobacter sp. And a process for the preparation thereof	Ahmed Kamal, Rohini Khanna, Chityal Ganesh Kumar, Anver Basha Shaik, Matam Shiva Kumar

63.	France	EP3183230	N-((3,4,5-trimethoxystyryl) aryl) cinnamamide compounds as potential anticancer agents and process for the preparation thereof	Ahmed Kamal, Shaik Bajee, Challa Ratna Reddy, Mohammed Shaheer Malik, Vadithe Lakshma Nayak
64.	United Kingdom	2748303	A highly enantioselective epoxide hydrolase from achromobacter sp. And a process for the preparation thereof	Ahmed Kamal, Rohini Khanna, Chityal Ganesh Kumar, Anver Basha Shaik, Matam Shiva Kumar
65.	United Kingdom	EP3183230	N-((3,4,5-trimethoxystyryl) aryl)cinnamamide compounds as potential anticancer agents and process for the preparation thereof	Ahmed Kamal, Shaik Bajee, Challa Ratna Reddy, Mohammed Shaheer Malik, Vadithe Lakshma Nayak
66.	United Kingdom	2947153	A process for the preparation of polymeric biosurfactants	Chityal Ganesh Kumar, Pombala Sujitha
67.	United Kingdom	3039013	Pyrazolochalcones as potential anticancer agents	Ahmed Kamal, Shaik Anver Basha, Gajjela Bharath Kumar, Vangala Santhosh Reddy, Chityal Ganesh Kumar
68.	United Kingdom	GB2511240	Phenyl nitrofurfuryl linked piperidino-oxadiazoline conjugates as anti-tubercular agents and process for the preparation thereof	Ahmed Kamal, Arutla Viswanath, Jayanti Naga Srirama Chandra Murty, Farheen Sulthana, Gadupudi Ramakrishna, Inshad Ali Khan, Nitin Pal Kalia
69.	Japan	6360074	Process for synthesis of novel mannose - receptor selective lysinylated cationic amphiphile for invivo delivery of DNA vaccines	Arup Garu, Gopikrishna Moku, Sachin Barad Agawane, Arabinda Chaudhuri
70.	Japan	6338667	Pyrazolochalcones as potential anticancer agents	Ahmed Kamal, Shaik Anver Basha, Gajjela Bharath Kumar, Vangala Santhosh Reddy, Chityal Ganesh Kumar

71.	Japan	6333380	Synthesis and biological evaluation of 3-(4-ethynylphenyl) pyridopyrimidinone compounds as potential anticancer agents	Ahmed Kamal, Ranjita Nayak, Farheen Sultana
72.	United States of America	10100079	Progesterone-cationic lipid hybrid as anticancer agent and the process of synthesis thereof	Sujan Kumar Mondal, Sudhakar Jinka, Rajkumar Banerjee
73.	United States of America	10106627	A process for the preparation of polymeric biosurfactants	Chityal Ganesh Kumar, Pombala Sujitha
74.	United States of America	9951049	Pyrazole linked benzimidazole conjugates as potential anticancer agents	Ahmed Kamal, Anver Basha Shaik, Gajjela Bharath Kumar, Vangala Santhosh Reddy
75.	United States of America	10227589	A liposomal composition useful for inhibiting tumor growth through rna-interference using liposomally associated CDC20 siRNA	Anubhab Mukherjee, Jayanta Bhattacharyya, Arabinda Chaudhuri
76.	United States of America	9,969,763	1,2,3-Triazole-tethered carbohydrate-di and tri lipidated cysteine conjugates useful as novel Vaccine adjuvants and methods for the preparation thereof	Halmuthur Mahabalarao Sampathkumar, Naresh Nalla, Sathyaseelam Sathyabama, Sabbana Surya Vamshi, Bonam Srinivasa Reddy, Veerjala Naveen Kumar
77.	United States of America	10231996	Biocompatible polymer coated silver prussian blue nanoparticles (SPB-NPS: Ag3[Fe(CN)6])	Sudip Mukherjee, Chitta Ranjan Patra
78.	United States of America	9944676	Cationic lipid formulations for regressing established tumor	Sugata Barui, Soumen Saha, Chaudhuri Arabinda

79.	United States of America	9963476	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
80.	United States of America	9949970	Synthesis of new benzothiazole derivatives as potential anti-tubercular agents	Ahmed Kamal, Rajesh Vcrnc Shetti, P Swapna, Shaik Azeeza, A Malla Reddy, Inshad Ali Khan, Sheikh Tasduq Abdullah, Sandeep Sharma, Nitin Pal Kalia
CSIR-IIIM				
S.No	**Country**	**Patent No**	**Title of Invention**	**Inventors**
81.	European Patent Office	3110801	6-ARYL-4-phenylamino-quinazoline analogs as phosphoinositide-3-kinase inhibitors	Ram Asrey Vishwakarma, Sandip Bibishan Bharate, Shashi Bhushan, Rammohan Rao Yadav, Santosh Kumar Guru, Prashant Joshi
82.	European Patent Office	2828269	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
83.	European Patent Office	3209671	Alkylidene phosphonate esters as p-glycoprotein inducers	Sandip Bharate, Ajay Kumar, Sudhakar Manda, Prashant Joshi, Sonali Bharate, Abubakar Wani, Sadhana Sharma, Ram Vishwakarma
84.	European Patent Office	3212235	A pharmaceutical composition for the treatment of multi-drug resistant infections	Ram Vishwakarma, Ajay Kumar, Inshad Ali Khan, Sandip Bibishan Bharate, Prashant Joshi, Samsher Singh, Naresh Satti

85.	European Patent Office	3207026	10-substituted colchicinoids as potent anticancer agents	Ram Vishwakarma, Sandip Bibishan Bharate, Ajay Kumar, Baljinder Singh, Ashok Kumar, Shashi Bhushan, Abid Hamid, Prashant Joshi, Santosh Kumar Guru, Suresh Kumar, Aashiq Hussain, Asif Khurshid Qazi, Sonali Sandip Bharate, Parduman Sharma, Ajit Kumar Saxena, Dilip Manikrao Mondhe, Girish Mahajan, Zahoor Wani
86.	European Patent Office	3209669	Substituted 1,2,3-triazol-1-yl-methyl-2,3-dihydro-2-methyl-6-nitroimidazo[2,1-b] oxazoles as anti-mycobacterial agents and a process for the preparation thereof	Yempalla Kushalava Reddy, Munagala Gurunadham, Singh Samsher, Sharma Sumit, Khan Inshad Ali, Vishwakarma Ram Asrey, Singh Parvinder Pal
87.	European Patent Office	3052503	6-Notro-2,3-dihydroimidazo[2,1-b] oxazoles and a process for the preparation thereof	Parvinder Pal Singh, Gurunadham Munagala, Kushalava Reddy Yempalla, Inshad Ali Khan, Nitin Pal Kalia, Vikrant Singh Rajput, Amit Nargotra, Sanghapal Damodhar Sawant, Ram Asrey Vishwakarma
88.	Spain	3052503	6-Notro-2,3-dihydroimidazo[2,1-b] oxazoles and a process for the preparation thereof	Parvinder Pal Singh, Gurunadham Munagala, Kushalava Reddy Yempalla, Inshad Ali Khan, Nitin Pal Kalia, Vikrant Singh Rajput, Amit Nargotra, Sanghapal Damodhar Sawant, Ram Asrey Vishwakarma
89.	France	3052503	6-Notro-2,3-dihydroimidazo[2,1-b] oxazoles and a process for the preparation thereof	Parvinder Pal Singh, Gurunadham Munagala, Kushalava Reddy Yempalla, Inshad Ali Khan, Nitin Pal Kalia, Vikrant Singh Rajput, Amit Nargotra, Sanghapal Damodhar Sawant, Ram Asrey Vishwakarma

90.	United Kingdom	2828269	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
91.	United Kingdom	3052503	6-Notro-2,3-dihydroimidazo[2,1-b] oxazoles and a process for the preparation thereof	Parvinder Pal Singh, Gurunadham Munagala, Kushalava Reddy Yempalla, Inshad Ali Khan, Nitin Pal Kalia, Vikrant Singh Rajput, Amit Nargotra, Sanghapal Damodhar Sawant, Ram Asrey Vishwakarma
92.	United Kingdom	3209669	substituted 1,2,3-triazol-1-yl-methyl-2,3-dihydro-2-methyl-6-nitroimidazo[2,1-b] oxazoles as anti-mycobacterial agents and a process for the preparation thereof	Yempalla Kushalava Reddy, Munagala Gurunadham, Singh Samsher, Sharma Sumit, Khan Inshad Ali, Vishwakarma Ram Asrey, Singh Parvinder Pal
93.	United Kingdom	3207026	10-substituted colchicinoids as potent anticancer agents	Ram Vishwakarma, Sandip Bibishan Bharate, Ajay Kumar, Baljinder Singh, Ashok Kumar, Shashi Bhushan, Abid Hamid, Prashant Joshi, Santosh Kumar Guru, Suresh Kumar, Aashiq Hussain, Asif Khurshid Qazi, Sonali Sandip Bharate, Parduman Sharma, Ajit Kumar Saxena, Dilip Manikrao Mondhe, Girish Mahajan, Zahoor Wani
94.	United Kingdom	3212235	A pharmaceutical composition for the treatment of multi-drug resistant infections	Ram Vishwakarma, Ajay Kumar, Inshad Ali Khan, Sandip Bibishan Bharate, Prashant Joshi, Samsher Singh, Naresh Satti

95.	United Kingdom	3110801	6-aryl-4-phenylamino-quinazoline analogs as phosphoinositide-3-kinase inhibitors	Ram Asrey Vishwakarma, Sandip Bibishan Bharate, Shashi Bhushan, Rammohan Rao Yadav, Santosh Kumar Guru, Prashant Joshi
96.	United Kingdom	3209671	Alkylidene phosphonate esters as p-glycoprotein inducers	Sandip Bharate, Ajay Kumar, Sudhakar Manda, Prashant Joshi, Sonali Bharate, Abubakar Wani, Sadhana Sharma, Ram Vishwakarma
97.	Japan	6467042	substituted 1,2,3-triazol-1-yl-methyl-2,3-dihydro-2-methyl-6-nitroimidazo[2,1-b] oxazoles as anti-mycobacterial agents and a process for the preparation thereof	Kushalava Reddy Yempalla, Gurunadham Munagala, Samsher Singh, Sumit Sharma, Inshad Ali Khan, Ram Asrey Vishwakarma, Parvinder Pal Singh
98.	Taiwan	I654192	6-nitro-2,3-dihydroimidazo[2,1-b] oxazoles and a process for the preparation thereofanti-mycobacterial agents	Parvinder Pal Singh, Gurunadham Munagala, Kushalava Reddy Yempalla, Inshad Ali Khan, Nitin Pal Kalia, Vikrant Singh Rajput, Amit Nargotra, Sanghapal Damodhar Sawant, Ram Asrey Vishwakarma
99.	United States of America	10064840	A pharmaceutical composition for the treatment of multi-drug resistant infections	Ram Vishwakarma, Ajay Kumar, Inshad Ali Khan, Sandip Bibishan Bharate, Prashant Joshi, Samsher Singh, Naresh Satti
100.	United States of America	9932327	Rohitukine analogs as cyclin-dependent kinase inhibitors and a process for the preparation thereof	Ram Asrey Vishwakarma, Sandip Bibishan Bharate, Shashi Bhushan, Dilip Manikrao Mondhe, Shreyans Kumar Jain, Samdarshi Meena, Santosh Kumar Guru, Anup Singh Pathania, Suresh Kumar, Akanksha Behl, Mubashir Javed Mintoo, Sonali Sandip Bharate, Prashant Joshi

101.	United States of America	10072009	N-substituted beta-carbolinium compounds as potent P-glycoprotein inducers	Sandip Bharate, Ajay Kumar, Sudhakar Manda, Prashant Joshi, Sonali Bharate, Ram Vishwakarma
102.	United States of America	10202326	Polyalkylated acyl and benzoyl-phloroglucinols as potent p-glycoprotein inducers	Sandip Bharate, Ajay Kumar, Jaideep Bharate, Prashant Joshi, Abubakar Wani, Ramesh Mudududdla, Rohit Sharma, Ram Vishwakarma
103.	United States of America	9951040	Novel 1,3,5 -triazine based pi3k inhibitors as anticancer agents and a process for the preparation thereof	Thanusha Thatikonda, Suresh Kumar, Umed Singh, Priya Mahajan, Girish Mahajan, Amit Nargotra, Fayaz Malik, Dilip Manikrao Mondhe, Ram Asrey Vishwakarma, Parvinder Pal Singh
104.	United States of America	10017511	Novel pyrazolopyrimidinones as PDE-5 inhibitors	Sanghapal Damodhar Sawant, Lakshma Reddy Ginnereddy, Srinivas Mahesuni, Sajad Hussain Syed, Mohd Ishaq Dar, Amit Nargotra, Priya Mahajan, Ram Asrey Vishwakarma
105.	United States of America	10202374	6-ARYL-4-phenylamino-quinazoline analogs as phosphoinositide-3-kinase inhibitors	Ram Asrey Vishwakarma, Sandip Bibishan Bharate, Shashi Bhushan, Rammohan Rao Yadav, Santosh Kumar Guru, Prashant Joshi
CSIR-IIP				
S.No	**Country**	**Patent No**	**Title of Invention**	**Inventors**
106.	European Patent Office	3191565	An improved process to produce aromatics rich aviation fuel along with other C1-C24 hydrocarbons	Anil Kumar Sinha, Mohit Anand, Saleem Akhtar Farooqui, Rakesh Kumar, Rakesh Kumar Joshi, Rohit Kumar, Tasleem Khan, Parvez Alam
107.	United States of America	9950315	An improved process and catalyst containing Ni-MgO-ZnO for reforming of methane with carbon dioxide to produce synthesis gas	Rajaram Bal, Rajib Kumar Singha, Chandrashekar Pendem, Laxmi Narayan Sivakumar Konathala, Ankur Bordoloi, Sandeep Saran

108.	United States of America	10105620	An improved process for simultaneous production of benzene lean gasoline and high purity benzene from cracked gasoline faction	Madhukar Onkarnath Garg, Prasenjit Ghosh, Sunil Kumar, Shrikant Madhusudan Nanoti, Bhagat Ram Nautiyal
109.	United States of America	10190064	Integrated process for simultaneous removal and value addition to the sulfur and aromatics compounds of gas oil	Sunil Kumar, Shrikant Madhusudan Nanoti, Madhukar Onkarnath Garg, Bhagat Ram Nautiyal, Prasenjit Ghosh, Pooja Yadav, Nisha
110.	United States of America	10,005,747	An improved process for the production of -verolactone by hydrogenation of levulinic acid over Pt-hydrotalcite catalyst	Rajaram Bal, Chandrashekar Pendem, Ankur Bordoloi, Laxmi Narayan Sivakumar Konathala, Manoj Kumar, Sandeep Saran
CSIR-IMMT				
S.No	**Country**	**Patent No**	**Title of Invention**	**Inventors**
111.	Germany	3013742	Reduced graphene oxide-silver phosphate (RGO-AgP) and a process for the preparation thereof for the photodegradation of organic dyes	Dipti Prakasini Das, Alaka Samal, Jasobanta Das, Ajit Dash
112.	European Patent Office	3013742	Reduced graphene oxide-silver phosphate (RGO-AgP) and a process for the preparation thereof for the photodegradation of organic dyes	Dipti Prakasini Das, Alaka Samal, Jasobanta Das, Ajit Dash
CSIR-IMT				
S.No	**Country**	**Patent No**	**Title of Invention**	**Inventors**
113.	Australia	2016242472	Metal nanoparticle synthesis by gelsolin variants	Ashish, Yogendra Singh Rathore, Nagesh Peddada, Kunzes Dolma, Renu Garg
114.	Australia	2015329528	Aptamers for purifying and quantifying gelsolin and its variants	Ashish, Renu Garg, Nagesh Peddada

115.	Belgium	3124496	Cysteine variants of streptokinase and its covalently modified forms	Shekhar Kumar, Neeraj Maheshwari, Girish Sahni
116.	Switzerland	3124496	Cysteine variants of streptokinase and its covalently modified forms	Shekhar Kumar, Neeraj Maheshwari, Girish Sahni
117.	China	ZL201480022301.2	Designer cells for enantio-selective reduction of ketones and use thereof in efficient production of enantioenriched alcohols.	Gautam Srivastava, Suneet Kaur, Ravinder Singh Jolly
118.	Germany	3124496	Cysteine variants of streptokinase and its covalently modified forms	Shekhar Kumar, Neeraj Maheshwari, Girish Sahni
119.	European Patent Office	2986724	Designer cells for enantio-selective reduction of ketones and use thereof in efficient production of enantioenriched alcohols.	Srivastava Gautam, Kaur Suneet, Jolly Ravinder Singh
120.	European Patent Office	3124496	Cysteine variants of streptokinase and its covalently modified forms	Shekhar Kumar, Neeraj Maheshwari, Girish Sahni
121.	France	2986724	Designer cells for enantio-selective reduction of ketones and use thereof in efficient production of enantioenriched alcohols.	Gautam Srivastava, Suneet Kaur, Ravinder Singh Jolly
122.	France	3124496	Cysteine variants of streptokinase and its covalently modified forms	Shekhar Kumar, Neeraj Maheshwari, Girish Sahni

123.	United Kingdom	2986724	Designer cells for enantio-selective reduction of ketones and use thereof in efficient production of enantioenriched alcohols.	Gautam Srivastava, Suneet Kaur, Ravinder Singh Jolly
124.	United Kingdom	3124496	Cysteine variants of streptokinase and its covalently modified forms	Shekhar Kumar, Neeraj Maheshwari, Girish Sahni
125.	Gulf Cooperation Council	GC0007780	Strain independent anti-influenza peptides for targeting a novel drug site in hemagglutinin trimer	Ashish, Kalpana Pandey, Yogendra Singh Rathore
126.	Japan	6330028	Designer cells for enantio-selective reduction of ketones and use thereof in efficient production of enantioenriched alcohols.	Gautam Srivastava, Suneet Kaur, Ravinder Singh Jolly
127.	Japan	6488406	Metal nanoparticle synthesis by gelsolin variants	Ashish, Yogendra Singh Rathore, Nagesh Peddada, Kunzes Dolma, Renu Garg
128.	South Korea	10-1876172	Designer cells for enantio-selective reduction of ketones and use thereof in efficient production of enantioenriched alcohols.	Gautam Srivastava, Suneet Kaur, Ravinder Singh Jolly
129.	United States of America	10167475	Aptamers for purifying and quantifying gelsolin and its variants	Ashish, Renu Garg, Nagesh Peddada
130.	South Africa	2017/06514	Metal nanoparticle synthesis by gelsolin variants	Ashish, Yogendra Singh Rathore, Nagesh Peddada, Kunzes Dolma, Renu Garg
131.	South Africa	2017/01730	Aptamers for purifying and quantifying gelsolin and its variants	Ashish, Renu Garg, Nagesh Peddada

CSIR-NAL				
S.No	**Country**	**Patent No**	**Title of Invention**	**Inventors**
132.	China	ZL201380072446.9	A hybrid multilayer solar selective coating for high temperature solar thermal applications and a process for the preparation thereof	Harish Chandra Barshilia, Jyothi Basu Bharathibai, Vara Lakshmi Ramachandrappa
133.	Germany	2669340	An improved binary pressure sensitive paint coating	Jyothi Basu Bharathibai, Vara Lakshmi Ramachandrappa, Raju Channa
134.	European Patent Office	2669340	An improved binary pressure sensitive paint coating	Jyothi Basu Bharathibai, Vara Lakshmi Ramachandrappa, Raju Channa
135.	France	2669340	An improved binary pressure sensitive paint coating	Jyothi Basu Bharathibai, Vara Lakshmi Ramachandrappa, Raju Channa
136.	United Kingdom	2669340	An improved binary pressure sensitive paint coating	Jyothi Basu Bharathibai, Vara Lakshmi Ramachandrappa, Raju Channa
137.	South Korea	10-1866319	A process for the preparation of high density slip-cast fused silica bodies	Udaya Kumar Andi, Senthil Kumar Selvaraj
CSIR-NBRI				
S.No	**Country**	**Patent No**	**Title of Invention**	**Inventors**
138.	Canada	2861194	A process for preparation of a novel insecticidal chitinase toxic against whiteflies, it"s encoding nucleotides and application there off	Pradhyumna Kumar Singh, Santosh Kumar Upadhyay, Chandrashekar Krishnappa, Sharad Saurabh, Rahul Singh, Preeti Rai, Harpal Singh, Manisha Mishra, Ajit Pratap Singh, Praveen Chandra Verma, Kuttan Pillai Narayanan Nair, Rakesh Tuli
139.	United States of America	10076550	A synergistic pharmaceutical composition for gastroinestinal disorders	Garima Pandey, Chandana Venkateswara Rao, Om Prakash Sidhu, Ajay Kumar Singh Rawat, Chandra Shekhar Nautiyal

140.	United States of America	10041086	A method for production of transgenic cotton plant.	Samir Viswanath Sawant, Rajiv Kumar Tripathi, Asif Idris
141.	United States of America	10111427	A novel formulation for improving the yield and quality of fiber in cotton plants	Samir Viswanath Sawant, Sunil Kumar Singh, Babita Singh, Parthasarathi Bhattacharya
142.	United States of America	10006014	A process for preparation of a novel insecticidal chitinase toxic against whiteflies, it"s encoding nucleotides and application there off	Pradhyumna Kumar Singh, Santosh Kumar Upadhyay, Chandrashekar Krishnappa, Sharad Saurabh, Rahul Singh, Preeti Rai, Harpal Singh, Manisha Mishra, Ajit Pratap Singh, Praveen Chandra Verma, Kuttan Pillai Narayanan Nair, Rakesh Tuli
CSIR-NCL				
S.No	**Country**	**Patent No**	**Title of Invention**	**Inventors**
143.	Belgium	3097141	Blend membranes based on polybenzimidazole (PBI) and polymeric ionic liquids (PILs)	Ulhas Kanhaiyalal Kharul, Sreekumar Kurungot, Anita Sanwarmal Rewar, Harshal Dilip Chaudhari
144.	Belgium	3097111	A Novel process for conversion of hemicellulose into C5 sugars	Paresh Laxmikant Dhepe, Babasaheb Mansub Matsagar
145.	Belgium	2841624	Porous co3o4 nanorods for photoelectrochemical water splitting	Pattayil Alias Joy, Vijayamohanan Kunjikrishnan Pillai, Ramsundar Mohan Rani, Joyashish Debgupta
146.	Brazil	BR112012017478-9	Hydrolysis of hemicellulose by heterogeneous catalysts	Dhepe Paresh, Sahu Ramakanta
147.	Canada	2767516	Continuous flow process for the preparation of sulphoxide compounds	Amol Arvind Kulkarni, Ramesh Anna Joshi, Rohini Ramesh Joshi, Nayana Tushar Nivangune, Manisha Abhiman Jagtap

148.	Switzerland	3089985	Silicon-based Fungicides	Dumbala Srinivasa Reddy, Gorakhnath Rajaram Jachak, Remya Ramesh, Santosh Genba Tupe, Mukund Vinayak Deshpande
149.	Germany	2766111	Continuous modular reactor	Vivek Vinayak Ranade, Amol Arvind Kulkarni
150.	Germany	2274262	Method for the preparation of biofuels from glycerol	Dharbha Srinivas, Lakshmi Saikia, Paul Ratnasamy
151.	Germany	2885401	In situ PH management using hydrogel and applications thereof	Mugdha Chetan Gadgil
152.	Germany	2766383	A process for the production of low molecular weight peptides from gelatine	Ramchandra Vithal Gadre, Vithal Venkatrao Jogdand, Sanjay Narayan Nene
153.	Germany	3097111	A Novel process for conversion of hemicellulose into C5 sugars	Paresh Laxmikant Dhepe, Babasaheb Mansub Matsagar
154.	Germany	3089985	Silicon-based Fungicides	Dumbala Srinivasa Reddy, Gorakhnath Rajaram Jachak, Remya Ramesh, Santosh Genba Tupe, Mukund Vinayak Deshpande
155.	Germany	3013809	Process for producing furan and its derivatives	Darbha Srinivas, Bhogeswararao Seemala
156.	Germany	3097141	Blend membranes based on polybenzimidazole (PBI) and polymeric ionic liquids (PILs)	Ulhas Kanhaiyalal Kharul, Sreekumar Kurungot, Anita Sanwarmal Rewar, Harshal Dilip Chaudhari
157.	Germany	3186260	Novel Metal Coordination Complex for Multi-Action Naked Eye Colorimetric Anion Sensor	Vedavati Gururaj Puranik, Rajesh Ghanshyam Gonnade, Rupesh Liladhar Gawade
158.	Germany	2880041	Aryl phosphonates and process for the preparation thereof	Santosh Baburao Mhaske, Ranjeet Ashokrao Dhokale

159.	Germany	2763999	Water soluble mofs	Rahul Banerjee, Subhash Chandra Sahoo, Tanay Kundu
160.	Germany	2804832	Reversible switching between super hydrophobic and super hydrophilic states	K Krishnamoorthy
161.	Germany	2709979	Catalytic dehydration of lactic acid to acrylic acid	Mohan Keraba Dongare, Shubhangi Bhalchandra Umbarkar, Samadhan Tanaji Lomate
162.	Germany	3233816	New Difunctional Monomers Containing Clickable Pendant Furyl Group and Polymers Therefrom	Kavita Garg, Deepshikha Chatterjee, Prakash Purushottam Wadgaonkar
163.	Germany	1945354	Transesterification catalyst, process for preparation thereof and a process for transesterification using the catalyst	Darbha Srinivas, Rajendra Srivastava, Paul Ratnasamy
164.	European Patent Office	2885401	In situ ph management using hydrogel and applications thereof	Mugdha Chetan Gadgil
165.	European Patent Office	3019498	Hunanamycin a and its analogs: synthesis and uses thereof	Dumbala Srinivasa Reddy, Rahul Dilip Shingare, Velayudham Ramdoss
166.	European Patent Office	2841624	Porous co3o4 nanorods for photoelectrochemical water splitting	Pattayil Alias Joy, Vijayamohanan Kunjikrishnan Pillai, Ramsundar Mohan Rani, Joyashish Debgupta
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170.	European Patent Office	3089985	Silicon-based Fungicides	Dumbala Srinivasa Reddy, Gorakhnath Rajaram Jachak, Remya Ramesh, Santosh Genba Tupe, Mukund Vinayak Deshpande
171.	European Patent Office	2766383	A process for the production of low molecular weight peptides from gelatine	Ramchandra Vithal Gadre, Vithal Venkatrao Jogdand, Sanjay Narayan Nene
172.	European Patent Office	3097141	Blend membranes based on polybenzimidazole (PBI) and polymeric ionic liquids (PILs)	Ulhas Kanhaiyalal Kharul, Sreekumar Kurungot, Anita Sanwarmal Rewar, Harshal Dilip Chaudhari
173.	European Patent Office	3063281	A simple & efficient preparation of enantiomerically pure (R)- alcohol	Dipesh Dattu Jadhav, Nilofer Jahan Khairunnasar Siddiqui, Swati Pramod Kolet, Hirekodathakallu Venkataramaiah Thulasiram
174.	European Patent Office	3013809	Process for producing furan and its derivatives	Darbha Srinivas, Bhogeswararao Seemala
175.	European Patent Office	3186260	Novel Metal Coordination Complex for Multi-Action Naked Eye Colorimetric Anion Sensor	Vedavati Gururaj Puranik, Rajesh Ghanshyam Gonnade, Rupesh Liladhar Gawade
176.	European Patent Office	2709979	Catalytic dehydration of lactic acid to acrylic acid	Mohan Keraba Dongare, Shubhangi Bhalchandra Umbarkar, Samadhan Tanaji Lomate
177.	European Patent Office	3097111	A Novel process for conversion of hemicellulose into C5 sugars	Paresh Laxmikant Dhepe, Babasaheb Mansub Matsagar
178.	European Patent Office	2766111	Continuous modular reactor	Vivek Vinayak Ranade, Amol Arvind Kulkarni
179.	European Patent Office	3233816	New Difunctional Monomers Containing Clickable Pendant Furyl Group and Polymers Therefrom	Kavita Garg, Deepshikha Chatterjee, Prakash Purushottam Wadgaonkar

180.	European Patent Office	1945354	Transesterification catalyst, process foer preparation thereof and a process for transesterification using the catalyst	Darbha Srinivas, Rajendra Srivastava, Paul Ratnasamy
181.	European Patent Office	2812333	Pyrroloquinoline alkaloids and process for the preparation thereof	Santosh B.Mhaske, Jyoti R. Lande
182.	European Patent Office	2274262	Method for the preparation of biofuels from glycerol	Dharbha Srinivas, Lakshmi Saikia, Paul Ratnasamy
183.	Spain	2766111	Continuous modular reactor	Vivek Vinayak Ranade, Amol Arvind Kulkarni
184.	France	2766111	Continuous modular reactor	Vivek Vinayak Ranade, Amol Arvind Kulkarni
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186.	France	2274262	Method for the preparation of biofuels from glycerol	Dharbha Srinivas, Lakshmi Saikia, Paul Ratnasamy
187.	France	3019498	Hunanamycin a and its analogs: synthesis and uses thereof	Dumbala Srinivasa Reddy, Rahul Dilip Shingare, Velayudham Ramdoss
188.	France	3097141	Blend membranes based on polybenzimidazole (PBI) and polymeric ionic liquids (PILs)	Ulhas Kanhaiyalal Kharul, Sreekumar Kurungot, Anita Sanwarmal Rewar, Harshal Dilip Chaudhari
189.	France	3233816	New difunctional monomers containing clickable pendant furyl group and polymers therefrom	Kavita Garg, Deepshikha Chatterjee, Prakash Purushottam Wadgaonkar

190.	France	2709979	Catalytic dehydration of lactic acid to acrylic acid	Mohan Keraba Dongare, Shubhangi Bhalchandra Umbarkar, Samadhan Tanaji Lomate
191.	France	3063281	A simple & efficient preparation of enantiomerically pure (r)- alcohol	Dipesh Dattu Jadhav, Nilofer Jahan Khairunnasar Siddiqui, Swati Pramod Kolet, Hirekodathakallu Venkataramaiah Thulasiram
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193.	France	1945354	Transesterification catalyst, process foer preparation thereof and a process for transesterification using the catalyst	Darbha Srinivas, Rajendra Srivastava, Paul Ratnasamy
194.	United Kingdom	2709979	Catalytic dehydration of lactic acid to acrylic acid	Mohan Keraba Dongare, Shubhangi Bhalchandra Umbarkar, Samadhan Tanaji Lomate
195.	United Kingdom	1945354	Transesterification catalyst, process foer preparation thereof and a process for transesterification using the catalyst	Darbha Srinivas, Rajendra Srivastava, Paul Ratnasamy
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208.	United Kingdom	3013809	Process for producing furan and its derivatives	Darbha Srinivas, Bhogeswararao Seemala
209.	Indonesia	IDP000051041	Antitubercular agents	Dhiman Sarkar, Sampa Sarkar, Rohit Ramesh Joshi, Vijay Murlidhar Khedkar, Raghuvir Ramakant Pissurlenkar, Evans Cliffton Coutinho, Anamik Kantilal Shah

210.	Japan	6463760	ABPBI co-polymers and their synthesis thereof	Ulhas Kanhaiyalal Kharul, Kurungot Sreekumar, Harshal Dilip Chaudhari, Vinaya Bhagwat Ghodake
211.	Japan	6474392	Stereospecific and proficient synthesis of seven membered sulfide: its application for Tamiflu synthesis	Subhash Prataprao Chavan, Prakash Narsing Chavan
212.	Japan	6474808	Novel indazole compounds, preparation and uses thereof	Dumbala Srinivasa Reddy, Chaitanya Saxena, Kashinath Komirishetty
213.	Japan	6395812	Acidic Ionic Liquids catalyzed depolymerization of lignin	Dhepe Paresh Laxmikant, Ashutosh Anant Kelkar, Babasaheb Mansub Matsagar, Sandip Kumar Singh
214.	South Korea	10-1850954	Abpbi based porous membranes	Ulhas Kanhaiyalal Kharul, Harshada Ramesh Lohokare
215.	South Korea	10-1920092	Electrochemical process for synthesis of graphene	Dhanraj Bhagwanrao Shinde, Vijayamohanan Kunjikrishnan Pillai
216.	South Korea	101954381	A novel nano-heterojunction synthesis of catalyst free vertically aligned cnts on sinw arrays	Manjusha Vilas Shelke
217.	South Korea	10-1858140	A process for the removal of polymer thermosets from the specific substrate	Kothandam Krishnamoorthy
218.	Netherlands	2880041	Aryl phosphonates and process for the preparation thereof	Santosh Baburao Mhaske, Ranjeet Ashokrao Dhokale
219.	Philippines	1-2012-502370	Antitubercular agents	Dhiman Sarkar, Sampa Sarkar, Rohit Ramesh Joshi, Vijay Murlidhar Khedkar, Raghuvir Ramakant Pissurlenkar, Evans Cliffton Coutinho, Anamik Kantilal Shah

220.	Russia	2649951	PCDA-PHBV electrospun adherent mats as authentication feature	Premnath Venugopalan, Jyoti Prakash Jog, Sachin Dubey, Usman Khan
221.	Russia	2671688	Nitrite Reductase as a drug target/Biomarker for Mycobacterium tuberculosis detection.	Dhiman Sarkar
222.	United States of America	10144712	Novel N-heterocylic compounds and preparation thereof	Balaraman Ekambaram, Vinod Gokulkrishna Landge
223.	United States of America	10029240	Synthesis of Functionalized carbon microspheres and their catalyst activity in C-O and C-N bond formation reactions	Ankush Venkatrao Biradar, Shubhangi Bhalchandra Umbarkar, Mohan Keraba Dongare
224.	United States of America	10170770	N-doped Porous Carbon derived from Graphitic C3N4-MOF Composite as efficient non-metal Electrocatalyst	Sreekumar Kurungot, Rahul Banerjee, Sekar Pandiaraj, Harshitha Barike Aiyappa
225.	United States of America	10,005,706	Novel method to introduce chiral silane in crystalline tetrahedral framework of porous silicate and metallo-silicate materials	Anil Kisan Kinage, Balasaheb Rajendra Javale, Pralhad Arjun Burate
226.	United States of America	9,988,337	One step process for conversion of ethyl acetate to butyl acetate	Vijay Vasant Bokade
227.	United States of America	10058575	A probiotic composition comprising the novel isolated bacterial strain of brevebacterium casei ap9	Hrishikesh Vinayak Mungi, Pooja Vijay Ghushe, Avinash Vellore Sunder, Archana Vishnu Pundle
228.	United States of America	10239865	Novel bisphenols containing pendant clickable maleimide group and polymers therefrom	Samadhan Suresh Nagane, Sachin Suresh Kuhire, Prakash Purushottam Wadgaonkar

229.	United States of America	9931309	Sophorolipid mediated enhancement of curcumin bioavailability and synergistic effect for cyto-toxicity of cancer cell lines	Pradeep Kumar Singh, Asmita Ashutosh Prabhune, Satishchandra Balkrishna Ogale
230.	United States of America	10239836	Novel analogues of benzenecarbothioccyclopenta[c] pyrrole-1,3-dioneand synthesis thereof	Dumbala Srinivasa Reddy, Satish Chandra Philkhana, Gorakhnath Rajaram Jachak, Vidya Bhausaheb Gunjal
231.	United States of America	10081720	Polypropylene compositions for reduced necking in extrusion film casting or extrusion coating processes	Kalyani Suresh Chikhalikar, Ashish Kishore Lele, Harshwardhan Vinayak Pol, Kishor Shankar Jadhav, Sunil Janardan Mahajan, Zubair Ahmad
232.	United States of America	9981923	Novel 1,2,3 Triazole Antifungal Agents and their preparation thereof	Venkata Ramana Chepuri, Mukund Vinayak Deshpande, Santosh Genba Tupe, Yadagiri Kommagala
233.	United States of America	10155776	Method for Selective detection and estimation of Histidine and Cysteine	Amitava Das, Samit Chattopadhyay, Upendar Reddy Gandra, Hridesh Agarwalla
234.	United States of America	10227355	Novel quinoline derivatives and process for preparing the same	Ekambaram Balaraman, Siba Prasad Midya, Garima Jaiswal
235.	United States of America	10216910	Simulated carbon and proton NMR chemical shift based binary fingerprints for virtual screening	Muthukumarasamy Karthikeyan, Renu Vyas, Pattuparambil Ramanpillai Rajamohanan
236.	United States of America	10030002	Novel coumarin ligand useful for selective determination of cysteine and and process for the preparation thereof	Amitava Das, Anila Ashoka Hoskere, Upendar Reddy Gandra, Firoj Ali
237.	United States of America	9,975,913	A catalytic probe for in-gel visual defection of bioanalytes	Sayam Sen Gupta, Sushma Kumari, Chakadola Panda

238.	United States of America	10053472	Silicon-based Fungicides	Dumbala Srinivasa Reddy, Gorakhnath Rajaram Jachak, Remya Ramesh, Santosh Genba Tupe, Mukund Vinayak Deshpande
239.	United States of America	9,975,101	A process for preparation of self-healing microcapsules	Parshuram Gajanan Shukla, Arun Savalaram Jadhav
240.	United States of America	10,000,527	Novel bile acid derivatives and process for the preparation thereof	Pore Vandana Sudhir, Jaisingh Manohar Divse, Chaitanya Rajendra Charolkar
241.	United States of America	9944617	Novel metal free catalyst for selective oxidation of hydrocarbons	Satyanarayana Vera Venkata Chilukuri, Narasimharao Kanna, Lakshmiprasad Gurrala
242.	United States of America	9956537	Tube in tube continuous glass lined reactors	Amol Arvind Kulkarni, Vivek Vinayak Ranade
243.	United States of America	9,993,795	Glass lined microreactors	Amol Arvind Kulkarni, Vivek Vinayak Ranade
244.	United States of America	10195158	Bioactive oil based polyesteramide nanofibers and applications in wound healing	Rathna Venkata Naga Gundloori
245.	United States of America	10221122	An enantiospecific process for the preparation of (R) and (S) enantiomers of sex pheromones	Dumbala Srinivasa Reddy, Remya Ramesh
246.	United States of America	10023891	A simple & efficient preparation of enantiomerically pure (R)- alcohol	Dipesh Dattu Jadhav, Nilofer Jahan Khairunnasar Siddiqui, Swati Pramod Kolet, Hirekodathakallu Venkataramaiah Thulasiram
247.	United States of America	9944579	Catalytic hydrogenation process for the synthesis of terminal diols from dialkyl aliphatic esters	Balaraman Ekambaram, Manoj Kumar Sahoo

248.	United States of America	10106487	Oxidative dehydrogenation of lactate to pyruvate	Shubhangi Bhalchandra Umbarkar, Mohan Keraba Dongare, Swati Laxmikantrao Pandhare, Sonali Balasaheb Khomane, Dhananjay Shahauraj Doke
249.	United States of America	10054597	A method for identifying and quantifying AGE modified haemoglobin	Mahesh Jagdishrao Kulkarni, Jagadeeshaprasad Guddadarangaiah Mashanipalya, Kedar Balaji Batkulwar, Moneesha Fernandes
250.	United States of America	9988272	Laser-induced dissociative stitching (LDS) for synthesis of carbon and carbon based nanocomposites	Rohan Rajeev Gokhale, Satishchandra Balkrishna Ogale
251.	United States of America	10131698	Designing novel synthetic antimicrobial peptides	Shuchishweta Vinay Kendurkar, Durba Sengupta
252.	United States of America	10221165	Novel flavone based EGFR inhibitors	Pradeep Kumar, Jignesh Kantilal Parikh, Eeshwaraiah Begari
253.	United States of America	9988413	A Novel process for conversion of hemicellulose into C5 sugars	Paresh Laxmikant Dhepe, Babasaheb Mansub Matsagar
254.	United States of America	10023774	Improved adhesive composition and uses thereof	Kundalik Ganpat Raut, Manohar Virupax Badiger, Sivaram Swaminathan, Vivek Vitthal Kodigire, Rajeshwari Shyamji Gour
255.	United States of America	9950311	Magnetically recoverable high surface area mof based synthesis of carbon based nanocomposite	Abhik Banerjee, Satishchandra Balkrishna Ogale
256.	United States of America	10052692	A method for the preparation of ultra-small size (2-3 NM) transition metal nanoparticles	Prasad Lakshmi Vara Bhagavatula, Jhumur Seth

257.	United States of America	10023705	ABPBI co-polymers and their synthesis thereof	Ulhas Kanhaiyalal Kharul, Kurungot Sreekumar, Harshal Dilip Chaudhari, Vinaya Bhagwat Ghodake
258.	United States of America	10106432	Sol-Gel Process for Synthesis of Nanocrystalline Oxides	Venkata Ravi Kumar Darbha, Lakhsmi Vara Prasad Bhagavatula, Amol Arvind Kulkarni
259.	United States of America	10017583	Synthesis of nanostructured carboxycelluloses from non-wood cellulose	Anjanikumar Jyotiprasad Varma, Priyanka Radheyshyam Sharma
260.	United States of America	10218006	Nitrogen doped carbon nanohorns as enhanced electro catalysts	Sreekumar Kurungot, Sreekuttan Maraveedu Unni, Sarath Ramadas
261.	United States of America	9,987,599	Asymmetric membranes based on bupbi	Ulhas Kanhaiyalal Kharul, Deepti Gangaram Bhagat, Harshal Dilip Chaudhari
262.	United States of America	9950983	Novel tricyclic compounds, process for synthesis and use thereof	Dumbala Srinivasa Reddy, Kishor Laxman Handore
263.	United States of America	9950996	Novel aromatic diisocyanates and polyurethanes therefrom	Prakash Purushottam Wadgaonkar, Sachin Suresh Kuhire
264.	United States of America	10195599	Synthesis of Functionalized carbon microspheres and their catalyst activity in C-O and C-N bond formation reactions	Ankush Venkatrao Biradar, Shubhangi Bhalchandra Umbarkar, Mohan Keraba Dongare
265.	United States of America	9994602	Library of spiroannulated nucleosides	Chepuri Venkata Ramana, Mangesh Pandurang Dushing
266.	United States of America	10121604	New synthesis of multilayer fullerenes and its nanocomposite with transition metal oxide for energy storage	Manjusha Vilas Shelke, Vedi Kuyil Azhagan Muniraj, Mukta Vinayak Vaishampayan

CSIR-NEIST				
S.No	**Country**	**Patent No**	**Title of Invention**	**Inventors**
267.	European Patenot Office	2863903	A synergistic pharmaceutical composition useful for the treatment of lung cancer	Mantu Bhuyan, Pranab Ram Bhattacharyya, Pranab Kumar Baruah, Nabin Chandra Barua, Paruchuri Gangadhar Rao, Sushmita Bhattacharya, Rakesh Kundu, Priyajit Chatterjee, Soma Seal, Sandeep Mukherjee, Suman Dasgupta, Sudipta Moitra, Shelley Bhattacharya, Samir Bhattacharya
CSIR-NGRI				
S.No	**Country**	**Patent No**	**Title of Invention**	**Inventors**
268.	European Patent Office	2089738	An exact algebric formula for the impulse response of a plane acoustic reflector at zero offset due to a point acoustic source	Santi Kumar Ghosh
CSIR-NIIST				
S.No	**Country**	**Patent No**	**Title of Invention**	**Inventors**
269.	China	CN106414618B	New Inorganic Blue pigments from Cobalt doped Magnesium having Transition Element Oxides and a Process for the preparing the same	Padala Prabhakar Rao, Saraswathy Divya
270.	Japan	6360896	A squaraine based fluorescent probe for selective labeling and sensing of serum albumin proteins, ph monitoring and thiol imaging in cells and a process for the preparation thereof	Ayyappanpillai Ajayaghosh, Palappuravan Anees

271.	United States of America	10035914	Inorganic Blue pigments from Cobalt doped Magnesium having Transition Element Oxides and a Process for the preparing the same	Padala Prabhakar Rao, Saraswathy Divya
272.	United States of America	9993814	Semiconductor-oxides nanotubes-based composite particles useful for dye-removal and process thereof	Shukla Satyajit Vishnu, Padinhattayil Hareesh, Narayani Harsha, Jose Manu, Karunakaran Remya
273.	United States of America	10144722	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
CSIR-NMITLI				
S.No	**Country**	**Patent No**	**Title of Invention**	**Inventors**
274.	Argentina	AR066825B1	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
275.	Canada	2689306	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
276.	South Korea	10-1866766	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

CSIR-NPL				
S.No	**Country**	**Patent No**	**Title of Invention**	**Inventors**
277.	African Regional Intellectual Property Organization	AP4571	Nucleic acid primers and probe for detection of neisseria gonorrhoeae	Seema Sood, Rachna Verma, Renu Singh, Sumana Gajjala, Manju Bala, Jyotish Chandra Sumantaray, Manoj Kumar Pandey, Bansi Dhar Malhotra
278.	China	ZL201480061558.9	Nanostructured copper-selenide (CU2SE) with high thermoelectric figure-of-merit and process for the preparation thereof	Bhasker Gahtori, Sivaiah Bathula, Kriti Tyagi, Avanish Kumar Srivastava, Ajay Dhar, Ramesh Chandra Budhani
279.	Germany	112007003312	A novel method for joining oxide-superconducting tubes with a superconducting joint	Shrikant Narayan Ekbote, Gursharan Kaur Padam, Narendra Kumar Arora, Mukul Sharma, Ramesh Sethi
280.	Japan	6336947	Low cost and high yield electrospun poly(vinyl alcohol) based carbon nanofibers	Sanjay Rangnath Dhakate, Ashish Gupta, Anisha Chaudhary, Rakesh Behari Mathur
281.	Russia	2675417	Boron doped manganese antimonide as a useful permanent magnet material	Nidhi Singh, Jiji Thomas Joseph Pulikkotil, Anurag Gupta, Kanika Anand, Ajay Dhar, Ramesh Chandra Budhani
282.	United States of America	10074453	A novel process for the development of P-toluenesulfonate doped polypyrrole/ carbon composite electrode and a preparation of the same electrode for supercapacitor	Amit Kumar, Hari Krishna Singh, Rajiv Kumar Singh, Ramadhar Singh, Pankaj Srivastava
283.	United States of America	10115456	Multi-states nonvolatile opto-ferroelectric memory element and its process thereof	Ashok Kumar, Hitesh Borkar, Vaibhav Rao, Monika Tomar, Vinay Gupta

284.	United States of America	9968999	Boron doped manganese antimonide as a useful permanent magnet material	Nidhi Singh, Jiji Thomas Joseph Pulikkotil, Anurag Gupta, Kanika Anand, Ajay Dhar, Ramesh Chandra Budhani
285.	United States of America	10,003,075	Carbon nanotube-metal nanocomposites as flexible, free standing, binder free high performance anode for li -ion battery	Heda Priyanka Maheshwari, Indu Elizabeth, Bhanu Pratap Singh, Chanchal Gupta, Rakesh Behari Mathur, Gopukumar Sukumaran

ANNEXURE - IV

Publications (Area-wise Research Publications (TOP 25 Papers) by CSIR Labs)

Area-wise Research Publications (TOP 25 Papers) by CSIR Labs

BIOLOGICAL SCIENCES

BASED ON IMPACT FACTOR OF THE JOURNALS

S.No.	Lab	First three Author	Journals	IF-2018
1.	IGIB	Fullman, N; Yearwood, J; Abay	LANCET, 2018 Vol. 391, Iss. 10136	59.102
2.	IGIB	Dicker, D; Nguyen, G; Abate, D;	LANCET, 2018, Vol. 392, Iss. 10159, pp. 1684 - 1735	59.102
3.	IGIB, IITR	Roth, GA; Abate, D; Abate, KH	LANCET, 2018, Vol. 392, Iss. 10159, pp. 1736 - 1788	59.102
4.	IGIB, IITR	Stanaway, JD; Afshin, A; Gakidou, E	LANCET, 2018, Vol. 392, Iss. 10159, pp. 1923 - 1994	59.102
5.	IGIB, IITR	Lozano, R; Fullman, N; Abate, D	LANCET, 2018, Vol. 392, Iss. 10159, pp. 2091 - 2138	59.102
6.	CCMB	Sharma, AK	NATURE, 2018, Vol. 554, Iss. 7691, pp. 169 - 169	43.07
7.	IGIB	Proto, JD; Doran, AC; Gusarova, G	IMMUNITY, 2018, Vol. 49, Iss. 4, pp. 666 - +	21.522
8.	IGIB	Salvi, S; Kumar, GA; Dhaliwal, RS	LANCET GLOBAL HEALTH, 2018, Vol. 6, Iss. 12, pp. E1363, E1374	15.873
9.	CFTRI	Wisser, D; Karthikeyan, G; Lund, A	JOURNAL OF THE AMERICAN CHEMICAL SOCIETY, 2018, Vol. 140, Iss. 41, pp. 13340 - 13349	14.695
10.	IICB	Bhunia, D; Mondal, P; Das, G	JOURNAL OF THE AMERICAN CHEMICAL SOCIETY, 2018, Vol. 140, Iss. 5, pp. 1697 - 1714	14.695
11.	NBRI	Singh, BN; Singh, BR; Gupta, VK	TRENDS IN BIOTECHNOLOGY, 2018, Vol. 36, Iss. 11, pp. 1103 - 1106	13.747
12.	IICB	Ganguly, D	TRENDS IN IMMUNOLOGY, 2018, Vol. 39, Iss. 1, pp. 28 - 43	13.000

Patents data

13.	IGIB	Proto, JD; Doran, AC; Subramanian, M	JOURNAL OF CLINICAL INVESTIGATION, 2018, Vol. 128, Iss. 6, pp. 2370 - 2375	12.282
14.	CCMB	Kuncha, SK; Mazeed, M; Singh, R	NATURE COMMUNICATIONS, 2018, Vol. 9	11.878
15.	IGIB	Tripathi, V; Agarwal, H; Priya, S	NATURE COMMUNICATIONS, 2018, Vol. 9	11.878
16.	IIIM	Thottacherry, JJ; Kosmalska, AJ; Kumar, A	NATURE COMMUNICATIONS, 2018, Vol. 9	11.878
17.	IGIB	Motiani, RK; Tanwar, J; Raja, DA	EMBO JOURNAL, 2018, Vol. 37, Iss. 5	11.227
18.	IGIB	Sarangdhar, MA; Chaubey, D; Srikakulam, N	NUCLEIC ACIDS RESEARCH, 2018, Vol. 46, Iss. 18, pp. 9726 - 9735	11.147
19.	IICB	Sengupta, P; Banerjee, N; Roychowdhury, T	NUCLEIC ACIDS RESEARCH, 2018, Vol. 46, Iss. 19, pp. 9932 – 9950	11.147
20.	IMTech	Deep, A; Tiwari, P; Agarwal, S	NUCLEIC ACIDS RESEARCH, 2018, Vol. 46, Iss. 21, pp. 11639- 11655	11.147
21.	IMTech	Rajput, A; Thakur, A; Sharma, S	NUCLEIC ACIDS RESEARCH, 2018, Vol. 46, Iss. D1, pp. D894 - D900	11.147
22.	IMTech	Singh, N; Kansal, P; Ahmad, Z	AUTOPHAGY, 2018, Vol. 14, Iss. 6, pp. 972 - 991	11.059
23.	CCMB	Vizcaya-Molina, E; Klein, CC; Serras, F	GENOME RESEARCH, 2018, Vol. 28, Iss. 12, pp. 1852 - 1866	9.944
24.	CIMAP, CDRI	Awasthi, H; Mani, D; Singh, D	MEDICINAL RESEARCH REVIEWS, 2018, Vol. 38, Iss. 6, pp. 2024 - 2057	9.791
25.	CFTRI	Akshath, US; Bhatt, P	BIOSENSORS & BIOELECTRONICS, 2018, Vol. 100, pp. 201 - 207	9.518

Area-wise Research Publications (TOP 25 Papers) by CSIR Labs

CHEMICAL SCIENCES

BASED ON IMPACT FACTOR OF THE JOURNALS

S.No.	Lab	First three Author	Journals	IF-2018
1.	CSMCRI	Bhadra, S; Yamamoto, H	CHEMICAL REVIEWS, 2018, Vol. 118, Iss. 7, pp. 3391 - 3446	54.301
2.	CECRI	Anantharaj, S; Ede, SR; Karthick, K	ENERGY & ENVIRONMENTAL SCIENCE, 2018, Vol. 11, Iss. 4, pp. 744 - 771	33.25
3.	CSMCRI	Jiang, ZW; Karan, S; Livingston, AG	ADVANCED MATERIALS, 2018, Vol. 30, Iss. 15, Art. No. 1705973	25.809
4.	NCL	Pansare, AV; Khairkar, SR; Shedge, AA	ADVANCED MATERIALS, 2018, Vol. 30, Iss. 33, Art. No. 1801523	25.809
5.	NCL	Haldar, S; Roy, K; Nandi, S	ADVANCED ENERGY MATERIALS, 2018, Vol. 8, Iss. 8, Art. No. 1702170	24.884
6.	IITR	Mandal, D; Mallick, D; Shaik, S	ACCOUNTS OF CHEMICAL RESEARCH, 2018, Vol. 51, Iss. 1, pp. 107 - 117	21.661
7.	NIIST	Pancrecious, JK; Ulaeto, SB; Ramya, R	INTERNATIONAL MATERIALS REVIEWS, 2018, Vol. 63, Iss. 8, pp. 488 - 512	21.086
8.	CSMCRI	Chatterjee, S; Paital, AR	ADVANCED FUNCTIONAL MATERIALS, 2018, Vol. 28, Iss. 9, Art. No.1704726	15.621
9.	NCL	Halder, A; Ghosh, M; Khayum, MA	JOURNAL OF THE AMERICAN CHEMICAL SOCIETY, 2018, Vol. 140, Iss. 35, pp. 10941 - 10945	14.695
10.	NCL	Karak, S; Kumar, S; Pachfule, P	JOURNAL OF THE AMERICAN CHEMICAL SOCIETY, 2018, Vol. 140, Iss. 15, pp. 5138 - 5145	14.695
11.	NCL	Pandey, S; Raj, KV; Shinde, DR	JOURNAL OF THE AMERICAN CHEMICAL SOCIETY, 2018, Vol. 140, Iss. 12, pp. 4430 - 4439	14.695
12.	CSMCRI	Natarajan, TS; Thampi, KR; Tayade, RJ	APPLIED CATALYSIS B-ENVIRONMENTAL, 2018, Vol. 227, Iss. , pp. 296 - 311	14.229

13.	NCL	Dama, S; Ghodke, SR; Bobade, R	APPLIED CATALYSIS B-ENVIRONMENTAL, 2018, Vol. 224, Iss. , pp. 146 - 158	14.229
14.	NCL	Liu, J; Xiong, RH; Brans, T	LIGHT-SCIENCE & APPLICATIONS, 2018, Vol. 7, Iss. , Art.No. 47	14
15.	CECRI	Liu, W; Ulaganathan, M; Abdelwahab, I	ACS NANO, 2018, Vol. 12, Iss. 1, pp. 852 - 860	13.903
16.	IICT	Singh, S; Samineni, R; Pabbaraja, S	ANGEWANDTE CHEMIE-INTERNATIONAL EDITION, 2018, Vol. 57, Iss. 51, pp. 16847 - 16851	12.257
17.	NCL	Sasmal, HS; Aiyappa, HB; Bhange, SN	ANGEWANDTE CHEMIE-INTERNATIONAL EDITION, 2018, Vol. 57, Iss. 34, pp. 10894 - 10898	12.257
18.	NCL	Vijayakanth, T; Srivastava, AK; Ram, F	ANGEWANDTE CHEMIE-INTERNATIONAL EDITION, 2018, Vol. 57, Iss. 29, pp. 9054 - 9058	12.257
19.	NCL	Ozaki, T; Shinde, SS; Gao, L	ANGEWANDTE CHEMIE-INTERNATIONAL EDITION, 2018, Vol. 57, Iss. 22, pp. 6629 - 6632	12.257
20.	NCL	Halder, A; Karak, S; Addicoat, M	ANGEWANDTE CHEMIE-INTERNATIONAL EDITION, 2018, Vol. 57, Iss. 20, pp. 5797 - 5802	12.257
21.	NCL	Gade, AB; Bagle, PN; Shinde, PS	ANGEWANDTE CHEMIE-INTERNATIONAL EDITION, 2018, Vol. 57, Iss. 20, pp. 5735 - 5739	12.257
22.	NCL	Di Leva, FS; Tomassi, S; Di Maro, S	ANGEWANDTE CHEMIE-INTERNATIONAL EDITION, 2018, Vol. 57, Iss. 44, pp. 14645 - 14649	12.257
23.	NCL, NIIST	Mal, A; Mishra, RK; Praveen, VK	ANGEWANDTE CHEMIE-INTERNATIONAL EDITION, 2018, Vol. 57, Iss. 28, pp. 8443 - 8447	12.257
24.	NEIST	Kaishap, PP; Duarah, G; Sarma, B	ANGEWANDTE CHEMIE-INTERNATIONAL EDITION, 2018 , Vol. 57, Iss. 2, pp. 456-460	12.257
25.	CECRI	Anantharaj, S; Amarnath, TS; Subhashini, E	ACS CATALYSIS, 2018, Vol. 8, Iss. 7, pp. 5686-5697	12.221

Area-wise Research Publications (TOP 25 Papers) by CSIR Labs

ENGINEERING SCIENCES

BASED ON IMPACT FACTOR OF THE JOURNALS

S.No.	Lab	First three Author	Journals	IF-2018
1.	IMMT	Dutta, A; Mutyala, S; Samantara, AK	ACS ENERGY LETTERS	16.331
2.	CGCRI	Thakur, P; Kool, A; Hoque, NA	NANO ENERGY	15.548
3.	CGCRI	Ghosh, S; Remita, H; Basu, RN	APPLIED CATALYSIS B-ENVIRONMENTAL	14.229
4.	NEERI	Vidyasagar, D; Ghugal, SG; Kulkarni, A	APPLIED CATALYSIS B-ENVIRONMENTAL	14.229
5.	IMMT, CECRI	Mohanty, B; Ghorbani-Asl, M; Kretschmer, S	ACS CATALYSIS	12.221
6.	CMERI	Saha, S; Kumar, JS; Murmu, NC	JOURNAL OF MATERIALS CHEMISTRY A	10.733
7.	IMMT	Mishra, M; Mukherjee, I; Mall, AK	JOURNAL OF MATERIALS CHEMISTRY A	10.733
8.	CGCRI	Bodhak, S; de Castro, LF; Kuznetsov, SA	BIOMATERIALS	10.273
9.	CGCRI	Bera, S; Lee, SA; Kim, CM	CHEMISTRY OF MATERIALS	10.159
10.	CMERI	Shit, S; Chhetri, S; Fang, W	ACS APPLIED MATERIALS & INTERFACES	8.456
11.	CGCRI	Choudhury, PR; Majumdar, S; Sahoo, GC	CHEMICAL ENGINEERING JOURNAL	8.355
12.	CMERI	Saha, S; Samanta, P; Murmu, NC	CHEMICAL ENGINEERING JOURNAL	8.355
13.	NEERI	Khatri, J; Nidheesh, PV; Singh, SA	CHEMICAL ENGINEERING JOURNAL	8.355
14.	IMMT	Panda, S; Akcil, A; Mishra, S	JOURNAL OF HAZARDOUS MATERIALS	7.65
15.	NEERI	Malik, SN; Ghosh, PC; Vaidya, AN	JOURNAL OF HAZARDOUS MATERIALS	7.65

16.	NEERI	Maddigpu, PR; Sawant, B; Wanjari, S	JOURNAL OF HAZARDOUS MATERIALS	7.65
17.	NML	Mishra, D; Sahu, KK; Agrawal, A	JOURNAL OF HAZARDOUS MATERIALS	7.65
18.	AMPRI	Singh, B; Devi, N; Srivastava, AK	JOURNAL OF POWER SOURCES	7.467
19.	NAL	Prakash, BS; Pavitra, R; Kumar, SS	JOURNAL OF POWER SOURCES	7.467
20.	SERC, CECRI, CEERI	Steffy, NJ; Selvaganesh, SV; Kumar, LM	JOURNAL OF POWER SOURCES	7.467
21.	NML	Kumar, S	CARBON	7.466
22.	CGCRI	Sen, M; Dana, K; Das, N	ULTRASONICS SONOCHEMISTRY	7.279
23.	CGCRI	Chalisgaonkar, V; Das, M; Balla, VK	ADDITIVE MANUFACTURING	7.173
24.	NEERI	Podgorski, JE; Labhasetwar, P; Saha, D	ENVIRONMENTAL SCIENCE & TECHNOLOGY	7.149
25.	NEERI	Trent, M; Dreibelbis, R; Bir, A	ENVIRONMENTAL SCIENCE & TECHNOLOGY	7.149

Area-wise Research Publications (TOP 25 Papers) by CSIR Labs

PHYSICAL SCIENCES

BASED ON IMPACT FACTOR OF THE JOURNALS

S.No.	Lab	First three Author	Journals	IF-2018
1.	NPL	Annapureddy, V; Na, SM; Hwang, GT	ENERGY & ENVIRONMENTAL SCIENCE	33.25
2.	NPL	Palneedi, H; Park, JH; Maurya, D	ADVANCED MATERIALS	25.809
3.	CSIO	Vellingiri, K; Kim, KH; Pournara, A	PROGRESS IN MATERIALS SCIENCE	23.725
4.	NPL	Bharti, M; Singh, A; Samanta, S	PROGRESS IN MATERIALS SCIENCE	23.725
5.	CEERI	Khan, A; Islam, SM; Ahmed, S	ADVANCED SCIENCE	15.804
6.	NIO	Wijayawardene, NN; Pawlowska, J; Letcher, PM	FUNGAL DIVERSITY	15.596
7.	CEERI	Banerjee, D; Vallin, O; Samani, KM	NANO ENERGY	15.548
8.	NIO	Snelgrove, PVR; Soetaert, K; Solan, M	TRENDS IN ECOLOGY & EVOLUTION	15.236
9.	CSIO	Sundriyal, S; Kaur, H; Bhardwaj, SK	COORDINATION CHEMISTRY REVIEWS	13.476
10.	CSIO	Kempahanumakkagari, S; Vellingiri, K; Deep, A	COORDINATION CHEMISTRY REVIEWS	13.476
11.	NGRI	Panda, D; Kundu, B; Gahalaut, VK	NATURE COMMUNICATIONS	11.878
12.	NIO, CSIR-HQ	Naqvi, SWA; Lam, P; Narvenkar, G	NATURE COMMUNICATIONS	11.878
13.	NPL	Singh, G; Jouan, A; Benfatto, L	NATURE COMMUNICATIONS	11.878
14.	NGRI	Atsawawaranunt, K; Comas-Bru, L; Mozhdehi, SA	EARTH SYSTEM SCIENCE DATA	10.951

15.	CEERI	Khan, A; Habib, MR; Kumar, RR	JOURNAL OF MATERIALS CHEMISTRY A	10.733
16.	CSIO	Bhardwaj, SK; Bhardwaj, N; Kaur, R	JOURNAL OF MATERIALS CHEMISTRY A	10.733
17.	CSIO	Dutta, T; Kim, KH; Deep, A	RENEWABLE & SUSTAINABLE ENERGY REVIEWS	10.556
18.	CSIO	Kukkar, M; Mohantaa, GC; Tuteja, SK	BIOSENSORS & BIOELECTRONICS	9.518
19.	CSIO	Kumar, P; Kim, KH; Vellingiri, K	BIOSENSORS & BIOELECTRONICS	9.518
20.	CSIO	Shakti, D; Mathew, L; Kumar, N	BIOSENSORS & BIOELECTRONICS	9.518
21.	NPL	Singh, VK; Kumar, S; Pandey, SK	BIOSENSORS & BIOELECTRONICS	9.518
22.	NIO	Boyd, PW; Collins, S; Dupont, S	GLOBAL CHANGE BIOLOGY	8.88
23.	NPL	Kaur, H; Yadav, S; Srivastava, AK	NANO RESEARCH	8.515
24.	NPL	Singh, AK; Singh, S; Gupta, BK	ACS APPLIED MATERIALS & INTERFACES	8.456
25.	NPL	Palneedi, H; Maurya, D; Geng, LWD	ACS APPLIED MATERIALS & INTERFACES	8.456

Area-wise Research Publications (TOP 25 Papers) by CSIR Labs

INFORMATAION SCIENCES

BASED ON IMPACT FACTOR OF THE JOURNALS

S.No.	Lab	First three Author	Journals	IF-2018
1.	CSIR-4PI	Lin, X; Ciais, P; Bousquet, P	ATMOSPHERIC CHEMISTRY AND PHYSICS	5.668
2.	CSIR-4PI, CSIO	Dosseto, A; May, JH; Choi, JH;	QUATERNARY SCIENCE REVIEWS	4.641
3.	CSIR-4PI	Paul, S; Ghosh, S; Rajendran, K	GEOPHYSICAL RESEARCH LETTERS	4.578
4.	NISCAIR	Sengwa, RJ; Dhatarwal, P; Choudhary, S	JOURNAL OF MOLECULAR LIQUIDS	4.561
5.	NISCAIR	Sengwa, RJ; Choudhary, S; Dhatarwal, P	JOURNAL OF MOLECULAR LIQUIDS	4.561
6.	CSIR-4PI	Jayasankar, CB; Rajendran, K; Surendran, S	JOURNAL OF GEOPHYSICAL RESEARCH-ATMOSPHERES	3.633
7.	CSIR-4PI	Mitra, S; Priestley, KF; Borah, K	JOURNAL OF GEOPHYSICAL RESEARCH-SOLID EARTH	3.585
8.	NISCAIR	Srilatha, M; Chinnarao, D; Venkateswararao, B	SPECTROCHIMICA ACTA PART A-MOLECULAR AND BIOMOLECULAR SPECTROSCOPY	2.931
9.	NISCAIR	Sengwa, RJ; Dhatarwal, P; Choudhary, S	SOLID STATE IONICS	2.886
10.	NISTADS	Bhattacharya, S	SCIENTOMETRICS	2.77
11.	NISCAIR	Choudhary, S	JOURNAL OF PHYSICS AND CHEMISTRY OF SOLIDS	2.752
12..	CSIR-4PI	KanthaRao, B; Rakesh, V	THEORETICAL AND APPLIED CLIMATOLOGY	2.72
13.	CSIR-4PI	Parvez, IA; Nekrasova, A; Kossobokov, V	NATURAL HAZARDS	2.319
14.	CSIR-4PI	Joshi, AU; Sant, DA; Parvez, IA	INTERNATIONAL JOURNAL OF EARTH SCIENCES	2.295
15.	NISCAIR	Choudhary, S	POLYMER COMPOSITES	2.268

16.	NISCAIR	Choudhary, S	JOURNAL OF MATERIALS SCIENCE-MATERIALS IN ELECTRONICS	2.195
17.	NISCAIR	Choudhary, S; Sengwa, RJ	CURRENT APPLIED PHYSICS	2.01
18.	CSIR-4PI	Ningombam, SS; Jade, S; Shrungeshwara, TS	JOURNAL OF ATMOSPHERIC AND SOLAR-TERRESTRIAL PHYSICS	1.79
19.	CSIR-4PI	Mohapatra, GN; Rakesh, V; Mohanty, PK	METEOROLOGICAL APPLICATIONS	1.711
20.	NISCAIR	Choudhary, S	JOURNAL OF POLYMER RESEARCH	1.53
21.	CSIR-4PI	Ashish; Parvez, IA	PURE AND APPLIED GEOPHYSICS	1.466
22.	NISTADS	Dwivedi, S; Garg, KC	CURRENT SCIENCE	0.756
23.	NISTADS	Garg, KC; Kumar, S; Bebi	CURRENT SCIENCE	0.756
24.	NISTADS	Goswami, P; Nishad, S	CURRENT SCIENCE	0.756
25.	NISCAIR	Choudhary, S	INDIAN JOURNAL OF CHEMICAL TECHNOLOGY	0.614

ANNEXURE - V

Members of CSIR Governing Body

List of the Governing Body Members		
1.	**Dr. Shekhar C. Mande** Director General Council of Scienific and Industrial Research (CSIR) 2, Rafi Marg, New Delhi-110001	Chairman (ex-officio)
2.	**Shri Ajay Narayan Jha** Secretary (Expenditure) Ministry of Finance North Block New Delhi-110001	Member Finance (ex – officio)
3.	**Dr. Ram A. Vishwakarma** Director CSIR-Indian Institute of Integrative Medicine Canal Road Jammu – 180 001	Member
4.	**Dr. Rakesh K. Mishra** Director CSIR-Centre for Cellular and Molecular Biology Uppal Road Hyderabad – 560 007	Member
5.	**Shri Dilip Shanghvi** Managing Director Sun Pharmaceutical Industrial Limited SUN House, CTS No. 201-B/1 Western Express Highway, Goregaon E Mumbai – 400 063	Member
6.	**Shri Dinesh K. Sarraf** Chairperson Petroleum and Natural Gas Regulatory Board 1st Floor, World Trade Centre, Babar Road New Delhi – 110 001 Flat No. 804, C- Bock CLEO County, GH-05, Sector-121 Noida – 201 301 (UP)	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 University of Kashmir Srinagar, J&K), Anusaktinagar Mumbai – 400 094	Member
9.	**Dr. Arun Kumar Grover** Honorary Emeritus Professor Department of Applied Sciences Punjab Engineering College (Deemed to be University), Sector-12 Chandigarh – 160 012 House No. 157, First Floor, Sector 16 A Chandigarh – 160 015	Member
10.	**Prof. Ashutosh Sharma** Secretary Department of Science and Technology (DST) Technology Bhawan New Mehrauli Road New Delhi – 110 016	Member
11.	**Dr. G. Satheesh Reddy** Secretary Department of Defence Research and Development (DDRD) and Chairman, Defence Research and Development Organisation (DRDO) Ministry of Defence New Delhi – 110 001	Member

ANNEXURE - VI

List of Approved Projects

A: DETAILS OF FAST TRACK PROJECTS

S.No.	Lab.	FTT Projects	MLP Code	Category
1.	CSIR-AMPRI	Development of multilayer sandwich panel for defense applications	**MLP0107**	**FTT**
2.		Development of Fly Ash based Geopolymeric Materials for Broad Application Spectrum	**MLP0120**	**FTT**
3.		Pilot scale production and demonstration of closed cell aluminium composite and hybrid composite foams for transportation, defence and construction sectors	**MLP0121**	**FTT**
4.		Electromyogram (EMG) controlled Below Elbow prosthesis	**MLP0051**	**FTT**
5.		Advanced Geopolymeric Coating Material for Structures of Mild Steel (AGCM)	**MLP0113**	**FTT**
6.		Development of solid-state electromagnetic joining technique for materials of interest in aerospace/space	**MLP0105**	**FTT**
7.		Design & Development of bamboo structures (Bamboo/composite sections & joints)	**MLP0109**	**FTT**
8.		Utilization of industrial waste through appropriate technologies for developing value-added Products	**MLP0122**	**FTT**
9.	CSIR-CBRI	Pilot Scale Preparation of Silica Nanoparticles and their applications in cement based materials	**MLP0514**	**FTT**
10.		Design & Development of bamboo structures (Bamboo/composite sections & joints)	**MLP0109**	**FTT**
11.	CSIR-CCMB	Develop novel DNA based identification system of Plant bioresources (both agri and wild varieties grown/harvested) for conservation	**MLP0118**	**FTT**

S.No.	Lab.	FTT Projects	MLP Code	Category
12.	CSIR-CCMB	Development of male infertility diagnostic kits (DeMID)	**MLP0113**	**FTT**
13.		Multi-analyte sensing platforms and molecular probes for detection of target biomarkers using electrochemical and optical methods	**MLP0207**	**FTT**
14.		Up scaling of high yielding / elite Samba Mahsuri mutant line 'SM93' for product translation	**MLP0114**	**FTT**
15.		Development of climate resilient lines of the bacterial blight resistant and low glycemic index rice variety, Improved Samba Mahsuri possessing resistance against blast disease and enhanced tolerance to submergence and drought	**MLP0123**	**FTT**
16.	CSIR-CDRI	Clinical development of antiplatelet compound S007-867 for treatment of cardiovascular diseases. (Antithrombo-867)	**MLP0119**	**FTT**
17.		Development of male infertility diagnostic kits (DeMID)	**MLP0113**	**FTT**
18.		Validation of potential biomolecules against Parkinson's disease: A pre-clinical study	**MLP0012**	**FTT**
19.		Development of a small molecule inhibitor of PCSK 9	**MLP0118**	**FTT**
20 .	CSIR-CECRI	SX-EW process for the regeneration of etchant and recovery of copper from spent alkaline ammoniacal cupric chloride PCB etchant	**MLP0208**	**FTT**
21.		Multi-analyte sensing platforms and molecular probes for detection of target biomarkers using electrochemical and optical methods	**MLP0207**	**FTT**
22.		Self-humidified Nafion based composite membranes for open cathode PEMFC stacks	**MLP0202**	**FTT**
23.		Development of 2.5V / 1A sodium-ion batteries with performance scalability possibilities	**MLP0203**	**FTT**

S.No.	Lab.	FTT Projects	MLP Code	Category
24.	**CSIR-CECRI**	Development and demonstration of rechargeable Li-S batteries for lighting and consumer electronics applications	**MLP0204**	**FTT**
25.		Processing of secondary resources for the production of battery materials	**MLP0036**	**FTT**
26.	**CSIR-CEERI**	Design and Development of Dispenser Cathodes for Microwave Tubes	**MLP0111**	**FTT**
27.		Development of an Image Processing based system for monitoring feed rate of materials moving on a conveyor	**MLP0028**	**FTT**
28.		Development of an induration furnace monitoring system with IoT and Artificial Intelligence (AI) technique in a pelletization plant	**MLP0027**	**FTT**
29.		Solar PV based Smart Multi-vehicle EV Charging Station	**MLP0113**	**FTT**
30.	**CSIR-CFTRI**	Development of applications of laccase for Diverse (Food health and cosmetic) Industries (DALDI)	**MLP0015**	**FTT**
31.		Technology assessment and integration of CSIR's lignocellulosic ethanol programs/ facilitating technologies for a feasible 2G ethanol technology (CSIR-2GE)	**MLP0244**	**FTT**
32.	**CSIR-CGCRI**	100 W CW/Modulated Thulium fiber laser: at 1.94 μm for efficient tissue vaporization and at 2.05 μm for strategic application	**MLP0102**	**FTT**
33.		Wear resistant Ceramics for cutting & milling operation: Process optimization of SiAlON-WC composites for rock drilling application	**MLP0204**	**FTT**
34.		Synthetic high alumina aggregate from sillimanite beach sand for refractory application	**MLP0402**	**FTT**
35.		Superior fused magnesia from impure Indian magnesite for self-sustenance	**MLP0403**	**FTT**

S.No.	Lab.	FTT Projects	MLP Code	Category
36.	**CSIR-CGCRI**	Technology assessment and integration of CSIR's lignocellulosic ethanol programs/ facilitating technologies for a feasible 2G ethanol technology (CSIR-2GE)	**MLP0305**	**FTT**
37.	**CSIR-CLRI**	Retanning cum fatliquoring agent	**MLP1801**	**FTT**
38.		Retanning agent from Paper Industry Wastes	**MLP1802**	**FTT**
39.		Waterless Chrome Tanning Technology	**MLP1811**	**FTT**
40.	**CSIR-CMERI**	Process technology for large area (10 cmX10 cm) manufacturing of micro-nano patterned (300 nm-300 micron) hydrophobic surfaces	**MLP222912**	**FTT**
41.		An engineered design and development of a solar assisted community level multifunctional adsorbent based integrated water filtration unit for removal of ground water fluoride, microorganism with supported handy fluoride level detection kit and proper management of generated sludge	**MLP223712**	**FTT**
42.		Design and Development of 1 TPD Fully Automatic Biodiesel Plant	**MLP223212**	**FTT**
43.		Development of Carbon-Graphite Piston Ring and Solenoid Valve suitable for high temperature aircraft LRUs	**MLP222612**	**FTT**
44.		Design and development of Mob Control Vehicle (MCV)	**MLP218112**	**FTT**
45.		Design of a combined cutting, binding and bailing equipment for stubble management	**MLP224812**	**FTT**
46.		Development of self-propelled specialty harvester for leafy crops with a minimum field capacity of 4 acre/day (ex. Stevia, mentha, vegetables)	**MLP224912**	**FTT**
47.		Smart Agro-informatics with Internet of Things to enable Agriculture-4.0 (SAGITA)	**MLP225012**	**FTT**
48.	**CSIR-CSIO**	Smart Electrochemical Tongue (e-Tongue) to detect heavy metal ions in potable water	**MLP0060**	**FTT**
49.		Image Guided vascular vein visualizer: VeinViz	**MLP0050**	**FTT**

S.No.	Lab.	FTT Projects	MLP Code	Category
50.	CSIR-CSIO	Electromyogram (EMG) controlled Below Elbow prosthesis	**MLP0051**	**FTT**
51.		Technological solutions for contactless alive/ dead detection of victim soldier in battle field	**MLP0040**	**FTT**
52.		Precision instrumentation towards whole-slide digital microscopy for high-throughput analytics	**MLP0041**	**FTT**
53.		Ligament Injury Assessment & Therapy Device for motor-rehabilitation of Soldiers "L-GEAR"	**MLP0042**	**FTT**
54.		Online Monitoring System for detection of Night-time Poor Visibility areas in Urban settings	**MLP0043**	**FTT**
55.		Harvesting of electrical energy using geared AC synchronous motor to charge batteries of mobile phones	**MLP0044**	**FTT**
56.		Design and Development of enhanced vision system for military surface transport vehicles	**MLP0046**	**FTT**
57.		Design and Development of Airfield Ground Lighting Systems (AGLS)	**MLP0045**	**FTT**
58.		Design & Development of Head Up Display for Passenger Aircraft	**MLP0047**	**FTT**
59.		Design & Development of bamboo structures (Bamboo/composite sections & joints)	**MLP0109**	**FTT**
60.		Design and Development of Indigenized Lyophiliser for preservation of Indian Fruits and Vegetables	**MLP0052**	**FTT**
61.		Smart Agro-informatics with Internet of Things to enable Agriculture-4.0 (SAGITA)	**MLP0064**	**FTT**
62.	CSIR-CSMCRI	Greener process for the synthesis of 3-methyl-5-phenylpentanol (Mefrosol) at 1 Kg level with >90% yield ad 98% purity	**MLP0032**	**FTT**
63.		Energy efficient process to treat the reject stream of water desalination plant	**MLP0033**	**FTT**
64.		Multi-analyte sensing platforms and molecular probes for detection of target biomarkers using electrochemical and optical methods	**MLP0207**	**FTT**

S.No.	Lab.	FTT Projects	MLP Code	Category
65.	**CSIR-CSMCRI**	Generation of energy from microalgal feedstock through CO2 capture from flue gases	**MLP0031**	**FTT**
66.		Technology assessment and integration of CSIR's lignocellulosic ethanol programs/ facilitating technologies for a feasible 2G ethanol technology (CSIR-2GE)	**MLP0041**	**FTT**
67.	**CSIR-IGIB**	Genomic Approaches for Rare Genetic Disease Diagnosis (RareGen)	**MLP1801**	**FTT**
68.		Radiological AI system for Parallel Informatic Detection of Clinical Triage emergencies (RAPID-CT)	**MLP1807**	**FTT**
69.		Genomics for Public Health in India (IndiGen)	**MLP1809**	**FTT**
70.	**CSIR-IHBT**	Development of bacterial formulations and organic dustbin for organic waste degradation in cold hilly regions	**MLP0137**	**FTT**
71.		Design & Development of bamboo structures (Bamboo/composite sections & joints)	**MLP0109**	**FTT**
72.		Introduction of high value spice Saffron (Crocus sativus L.) in unexplored areas	**MLP0127**	**FTT**
73.		Identification of improved clone(s) of Stevia *rebaudiana* (Bertoni)	**MLP0128**	**FTT**
74.		Rapid and Point Care Microfluidic Kit for Multiplex Diagnosis of Viral Diseases in Tomato and Apple	**MLP0039**	**FTT**
75.		Combating Iron and Zinc deficiency using microalgae based foods	**MLP0129**	**FTT**
76.		Indigenous enzymes for degumming of rice bran oil and other vegetable oils	**MLP0037**	**FTT**
77.		Design and Development of Indigenized Lyophiliser for preservation of Indian Fruits and Vegetables	**MLP0052**	**FTT**
78.		Development of applications of laccase for Diverse (Food health and cosmetic) Industries (DALDI)	**MLP0015**	**FTT**

S.No.	Lab.	FTT Projects	MLP Code	Category
79.	CSIR-IHBT	Optimization of aeroponic and hydroponic conditions for increasing commercial crop productivity	**MLP0151**	**FTT**
80.		Development of self-propelled specialty harvester for leafy crops with a minimum field capacity of 4 acre/day (ex. Stevia, mentha, vegetables)	**MLP0152**	**FTT**
81.	CSIR-IICT	Preparation of polymer-grade vinylidenefluoride (VDF) and chlorotrifluoroethylene (CTFE) and their polymerization processes	**MLP0038**	**FTT**
82.		Development of Engineered Biochar from non-edible de-oiled seed cake/stubble wastes for the removal of targeted herbicides/ pesticides from agricultural wastewaters and subsequent soil remediation	**MLP0041**	**FTT**
83.	CSIR-IICT	Indigenous enzymes for degumming of rice bran oil and other vegetable oils	**MLP0037**	**FTT**
84.		Catalytic conversion of linear alkylbenzene raffinate to be utilized for Jet rocket fuel	**MLP0040**	**FTT**
85.		Technology assessment and integration of CSIR's lignocellulosic ethanol programs/ facilitating technologies for a feasible 2G ethanol technology (CSIR-2GE)	**MLP0049**	**FTT**
86.	CSIR-IIP	Development of Catalyst and Alternate Process for Producing Light Olefins (C2-C4)	**MLP1091**	**FTT**
87.		Development of applications of laccase for Diverse (Food health and cosmetic) Industries (DALDI)	**MLP0015**	**FTT**
88.		Technology assessment and integration of CSIR's lignocellulosic ethanol programs/ facilitating technologies for a feasible 2G ethanol technology (CSIR-2GE)	**MLP1107**	**FTT**
89.	CSIR-IITR	Development of applications of laccase for Diverse (Food health and cosmetic) Industries (DALDI)	**MLP0015**	**FTT**

S.No.	Lab.	FTT Projects	MLP Code	Category
90.	CSIR-IMMT	Technology assessment and integration of CSIR's lignocellulosic ethanol programs/ facilitating technologies for a feasible 2G ethanol technology (CSIR-2GE)	**MLP011**	**FTT**
91.		In-house development and fabrication of stirred mills for energy-efficient processing of low-grade ores	**MLP0032**	**FTT**
92.		Synthesis of Mg-Y2O3 magnesium nano-composite by hot consolidation process for light weight applications	**MLP0041**	**FTT**
93.		Production of Sm2O3 and CO3O4 from SmCo permanent magnet scrap	**MLP0035**	**FTT**
94.		Design & development of a vertical slurry transport system for lifting of minerals/ores in heterogeneous regime	**MLP0033**	**FTT**
95.		Recovery of Nickel, Chromium and Iron from Chromite Overburden (COB) in 100 kg scale	**MLP0038**	**FTT**
96.	CSIR-IMMT	Development of Novel Tungsten Alloy Cubes for Strategic Applications	**MLP0031**	**FTT**
97.		Wireless Thermocouple for temperature measurement of rotating and moving surfaces	**MLP0029**	**FTT**
98.		Development of cost effective Industry grade non-contact type online moisture sensor using microwave and NIR	**MLP0030**	**FTT**
99.		Development of an Image Processing based system for monitoring feed rate of materials moving on a conveyor	**MLP0028**	**FTT**
100.		Development of an induration furnace monitoring system with IoT and Artificial Intelligence (AI) technique in a pelletization plant	**MLP0027**	**FTT**
101.		Processing of secondary resources for the production of battery materials	**MLP0036**	**FTT**
102.		Rapid and Point Care Microfluidic Kit for Multiplex Diagnosis of Viral Diseases in Tomato and Apple	**MLP0039**	**FTT**

S.No.	Lab.	FTT Projects	MLP Code	Category
103.	CSIR-IMTECH	Development of bio-better of G-CSF (Granulocyte-Colony Stimulating Factor) for prophylactic and therapeutic interventions in neutropenia	**MLP0011**	**FTT**
104.		Validation of potential biomolecules against Parkinson's disease: A pre-clinical study	**MLP0012**	**FTT**
105.		Technology development for Gellan gum production	**MLP0014**	**FTT**
106.		Development of applications of laccase for Diverse (Food health and cosmetic) Industries (DALDI)	**MLP0015**	**FTT**
107.	CSIR-NAL	Stealth Technologies: Development of Radar Absorbing Materials/ Coatings for Airborne Platforms	**MLP1803**	**FTT**
108.		VTOL Winged UAV for multi-mission application (VTOL-UAV)	**MLP1814**	**FTT**
109.	CSIR-NBRI	Bio-prospecting plant diversity for food grade colors	**MLP0025**	**FTT**
110.	CSIR-NCL	Continuous manufacturing platform for diazonium salt based reactions for synthesis of Azo dyes and APIs	**MLP034226**	**FTT**
111.		Energy efficient clean production of hydrogen	**MLP034026**	**FTT**
112.		Technology assessment and integration of CSIR's lignocellulosic ethanol programs/ facilitating technologies for a feasible 2G ethanol technology (CSIR-2GE)	**MLP**	**FTT**
113.		Smart Agro-informatics with Internet of Things to enable Agriculture-4.0 (SAGITA)	**MLP035226**	**FTT**
114.	CSIR-NEERI	Development, Demonstration and Dissemination of Improved Ceramic based Cook-stoves (Both domestic and Community) for Particulate Emissions Control	**MLP0115**	**FTT**
115.		RISK-PiNET : GIS based Risk Assessment Modelling Tool for Water Distribution System	**MLP0116**	**FTT**

S.No.	Lab.	FTT Projects	MLP Code	Category
116.	CSIR-NEERI	Smart Disposal, Incineration and Carbonization Systems (SMART-DISC) for Menstrual Waste Management	**MLP0120**	**FTT**
117.		Scale-up of process for CO2 capture based on biogenic molecules and pilot scale demonstrations	**MLP0112**	**FTT**
118.		Utilization of industrial waste through appropriate technologies for developing value-added Products	**MLP0128**	**FTT**
119.		Technology assessment and integration of CSIR's lignocellulosic ethanol programs/ facilitating technologies for a feasible 2G ethanol technology (CSIR-2GE)	**MLP0129**	**FTT**
120.	CSIR-NEIST	Efficient and large scale production of carbon quantum dots (CQDTs) from cheap coal feedstock	**MLP1006**	**FTT**
121.	CSIR-NIO	Coral Reef Monitoring and Surveillance Robot (C-Bot)	**MLP1803**	**FTT**
122.	CSIR-NIIST	Fluorescent Materials for Security Applications	**MLP0028**	**FTT**
123.		Development of an onsite sewage treatment for small establishments	**MLP0029**	**FTT**
124.		Development of Cellular Sensors: Biocompatible fluorescent molecules for sensing and cellular imaging of PH, Zn2+ and reactive oxygen species	**MLP0027**	**FTT**
125.		Fused Thiophene based FET devices for lung cancer VOC biomarker detection	**MLP0028**	**FTT**
126.		Electrochromic Devices for Efficient Energy Management and Utilization	**MLP0022**	**FTT**
127.		Development of lithium silicate based ceramics as CO2 sorbents for sorption enhanced steam methane reforming	**MLP0023**	**FTT**
128.		Technology assessment and integration of CSIR's lignocellulosic ethanol programs/ facilitating technologies for a feasible 2G ethanol technology (CSIR-2GE)	**MLP0035**	**FTT**

S.No.	Lab.	FTT Projects	MLP Code	Category
129.	CSIR-NML	Annealing simulator integrated with online process control sensors for run out table process simulation	**MLP3108**	**FTT**
130.		Piloting of the process for Production of Premium Grade Iron Oxide from Waste Ferrous Chloride Solution Generated from Steel Pickling and Ilmenite Processing Units	**MLP3107**	**FTT**
131.		Pilot scale processes for recycling of metals/ materials from E-waste	**MLP3109**	**FTT**
132.		Development of biodegradable eco-friendly flotation reagents for sillimanite, limestone, iron ore fines and coal	**MLP3106**	**FTT**
133.		Smart sensing system for cold drawn high end wires	**MLP3105**	**FTT**

B: DETAILS OF MISSION MODE PROJECTS

S.No.	Mission Title	Code
1.	CSIR Aroma Mission	HCP0007
2.	CSIR Sickle Cell Anemia Mission	HCP0008
3.	Catalysis for Sustainable Development (CSD)	HCP0009
4.	CSIR Phytopharmaceutical Mission	HCP0010
5.	INPROTICS-Pharma and Agro	HCP0011
6.	Nano-Biosensors and Microfluidics for Healthcare	HCP0012
7.	Intelligent System (IS) - Intelligent Technologies and Solutions	HCP0013
8.	Development of fast Durable and Energy Efficient Mass Housing Scheme	HCP0015
9.	Safety and Security of Vital Installations	HCP0017
10.	Technology for Robust Structural Health Monitoring of Critical Infrastructure and Conservation & Restoration of Heritage Structures	HCP0018
11.	Nutraceuticals and Nutritionals	HCP0019
12.	Drone based Electromagnetic and Magnetic System DREAM	HCP0020
13.	Development of Affordable Technologies for Quality Milk Assessment	HCP0014
14.	Establishment of CSIR-CMERI Centre for Post-harvest Processing and Research to augment the economy of rural tribal people of Arunachal Pradesh	MLP216212
15.	Next Generation insect resistance in cotton	HCP0023
16.	Food and Consumer Safety Solution (FOCUS)	HCP0016
17.	CSIR Mission Mode Project on Crop Protection Chemicals	HCP0021
18.	Mission Mode Programme on Commercial Deployment of Salt & Potash Technologies to Augment National Capability	HCP0022
19.	Technological convergence for sustainable production and utilization of seaweeds (TCSProUS)	HCP0024

C: DETAILS OF NCP/ FBR PROJECTS

S.No.	Lab.	Title of the Project	THEME	Category
1.	CSIR-AMPRI	Additive Manufacturing of Graphene reinforced metal and polymer composites	AEISS	NCP
2.	CSIR-AMPRI	Hierarchical Reinforcement Approach for improved ILSS of CFRP	AEISS	NCP
3.	CSIR-AMPRI	Prospects in Development of Magnesium Alloys for engineering and biological applications	4M	NCP
4.	CSIR-AMPRI	Development of Metallic foam for biological, thermal and engineering applications	4M	NCP
5.	CSIR-AMPRI	High performance metal matrix composites for transportation, defense, aerospace and engineering sectors	4M	FBR
6.	CSIR-AMPRI	Electrical insulating Hybrid Composite Sheet using Industrial Inorganic Wastes	CIE	NCP
7.	CSIR-CCMB	Apomixis Technologies for Increasing Agricultural Production	AGRI	FBR
8.	CSIR-CCMB	Towards product development in rice using mutants that have traits of agronomic importance	AGRI	FBR
9.	CSIR- CCMB	Genome sequencing of the halophyte Salicornia brachiata	AGRI	FBR
10.	CSIR-CCMB	Genome Regulatory Elements and the Evolution of Complexity	HTC	NCP
11.	CSIR-CCMB	Mechanistic and functional role of a 'Chiral Proofreading' variant in Animalia	HTC	NCP
12.	CSIR-CCMB	Genomics and epigenetics in health and disease (GEHeaD)	HTC	NCP
13.	CSIR-CCMB	Mechanistic insights into bacterial growth and morphogenesis	HTC	NCP
14.	CSIR-CCMB	Generation of monoclonal antibodies for research and diagnostics.	HTC	NCP
15.	CSIR-CCMB	Generation of Hepatic organoids by tissue engineering approaches	HTC	NCP

S.No.	Lab.	Title of the Project	THEME	Category
16.	CSIR-CCMB	Tissue Engineering of cartilage and IVD for arthritic and disc degeneration problems	HTC	NCP
17.	CSIR-CDRI	Non-alcoholic Steatohepatitis (NASH)	HTC	NCP
18.	CSIR-CDRI	Chronic Respiratory Disease Innovation and Solution Program(CRISP)	HTC	NCP
19.	CSIR-CDRI	Investigating chemical therapeutic space and determinants of survival and virulence in malaria [ParaDIgM]	HTC	FBR
20.	CSIR-CDRI	Development of identified lead molecule as novel anti-leishmanial therapeutic agent	HTC	FBR
21.	CSIR-CDRI	Development of therapeutics against skeletal targets to improve bone health	HTC	FBR
22.	CSIR-CDRI	Dissecting the architecture and molecular mechanism of multi-protein complexes (BERosomes) involved in DNA Base Excision Repair (BER) repair and Transcription Coupled DNA repair (TCR) pathways from M. tuberculosis	HTC	FBR
23.	CSIR-CDRI	Development of therapeutics against skeletal targets to improve bone health: therapeutic repurposing of pentoxyfylline	HTC	NCP
24.	CSIR-CDRI	Regulatory Development of CDRI Prioritized Lead Compounds	HTC	NCP
25.	CSIR-CDRI	Therapeutics for Lifestyle Disorders [TheraLSD]	HTC	NCP
26.	CSIR-CDRI	Cell penetrating peptide, IMT-P8 as a drug delivery vehicle in management of MRSA infections (PEPTIDOCURE)	HTC	NCP
27.	CSIR-CEERI	Development of novel compact high power THz device technologies	AEISS	NCP
28.	CSIR-CEERI	Development of new generation nano metal-oxide/graphene-polymer composite materials for use in wearable electronics (with CGCRI as implementing lab)	4M	NCP
29.	CSIR-CECRI	In-silico guided design of Corrosion Inhibiting Molecules to Materials (CIM2M)	CLP	NCP

S.No.	Lab.	Title of the Project	THEME	Category
30.	CSIR-CFTRI	Data analytics based on diet diversity, food consumption and nutritional deficiency targeted to the selected aspirational districts in Karnataka and Kerala	AGRI	NCP
31.	CSIR-CFTRI	Establishment of 'National Analytical Facility' for analysis of nutraceuticals and chemical markers in food products (NAFANC)	AGRI	FBR
32.	CSIR-CFTRI	Translation of pre-clinically tested probiotic formulation to human population with emphasis on immuno-modulation and gut microflora	AGRI	FBR
33.	CSIR-CFTRI	Understanding structure-function relationships in enzymes critical for the survival of bacterial food pathogens	AGRI	FBR
34.	CSIR-CGCRI	1KW Fiber Laser for Industrial and Strategic Applications (LISA)	AEISS	NCP
35.	CSIR-CGCRI	Development of new generation nano metal-oxide/graphene-polymer composite materials for use in wearable electronics	4M	NCP
36.	CSIR-CGCRI	Development of Hydrophobic Ceramic Hollow Fiber Membrane for MD-based Domestic Water Purification System	4M	FBR
37.	CSIR-CGCRI	Chalcogenide glass and fibers for mid infrared photonics applications	4M	FBR
38.	CSIR-CGCRI	Development of surface modified adsorbents with higher sorption capacity for specific contaminants removal in water/ industrial wastewater (SMA).	4M	FBR
39.	CSIR-CIMAP	Development of Withanamide enriched high yielding, variety of Ashwagandha (Withaniasomnifera)	AGRI	NCP
40.	CSIR-CIMAP	DNA-free CRISPR-mediated Genome-editing in rose-scented Geranium	AGRI	FBR
41.	CSIR-CIMAP	Understanding the biosynthesis of bioactive triterpenes in the medicinal tree banaba (Lagerstroemia *speciosa*) for the development of yeast-based synthetic biology platform	AGRI	FBR

S.No.	Lab.	Title of the Project	THEME	Category
42.	CSIR-CIMAP	Identification of molecular targets towards improvement of root biomass and/or texture in *Withania* somnifera	AGRI	FBR
43.	CSIR-CIMAP	UAV based high resolution remote sensing for modernized and efficient cultivation practices of commercially important medicinal and aromatic crops. (Acronym: DroneAgri)	AGRI	NCP
44.	CSIR-CIMFR	Studies on Sorption-Induced Strain and Permeability Changes in Coal and Shale as a Result of CO2 Injection	4M	NCP
45.	CSIR-CIMFR	Preparation of *in-situ* stress map of Jharia Coalfield	4M	FBR
46.	CSIR-CIMFR	Catalytic Petcoke Gasification	CLP	FBR
47.	CSIR-CLRI	Polymer Filaments for 3D printing	CLP	FBR
48.	CSIR-CMERI	Development of multifunctional care device for army personnel	AEISS	NCP
49.	CSIR-CMERI	Indigenous development of LRUs suitable for small aircraft (InDeLiRU)	AEISS	NCP
50.	CSIR-CMERI	Robotic Intervention for Industrial and Strategic Applications	CIE	NCP
51.	CSIR-CRRI	Development of Rejuvenating Agent (RA) for use in recycling of Asphalt Pavements RAP	CIE	FBR
52.	CSIR-CRRI	Cold Mix Technology for High Volume Roads	CIE	FBR
53.	CSIR-CRRI	Upgradation of Half Warm Mix Technology for Construction and Maintenance of Bituminous Surfacing	CIE	FBR
54.	CSIR-CSIO	Design & Development of Angle Independent Multilayer Thin Film Filter (AIMTF) on Foldable and Military Grade Optical Optical Substrates	AEISS	FBR
55.	CSIR-CSIO	Design and development of precision optics for soft X-Rays	AEISS	FBR
56.	CSIR-CSIO	Development of multifunctional care device for army personnel	AEISS	NCP
57.	CSIR-CSIO	Energy Management using Non-Intrusive Load Monitoring (NLIM) Technique	AEISS	NCP

S.No.	Lab.	Title of the Project	THEME	Category
58.	CSIR-CSIO	Magnetic Graphene Coated Polymeric Stationary Phase Ion-Exchangers for Ion Chromatography Column Separations	4M	FBR
59.	CSIR-CSIO	Low cost functional materials in Selenium Detection in Water	4M	FBR
60.	CSIR-CSIO	Photonic meta-surfaces for smart applications	4M	FBR
61.	CSIR-CSIO	Development of Customized Flow Hive for quality Honey Harvesting & Extraction	AGRI	NCP
62.	CSIR-CSIO	Development of Mobile-Soil-Sensing-System and Digital Spatial Repository for Precision Agriculture using Fusion of Proximity Sensors and Geo-statistics Modelling	AGRI	NCP
63.	CSIR-CSMCRI	Indigenously developed reverse electrodialysis process for salinity gradient based power generation	EED	FBR
64.	CSIR-CSMCRI	Genome sequencing of the halophyte Salicornia brachiata	AGRI	NCP
65.	CSIR-IGIB	Chronic Respiratory Disease Innovation and Solution Program(CRISP)	HTC	NCP
66.	CSIR-IGIB	Genomics and epigenomics in health and disease (GEHeaD)	HTC	NCP
67.	CSIR-IGIB	GEAR – Genomic, Evolutionary and Big Data Analytic strategies to address antimicrobial resistance	HTC	NCP
68.	CSIR-IGIB	Mechanistic basis of IncRNA mediated regulation in organ development and function (DevoRNA)	HTC	FBR
69.	CSIR-IGIB	Decoding telomerase reactivation in cancer - molecular mechanisms of G-quadruplex-mediated telomerase (hTERT) control	HTC	FBR
70.	CSIR-IGIB	GRAFT(Garnering Regenerative Approaches For Transplantation)	HTC	NCP
71.	CSIR-IHBT	UAV based high resolution remote sensing for modernized and efficient cultivation practices of commercially important medicinal and aromatic crops. (Acronym: DroneAgri)	AGRI	NCP

S.No.	Lab.	Title of the Project	THEME	Category
72.	CSIR-IHBT	Molecular mechanism underlying Apple scar skin viroid-whitefly interaction	AGRI	NCP
73.	CSIR-IHBT	Development of process for converting raw cellulosic biomass into textile fiber and nanocellulose	AGRI	NCP
74.	CSIR-IHBT	Creation of aroma bank by utilization of western Himalayan biodiversity (AROMA-BANK)	AGRI	NCP
75.	CSIR-IHBT	Bisoprospection Microbiome from Himalayan niches	AGRI	NCP
76.	CSIR-IHBT	Non-invasive technology for production of naphthoquinone pigments from Arnebia species on sustainable basis	AGRI	NCP
77.	CSIR-IHBT	conservation and sustainable resource generation of high altitude bioresources at CSIR – Centre for High Altitude Biology	AGRI	NCP
78.	CSIR-IHBT	Development of high-throughput genotyping platform for next generation plant breeding in tea	AGRI	FBR
79.	CSIR-IHBT	characterization and development of agro and process technology for low calorie natural sweetener (Siraitia grosvenorii)	AGRI	FBR
80.	CSIR-IHBT	Exploration of Himalayan Plants for Novel Antimalarial Agents: Characterization of potential molecules	AGRI	FBR
81.	CSIR-IICB	Non-alcoholic Steatohepatitis (NASH)	HTC	NCP
82.	CSIR-IICB	Chronic Respiratory Disease Innovation and Solution Program(CRISP)	HTC	NCP
83.	CSIR-IICB	Genomics and epigenomics in health and disease (GEHeaD)	HTC	NCP
84.	CSIR-IICB	EXOsomal MIRna Inhibitor: Identification of the new classes of inhibitors of miRNA trafficking via exosomes (EXOMIRIN)	HTC	FBR
85.	CSIR-IICT	Non-destructive depth profiling and identification of debonding defects across polymer interfacial layers by using portable single-sided NMR	AEISS	FBR

S.No.	Lab.	Title of the Project	THEME	Category
86.	CSIR-IICT	Mimicking Muscles: Electroactive Polymers for Bionics	4M	NCP
87.	CSIR-IICT	Development of hybrid flocculants at 100 g scale for selective adsorption of low grade iron ore slimes and fines to recover iron ore more than 80 %.	4M	FBR
88.	CSIR-IICT	Vegetable oil-based Gels as trans free fat (Oleogel)	AGRI	NCP
89.	CSIR-IICT	Sustainable production of Edible oils from Microalgae	AGRI	FBR
90.	CSIR-IICT	Chronic Respiratory Disease Innovation and Solution Program(CRISP)	HTC	NCP
91.	CSIR-IICT	Autologous Transplantation of Transgenically Modified Hepatic Progenitor Cells expressing therapeutic genes-mediated Liver Regeneration (PROMPT)	HTC	NCP
92.	CSIR-IICT	Enzymatic Process for the preparation of API intermediates	CLP	NCP
93.	CSIR-IICT	Scale up of materials for Dye Sensitized Solar Cells and Organic Photovoltaics	CLP	FBR
94.	CSIR-IICT	Accelerated Wound Healing by Bone marrow Stem Cells delivered using PEG-PU porous Polymer Scaffolds Grafted with KGF- and/or VEGF- Mimetic Peptides (GRAFT)	HTC	NCP
95.	CSIR-IIP	Modeling of mono/bi-metallic catalysts for hydro processing reactions	4M	FBR
96.	CSIR-IIP	Carboxylation of naphtha grade olefins to high value chemicals using CO_2	CLP	FBR
97.	CSIR-IIP	Catalytic oxidation of propylene to propylene oxide	CLP	FBR
98.	CSIR-IIP	Methane Transformation over Nanostructured Catalyst	EED	FBR
99.	CSIR-IIP	Process/catalyst development for reduced hydrogen consumption for the hydrocracking of renewable oils (HLess-HCRO)	EED	FBR

S.No.	Lab.	Title of the Project	THEME	Category
100.	CSIR-IIP	Catalytic process for the production of BTX/ gasoline from bio-naphtha	CLP	FBR
101.	CSIR-IIP	Electric Conversion of High Polluting Diesel/ Petrol 3W, 4W Vehicles in Electric Vehicles and Development of Solar Charging Station	E3OW	NCP
102.	CSIR- IMMT	Green synthesis of Silver nanoparticles against plant pathogens: An alternative solution for chemical pesticides	AGRI	FBR
103.	CSIR-IMMT	Developing magnetic refrigerant materials for cooling applications at cryogenic temperatures-(MRM)	AEISS	FBR
104.	CSIR-IMMT	Development of Active Noise Control Chair for Aircraft Cabin	AEISS	NCP
105.	CSIR-IMMT	Sensors for detection of heavy metal ion contaminations	AEISS	FBR
106.	CSIR-IMMT	Preparation of coke and ferro-coke from low ash non-coking coal	4M	NCP
107.	CSIR-IMMT	Recycling of spent battery materials for value addition	4M	NCP
108.	CSIR-IMMT	Solvatometallurgical extraction of Cu and Zn from low grade ores and secondaries through Deep Eutectic Solvents(DES)	4M	NCP
109.	CSIR-IMMT	Dephosphorization of high phosphorus iron ore	4M	FBR
110.	CSIR-IMMT	Ferro Manganese production from lean grade Manganese ore	4M	FBR
111.	CSIR-IMMT	Processing of Mineral & Metallurgical Wastes, and Flyash for their value addition	4M	FBR
112.	CSIR-IMMT	Kinetics and thermodynamics study on reduction roasting of low and lean grade iron ores using fluidized bed roaster to maximise the recovery of iron values	4M	FBR
113.	CSIR-IMMT	Thermodynamics and kinetics study of ferruginous ilmenite reduction and smelting for production of titania slag	4M	FBR

S.No.	Lab.	Title of the Project	THEME	Category
114.	CSIR-IMMT	Highly Ordered Functionalized Nano structured Electrolytic Manganese Dioxide with enhanced electrochemical performance for Batteries and Super capacitors	4M	FBR
115.	CSIR-IMMT	Protective conducting materials coating of La0.6Sr0.4Co0.2Fe0.8O3 (LSCF), MnCo2O4 and Mn1.5Co1.5O4 on SOFC interconnect Crofer 22 APU by Electrophoretic deposition to mitigate high temperature oxidation and degradation	EED	FBR
116.	CSIR-IMTECH	GEAR-Genomic, Evolutionary and Big Data Analytic strategies to address antimicrobial resistance	HTC	NCP
117.	CSIR-IMTECH	Identification of Missing Phosphatase in Metabolic Pathway (IMP2)	HTC	FBR
118.	CSIR-IMTECH	Evolutionary studies on Flexibility and Function of Lipid-bound efflux proteins for Understanding eXtreme drug resistance in microbes (EFFLUX)	HTC	FBR
119.	CSIR-IMTECH	Cell penetrating peptide, IMT-P8 as a drug delivery vehicle in management of MRSA infections (PEPTIDOCURE)	HTC	NCP
120.	CSIR-IMTECH	Developing high yielding CHO cell clone producing the anti-RSV mAb	HTC	NCP
121.	CSIR-IMTECH	Development of mass spectral library for characterization of recombinant therapeutic monoclonal antibodies (MSLAb)	HTC	NCP
122.	CSIR-IMTECH	Mega-genomic insights into co-evolution of rice and its microbiome	AGRI	NCP
123.	CSIR-IMTECH	Exploring the Indian coastal and marine biodiversity for discovery and production of industrially important microbial proteins	E3OW	NCP
124.	CSIR-IMTECH	Development of a microbial system for the production of neo-glycopeptides/ neo-glycoproteins for useful applications	AGRI	NCP
125.	CSIR-NAL	Active Thermal Imaging for Non-destructive Evaluation (NDE) of thin composite aircraft structures	AEISS	NCP

S.No.	Lab.	Title of the Project	THEME	Category
126.	CSIR-NAL	Aerodynamic studies of aircraft configurations including wing-propeller interaction	AEISS	FBR
127.	CSIR-NAL	Certification of 30 HP Indigenous Wankel Rotary Combustion Engine	AEISS	NCP
128.	CSIR-NAL	Design and Development of Integrated Avionics Display Processing Computer(IADC)	AEISS	NCP
129.	CSIR-NAL	Development of Airboat (JALDOST)	AEISS	NCP
130.	CSIR-NAL	Development of Active Noise Control Chair for Aircraft Cabin	AEISS	NCP
131.	CSIR-NAL	Development of Aeroelastic Algorithms in Aircraft Design	AEISS	FBR
132.	CSIR-NAL	Environment Establishment for generating Flight Worthy Code from the Display Simulator Code	AEISS	FBR
133.	CSIR-NAL	Iron Bird Technology Platform for Evaluating Aircraft Actuation Systems	AEISS	NCP
134.	CSIR-NAL	Tailoring of Carbon Fiber Reinforced Composites for Enhanced Heat Dissipation Capability, Mechanical Properties and Electrical Conductivity using Carbon Nanotubes /Carbon Materials for Aerospace Applications	AEISS	FBR
135.	CSIR-NAL	UAV based high resolution remote sensing for modernized and efficient cultivation practices of commercially important medicinal and aromatic crops. (Acronym: DroneAgri)	AGRI	NCP
136.	CSIR-NBRI	Genome-editing for enhanced yield and quality traits (GE-plant)	AGRI	NCP
137.	CSIR-NBRI	Characterization and value addition of plant-based resins, gums and waxes	AGRI	NCP
138.	CSIR-NBRI	Small RNAs and Associated factors for enhanced post-harvest Life (sRNA-life)	AGRI	FBR
139.	CSIR-NBRI	Pathway elucidation and identification of genes involved in guggulsterones biosynthesis in Commiphora sps	AGRI	FBR
140.	CSIR-NBRI	Sub-genome dominance in endoreduplication and its implication in heterotic benefits to F1-hybrids for biomass and their adaptation	AGRI	FBR

S.No.	Lab.	Title of the Project	THEME	Category
141.	CSIR-NBRI	Understanding the epigenetics of fitness advantage of high altitude *Arabidopsis thaliana* populations under new environments	AGRI	FBR
142.	CSIR-NCL	Scalable synthesis of multifunctional nanomaterials for advanced applications (batch processing/flow synthesis	4M	NCP
143.	CSIR-NCL	Nanofiber membrane of PET-cellulose derivative immobilized with nanocomposites as separators in lithium ion battery	4M	FBR
144.	CSIR-NCL	Towards Large Scale Solar Hydrogen Production (SoHy)	EED	NCP
145.	CSIR-NCL	Insight into cell physiology for cell culture medium formulation	HTC	NCP
146.	CSIR-NCL	Development of mass spectral library for characterization of recombinant therapeutic monoclonal antibodies (MSLAb)	HTC	NCP
147.	CSIR-NCL	In-silico guided design of Corrosion Inhibiting Molecules to Materials (CIM2M)	CLP	NCP
148.	CSIR-NCL	Design and Development of Indigenous Strain Portfolio for the Production of Penicillin V (PenV-IP)	AGRI	FBR
149.	CSIR-NEERI	Estimation of Ecosystem Services and Environmental Damage Cost Due to Climate Change: Biodiversity Perspective	E3OW	FBR
150.	CSIR-NEERI	Understanding Critical Zone Structure: WRJ-1 Critical Zone Observatory	E3OW	FBR
151.	CSIR-NEERI	Waste to Wealth	E3OW	FBR
152.	CSIR-NEIST	Utilization of North East Region (NER), India clay minerals for ceramic applications	4M	FBR
153.	CSIR-NEIST	Value addition of non-timber wood available in the North Eastern region of India by chemical modification for different industrial applications	4M	FBR
154.	CSIR-NEIST	Plasmonic nanoparticles decorated 2D nanosheets for detection of the fluoride and arsenic in drinking water: Fabrication of a paper strip based analytical device	4M	FBR

S.No.	Lab.	Title of the Project	THEME	Category
155.	CSIR-NEIST	Ammonia from dinitrogen at ambient condition by new advanced material: a potential energy saving process than Haber-Bosch	4M	FBR
156.	CSIR-NEIST	Development of brown spot (Drechsleraoryzae) disease tolerance in rice through multiplex-multi-gene CRISPR-Cpf1 genome editing system	AGRI	FBR
157.	CSIR-NGRI	Geodynamics and Metallogeny of parts of the East Indian Shield with specific reference to Diamond, Iron Ore & Chromitite-PGE occurrences (GeoMet)	E3OW	FBR
158.	CSIR-NGRI	Synthesis of Earthquake Hazard scenario in NW Himalaya by Investigating the multi-scale Variations in structural and seismotectonic Assemblages (SHIVA)	E3OW	FBR
159.	CSIR-NIIST	Development of Mn-based RE-free intermetallic permanent magnets for automotive and energy generation	4M	FBR
160.	CSIR-NIIST	Exploring in-situ synthesis for Titanium Metal Powder by direct reduction of synthetic rutile	4M	FBR
161.	CSIR-NIIST	Development of Warm White Light Emitting Single Phased Oxyfluoride Phosphors for Energy Efficient and High Color Rendering LEDs	4M	FBR
162.	CSIR-NIIST	Chromogenic Materials for Smart Coating Applications	CLP	NCP
163.	CSIR-NIIST	Deciphering the microbiome of native wild coastal saline tolerant rice varieties of southern India and understanding the impact of seawater in structuring the root associated core microbiota using pokkali rice as a model plant	AGRI	
164.	CSIR-NIO	Impact of Climate Change on the Physics, Biogeochemistry, and the Ecology of the North Indian Ocean (CliCNIO)	E3OW	FBR
165.	CSIR-NIO	Enhancing live stocks of herbivore fishes through captive breeding to control the macroalgal dominance in coral reefs to sustain the fishing revenue	AGRI	NCP
166.	CSIR-NML	Self-healing Coatings for Corrosion Protection of Steel &Aluminium alloys	4M	NCP

S.No.	Lab.	Title of the Project	THEME	Category
167.	CSIR-NML	Synthesis of new 2D materials other than graphene for energy application	4M	NCP
168.	CSIR-SERC	Development of Methodologies for Remaining Life Assessment and Risk-based Inspection Scheduling of Piping Systems under Corrosive Environment (ReLife-InS)	4M	NCP
169.	CSIR-SERC	Multi-scale damage characterization of laminated FRP composites under fatigue loading	4M	NCP
170.	CSIR-SERC	Development of composite Bridge Deck Systems for Fast Track construction	CIE	NCP
171.	CSIR-4PI	Carbon and Nitrogen cycling in the Earth Sciences (CNCES)	E3OW	NCP

D: DETAILS OF LAB PROJECTS

S. No.	Lab: Name	Title of the Project
1.	CSIR-CEERI	Indigenous design, development & qualification of Ku band (140-210 watts) and Ka band (100-150 watts) Travelling wave tube (TWT)
2.	CSIR-NPL	Creation and Calibration Facility for LED and LED based Lighting
3.	CSIR, URDIP	Informatics for drug-repurposing and rescue discoveries (IDrRD);
4.		Intellectual Property Evaluation and Commercialization (IPEC);
5.		Creation of E-Markets for Knowledge Products and Services
6.	CSIR-TKDL	Modernization and upgradation of Information Technology Infrastructure of Traditional Knowledge Digital Library Unit (TKDL)
7.		Digitising Traditional Indian Systems of Medicine
8.	CSIR-NAL	Design, Development and Certification of HANSA-NG
9.		Development and Certification of 19-Seat Light Transport Aircraft (LTA)
10.	CSIR-NPL	Excellence for Ballistic Material Testing at CSIR-NPL, Delhi under Make in India Project in Body Armour.
11.		Production of Certified Reference Materials- Bharatiya Nirdeshak Dravya (BND)

ANNEXURE - VII

Summary of Important audit observations

(Position as on 31.3.2019)

S.No.	No. & Year of the Report	Number of Paras/PA Reports on which ATNs have been submitted to Monitoring Cell. Ministry of Finance	Details of the Paras/ PAC Reports on which ATNs are pending		
			Number of ATNs not sent by the Ministry even for the first time	Number of ATNs sent but returned with observations and Audit is awaiting their resubmission by the Ministry	Number of ATNs which have been finally vetted by Audit but have not been submitted by the Ministry
1.	Report No. 17 of 2017 Para No. 5.1 titled "Management of Human Resources in CSIR" pertaining to CSIR Hqrs.	NIL	NIL	NIL	1
2.	Report No. 17 of 2017 Para No. 5.4 titled "Avoidable Expenditure Due to Non-disposal of Unutilized Land "pertaining to CSIR-CIMFR.	NIL	NIL	NIL	1
	Total=2 Paras				

ANNEXURE - VIII

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

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

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

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

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

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

Innovation Complexes
Innovation Complex, Mumbai

Designed and Printed by CSIR-NISCAIR