

GOVERNMENT OF INDIA
MINISTRY OF SCIENCE AND TECHNOLOGY
DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH
RAJYA SABHA
UNSTARRED QUESTION NO-616
ANSWERED ON – 07/12/2023

ACCOMPLISHMENTS AND INITIATIVES UNDERTAKEN BY CSIR

616 **Ms. Kavita Patidar:**
Smt. Kanta Kardam:
Shri Narhari Amin:

Will the Minister of *Science and Technology* be pleased to state:

- (a) the details of accomplishments and initiatives undertaken by Council of Scientific and Industrial Research (CSIR) over the past decade;
- (b) whether Government has established a mechanism to facilitate affordable and reliable access to medical imaging solutions, taking into account their high cost and limited availability; and
- (c) the measures implemented and progress that has been achieved in this domain aligned with the “Made in India – Made for the World” concept?

ANSWER

MINISTER OF STATE (INDEPENDENT CHARGE) OF
SCIENCE AND TECHNOLOGY
(DR. JITENDRA SINGH)

- (a) The accomplishments and initiatives undertaken by CSIR (Council of Scientific and Industrial Research) over the past decade are placed at Annexure – I.
- (b) & (c) Yes Sir. The Ministry has established a mechanism to facilitate affordable and reliable access to medical imaging solutions. Significant initiatives/measures undertaken by Council of Scientific and Industrial Research (CSIR), Department of Science and Technology (DST) and Department of Biotechnology (DBT) in the domain are at Annexure – II.

CSIR Decadal Accomplishments and Initiatives

CSIR recognizing that inclusive innovation in the country would be the way for achieving socio-economic growth and competitive advantage globally has facilitated the national endeavour of achieving faster and inclusive growth by undertaking R&D programmes that focus on innovation. The CSIR has thus been providing the S&T knowledgebase needed for the benefit of the Nation, its industries, including MSMEs and the common people. The efforts are focused at bringing in desired S&T interventions for enhancing the socio-economic development while improving the quality of life, removing drudgery and augmenting income of the people. The projects undertaken by CSIR have been contributing to the generation of valuable knowledgebase and S&T interventions with immense value and potential to create a niche for the country.

During the last decade, CSIR's performance has been very imposing. Some key achievements are as follows

- **CSIR's Global Positioning as a Front Rank R&D System:** According to the prestigious Scimago Institutions Ranking World Report 2023, CSIR is ranked 61st among 1747 government institutions worldwide and is the only Indian organization among the top 100 global government institutions. Further, CSIR holds 7th rank in research and 4th rank in societal category in Asia among 384 government organizations. CSIR leads the country at the 1st position in overall research and societal categories among government institutions.
- **Scientific Excellence:** CSIR has pursued cutting edge science and has advanced knowledge frontiers. During the period 2013-2022, CSIR has published about 54429 papers in SCI journals. Several research papers were in high impact factor journals like Lancet, Nature Biotechnology, Nature, Chemical Reviews, Progress in Materials Science, Energy & Environmental Science etc.
- **Value Generation through Intellectual Property:** CSIR has been at the forefront of Intellectual Property generation - it enjoys a unique position amongst publicly funded R&D organizations nationally and internationally. CSIR has filed 2393 patent applications in India and 3296 patent applications abroad (in multiple countries) while it was granted 1687 Indian patents and 3019 foreign patents (in multiple countries) during 2013-14 to 2022-23. Presently, CSIR has a patent portfolio of 1,234 unique patents in force in India, out of which 263 patents/patent applications have been licensed/assigned to industry. CSIR also has 1,365 in-force patents granted abroad in multiple countries.
- **Creating and Nurturing S&T Human Resource:** CSIR has focused in a significant manner on the development of S&T Human Resource and provided the yeoman service. CSIR's support for creation and nurturing of National S&T Human Resource transcends diverse sectors and discipline of science and technology. These young budding researchers are contributing in the scientific publications, patents, technology, processes and overall development of S&T in the country. This is the pool of young researchers which is being utilized by universities and R&D institutions for their research and development work/activities and is a precious S&T asset of the country. During the period 2013-14 to 2022-23, CSIR has supported 91469 doctoral and postdoctoral fellows including award of 36296 New Doctoral and Postdoctoral Fellowships and disbursed an amount of Rs. 3057.99 crores as fellowship during the same period.
- **Scaled-up plant for production of Hydrazine Hydrate:** The Hon'ble Prime Minister, Shri Narendra Modi, inaugurated the scaled-up plant for production of Hydrazine Hydrate

(HH) developed in collaboration of CSIR-Indian Institute of Chemical Technology (IICT), Hyderabad and Gujarat Alkalies and Chemicals Ltd (GACL), Gujarat on October 10th, 2022, as an initiative towards '*Atmanirbhar Bharat*'. The plant developed is based on CSIR-IICT's and GACL's jointly patented technology for production of 10,000 tonnes per year of Hydrazine Hydrate. The collaboration of CSIR-IICT and GACL led the process development from laboratory scale to pilot scale, and then to a commercial scale. The scale up ratio from pilot scale to commercial scale has been up to 100 times. The first consignment of the developed Hydrazine Hydrate (80%) was flagged off from Dahej complex on 8th July 2023.

- **National Atomic Timescale and Bhartiya Nirdeshak Dravya Pranali:** Hon'ble PM, Shri Narendra Modi dedicated the National Atomic Timescale and Bhartiya Nirdeshak Dravya Pranali to the Nation and laid the Foundation Stone of National Environmental Standards Laboratory on 75 years of CSIR-NPL.
- **Wax Deoiling Technology at Numaligarh Refinery, BPCL:** CSIR- Indian Institute of Petroleum (CSIR-IIP), Dehradun, in association with the Engineers India Ltd (EIL) had won international competition to adopt the Wax Deoiling Technology developed by CSIR-IIP, at Numaligarh Refinery Ltd (NRL). The Wax Deoiling Plant based on such indigenously developed technology was set up with an investment of ₹750 crore at NRL - a subsidiary of Bharat Petroleum Corporation Limited (BPCL) - situated in north-east part of India. The Plant was dedicated to the Nation by Hon'ble Prime Minister in February 2016. It will produce 50,000 MMTPA of high value Paraffin Wax and 4,500 MTPA of Microcrystalline Wax at the full capacity. The wax plant helped to develop small-scale ancillaries and cottage industries in the nearby areas and will promote industrial development in the north-east region of India. The commercialization of indigenous technology is in line with 'Make in India' initiative taken by the Government of India.
- **Development of Dental Implants:** Under the partnership of Maulana Azad Institute of Dental Sciences (MAIDS), Delhi and IIT, Delhi, an indigenous dental implant has been designed, developed and successfully validated in human clinical trial under CSIR-NMITLI project. The technology for Dental Implants has been transferred to M/s Innvolution Healthcare Pvt. Ltd., Delhi. With this, the country has taken the first step towards "Make in India" implants and import substituted technology. A dedicated manufacturing, cleaning and packaging setup has been established at Faridabad. The industry has obtained the manufacturing license in June 2019 and has commercialized the implants in the name of "ifix" in India. The developed technology has been appreciated through a letter of commendation by Hon'ble Prime Minister of India.
- **Technology for recovery of valuable Potash from spent wash:** CSIR-CSMCRI has developed a technology for recovery of valuable Potash from spent wash generated in sugarcane molasses-based alcohol distillery that saves foreign exchanges and prevents hazardous spent wash being discarded into the environment. Plant based on CSIR-CSMCRI spent wash technology commissioned at Aurangabad Distillery Ltd. (60 klpd), Walchandnagar, Maharashtra. The effort was appreciated by Hon'ble PM, Shri Narendra Modi.
- **Traditional Knowledge Digital Library (TKDL): Fight against bio-piracy:** CSIR has played a major role in protecting India's rich traditional knowledge in healthcare by creating the TKDL. The TKDL involves documentation of the traditional knowledge available in public domain in the form of existing literature related to Ayurveda, Unani, Siddha and Yoga, in digitized format. As a prior-art database of Indian traditional knowledge, the TKDL serves to prevent wrongful grant of patents on applications of relevance to the traditional knowledge. The access of the TKDL database containing over

4.39 lakh formulations from ancient texts of Ayurveda, Unani, Siddha, and Sowa Rigpa and practices of Yoga, is given to patent offices world-wide that have signed Non-disclosure Access Agreements with the CSIR, for search of TKDL evidences in the context of patent applications filed with them. The TKDL database is currently available to 15 patent offices. Further, in addition to the use of TKDL database by patent offices for examination of patent applications, the CSIR-TKDL Unit also files third party observations and pre-grant oppositions on patent applications related to Indian traditional knowledge, based on the TKDL evidences. Since 2009, 283 patent applications have been either refused, withdrawn/deemed withdrawn or amended or set aside on the basis of TKDL evidence, thus protecting Indian traditional knowledge. The TKDL is proving to be an effective deterrent against bio-piracy and is being recognized as a global leader in the area of traditional knowledge protection.

- **Widening access of the TKDL database to users, besides patent offices:** The Cabinet chaired by Hon'ble Prime Minister, Shri Narendra Modi approved the Widening access of the Traditional Knowledge Digital Library (TKDL) database to users, besides patent offices on 17 August 2022. The opening up of the TKDL database to users will drive research & development, and innovation based on India's valued heritage across diverse fields.
- **Contributions to Chandrayaan-3 Mission -** CSIR-NAL has played a crucial role in carrying out the wind tunnel tests of Chandrayaan-3 launch vehicle. The main launch vehicle, LVM3, that carried the Chandrayaan-3 module was extensively tested and characterised in the 1.2m trisonic wind tunnel of the CSIR-National Aerospace Laboratories (CSIR-NAL), Bengaluru. More than 3,000 wind tunnel tests were carried by CSIR-NAL to characterise the Launch Vehicle Mark 3 (LVM3) which included force measurements, steady and unsteady pressure measurements, booster-load measurements, booster misalignment studies, aero-elastic and nozzle load studies apart from surface and off-surface flow visualisation studies. All stages of LVM3 with Chandrayaan-3 payload fairing were acoustically characterised in this facility and cleared for launch, which was crucial for the mission.
- **CSIR's Indigenous E-Tractor, CSIR Prima ET11:** The Hon'ble Minister of State (Independent Charge), Science and Technology and Vice-President, CSIR, Dr. Jitendra Singh, on August 21st, 2023, launched the compact E-Tractor CSIR PRIMA ET11, indigenously designed and developed by CSIR-CMERI to cater to small and marginal farmers of India.
- **First Ever Biofuel-Powered Flight:** CSIR facilitated India's First Ever Biofuel-Powered Flight paving the way for sustainable and alternative fuels when the first biofuel-powered flight was flagged off from Dehradun to Delhi. The bio-aviation fuel was produced indigenously by CSIR-IIP from Jatropha oil and was based on the patented technology of the institute. For the first time in the country, on 26th January 2019, an IAF AN-32 aircraft powered with 10 percent blend of biofuel conducted flight operations at Leh, one of the highest airports in the world.
- **Indigenous Autoclave Technology:** CSIR-NAL has successfully developed state-of-art Indigenous Autoclave Technology for processing advanced light weight composites that are integral to modern day civil and military airframes.
- **Waste Plastics to Fuels:** CSIR-IIP in collocation with and GAIL (India) Ltd have developed a technology that can convert 1 tonne of plastic waste and other Polyolefin products into 850 litres of the cleanest grade of diesel.
- **High Rate Biomethanation Technology:** CSIR-IICT has developed and patented a high rate biomethanation technology known as anaerobic gas lift reactor (AGR) for the generation of biogas and bio manure from organic solid waste like poultry litter, food

waste, press mud, cattle manure, organic fraction of municipal solid waste (OFMSW), sewage sludge etc. This has been implemented in more than 20 places across the country including the Bowenpally Vegetable market in Hyderabad.

- **RENEU Technology:** CSIR-NEERI has developed the RENEU Technology for the construction of wetlands that are sustainable wastewater treatment processes. RENEU was successfully implemented at Jhunsi, Prayag Raj, in readiness for the Kumbh Mela of 2019, being part of the National Mission to keep the Ganges clean for the pilgrims during the holy festival.
- **Whole genome sequencing:** CSIR has conducted whole genome sequencing of 1,008 Indians from different populations across the country. The whole genome data is important for building the knowhow, baseline data and indigenous capacity in the emerging area of Precision Medicine. This genome sequencing has enabled benchmarking the scalability of genome sequencing and computational analysis at population scale in a defined timeline.
- **Technology for Diagnostic tests:** Technology for 27 Diagnostic tests for genetic diseases was developed and transferred to Lal Path Labs by CSIR-IGIB.
- **Global Licensing Pact with Sun Pharma:** CSIR-IICT has signed a Global Licensing Pact with Sun Pharma for patents on dermatology, ophthalmology and oncology. Sun Pharma will pay upfront, and milestone linked payments up to Rs 240 crore and royalties to CSIR-IICT from commercialization.
- **Zero-Wastewater Discharge Technology:** CSIR-CLRI has developed a **zero-wastewater discharge technology** based on Electro-oxidation (EO) in the pre-tanning phase of the leather manufacturing process.
- **Drishti Transmissometer:** CSIR-NAL has developed and transferred the technology of Drishti Transmissometer that have been deployed in many airports in India. The transmissometer is a visibility measuring system, useful for safe airport operations and landing. Drishti been installed at several airports in the country and recently the 50th Drishti was installed at the runway of Kempegowda International Airport (KIA).
- **Made in India aviation weather monitoring system installed at Bengaluru International airport:** CSIR-NAL has indigenously developed Aviation Weather Monitoring System (AWMS) which has recently been installed at the new runway of Kempegowda International Airport (KIA). With this, KIA has become the first airport in the country to install indigenous AWMS technology, at both ends of the new runway. With the web-enabled feature, the data can be accessed, and maintenance carried out from any location. The 10-meter mast on which AWMS sensors are installed is a first-of-its-kind, designed by NAL, with several unique features, including being eco-friendly and lightweight, with a life of over 60 years. The sliding mechanism enables easy maintenance - a useful feature-considering the busy traffic on the runway.
- **CSIR-NAL's Octa-Copter:** CSIR-NAL has developed a medium-class BVLOS (Beyond Visual Line of Sight) multi-copter UAV. The UAV is made out of a lightweight carbon fibre foldable structure for ease of transportation and has unique features like autonomous guidance through dual redundant MEMS-based digital Autopilot with advanced flight instrumentation systems. DGCA, Ministry of Civil Aviation, Govt. of India has granted conditional permission to CSIR-NAL for conducting BVLOS flight trials. Subsequently, the NAL drone has completed about 50 hrs of flying to verify the performance parameters and the report is being submitted to MoCA for type approval. NAL's Octa-copter Drone is capable of carrying payload of 20 kg for a duration of 20 minutes. These drones have been configured to suit multiple applications for societal needs. The three applications envisaged are (a) Emergency Medical/ Vaccine Delivery (b) Agricultural Spraying and (c) for Geophysical Survey applications.

- **CSIR Technologies for India's First Light Combat Aircraft - TEJAS:** CSIR has been Integral Partner with ADA in Design and Development of TEJAS. CSIR developed and fabricated 165 composite parts, Fly-by-Wire (FBW) Control Systems and State of art training simulator.
- **Indigenous Process Technology for Carbon Fiber for Aerospace application:** CSIR-NAL has developed standard modulus grade carbon fiber in pilot scale and demonstrated the process technology to Centre for Military Airworthiness and Certification (CEMILAC) & Directorate General of Aeronautical Quality Assurance (DGAQA). The developed product has been certified by CEMILAC for aerospace application. Technology know how has been transferred to Bhabha Atomic Research Centre (BARC) on non-exclusive basis.
- **Head-Up Display (HUD) for the Tejas Fighter Aircraft:** The HUD was developed and deployed by CSIR-Central Scientific Instruments Organisation (CSIR-CSIO) for Air Force Fighter, Air Force Trainer and Naval variant of the LCA. A transfer agreement for the manufacturing of a new variant of Head-Up Display (HUD) for the Tejas Fighter Aircraft for commercial production has been signed between CSIR-CSIO, Chandigarh and Bharat Electronics Limited (BEL).
- **Bharatiya Nirdeshak Dravya (BND 420)** 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.
- **CSIR-NPL as the National Verification Agency:** Union environment ministry has designated CSIR-NPL as the National Verification Agency for certifying instruments and equipment for monitoring emissions and ambient air quality, which will assist in maintaining standards of instruments and data of air quality being collected.
- **Mob Control Vehicles:** Following direction of the Prime Minister's Office to CSIR and Specification formulated by the Committee, constituted by Ministry of Home Affairs, CSIR-CMERI has designed and developed three categories of Mob Control Vehicle (MCV) prototypes (Heavy, Medium and Tractor based MCV) with 09 innovative featured technology modules. CRPF-RAF officials had participated in mock trials at CSIR-CMERI Durgapur/Ludhiana and training sessions at 103Bn and 108Bn CRPF-RAF campus. All 3-Categories of MCVs had been demonstrated to the MHA Committee members at CRPF-campus Gurugram and 103 Bn CRPF-RAF campus. DG-CRPF has approved the necessary QR/TD (Qualitative Requirements and Trial Directives) of all 3-categories of MCVs, based on recommendation of MHA committee. The developed MCVs have been licensed to the Industries for commercialization.
- **Discovery of Shale Gas:** CSIR-CIMFR has discovered shale gas in two areas in the Gondwana basin in Central India and Godavari basin. The total shale gas discovered so far in the country in these two basins is estimated to be about 63 Trillion Cubic Feet (TCF). It is considered as one of the best sources of non-conventional natural gas.
- **CSIR's Divya Nayan for Visually Impound:** A reading device developed by CSIR-CSIO helps the visually impaired by reading the text aloud. The advanced reading machine named "DivyaNayan" is a stand-alone, Portable Reading Machine (PRM). The technology has been transferred to CEL Central Electronics Limited (CEL).
- **Process Technology to create Dimethyl Ether (DME) from Methanol:** CSIR-NCL has set-up an indigenous process technology to create Dimethyl Ether (DME) from methanol. DME is a clean fuel with potential to replace diesel and will be a non-fossil additive to LPG gas. This will also help the Prime Minister UjjwalaYojana program, by reducing LPG imports.

- **Earthquake Warning System:** A first of its kind Earthquake Warning System has been developed by CSIR-CSIO. The system can sense tremors, record them and generate an SMS to the concerned action points, in real time. It has been deployed and is operational at Delhi Metro since July 2015.
- **Indigenously built Research Vessel ‘Sindhu Sadhana’:** The first indigenously built research vessel ‘Sindhu Sadhana’ was dedicated to the Nation in 2014 by Dr Jitendra Singh, Hon'ble Minister of State (I/C), S&T. The multi-disciplinary research vessel of CSIR-NIO is 80 meters long and 17.6 m wide and can accommodate 57 personnel including 29 scientists and 28 crew members. It is designed for a cruising speed of 13.5 knots and an endurance of 45 days. The research vessel has 10 laboratories which are fitted with state-of-the-art equipment facilitating high precision data and sample acquisition.
- **Development of Green crackers with less pollutant emission:** CSIR-NEERI developed Green Crackers in a bid to curb air pollution. These environment friendly Crackers are of new formulations for reduced emission light and sound emitting crackers with 30% reduction in particulate matter. CSIR has also successfully developed various environment-friendly fireworks such as sound emitting crackers, flowerpots, pencils, chakkar and sparklers. CSIR in developing these green crackers have signed nearly 230 MoUs and 165 Non-disclosure Agreements with firework manufacturers in order to deliver the crackers. Green logo and QR coding system was also launched to track manufacture & sale of counterfeit crackers.
- **KisanSabha App:** KisanSabha App has been developed by CSIR-CRRI to connect farmers to the supply chain and freight transportation management system. This portal acts as a one-stop solution for farmers, transporters, and other entities engaged in the agriculture Industry. More than one lakh downloads and also available in regional languages.
- **Handheld GPS-Enabled ‘Ksheer Tester’-System for detection of Adulteration in milk:** ‘Ksheer Tester’, developed by CSIR_CEERI, is a handheld GPS-enabled version of the Ksheer Scanner technology developed by CSIR to check adulteration in milk. It will empower the common man with a technology to tackle a national level health hazard due to adulteration in milk. The device would enable any person to track the location of the tested sample and receive the test results through SMS on the device.
- **3D-Printed Patient-Specific Medical Implants:** CSIR-CSIO developed a technology for manufacturing patient-specific medical implants for several human body parts. The technology has been transferred to industry for commercial production and marketing of the product. Patient-specific implants are required in trauma, diseases like cancer, fungal infection or other reconstructive surgeries for specifically targeted patients.
- **New Improved Samba Masuri (ISM):** CSIR-CCMB in collaboration with the Indian Institute of Rice Research at Hyderabad has released a new variety of rice that resists pests and is also beneficial for those with diabetes. The new Improved Samba Masuri (ISM) rice variety is resistant to Bacterial Blight (BB) and at the same time has the lowest Glycemic Index (GI) at 50.9 among all major rice varieties.
- **Barley-Seaweed-based Anti-obese supplement “SeaSlim”:** CSIR-CFTRI, Mysuru: The prevalence of obesity in India has increased over the past decade and it ranks third in the world. The market for anti-obese foods is getting propelled owing to rising obesity cases and side effects of the drug. In order to address the same, CSIR-CFTRI has developed Barley-Seaweed-based Anti-obese supplement “SeaSlim” to manage obesity. The food can provide an adequate amount of energy, fat, carbohydrate, and protein. SeaSlim helps in regulating body weight by reducing food intake, plasma glucose and blood and adipose lipid level and can be used as low-glycemic index food. Food can be

stored for more than 6 months in metallized polypropylene pouches. Product has no added preservative, color, flavor, thickening agent, anticaking agent. No side effects and no heavy metals and can be consumed daily.

- **Successful Inaugural Flight of SARAS PT1N:** SARAS PT1N (14 seater) light transport aircraft designed and developed by CSIR-National Aerospace Laboratories (CSIR-NAL) was flown successfully on 24th January 2018. The primary objective of PT1N is to evaluate system performance in about 20 flights and the data collected from this shall be used to freeze the design of 19 seater production version aircraft - SARAS MkII.
- **High-Power S-band, 2.6 MW, Magnetron:** Magnetron, a high-powered vacuum tube, is an essential component for Medical LINAC (Lineal accelerator), which are widely used for external radiation treatment of cancer patients. CSIR-CEERI designed and developed 2.6 MW S-band tunable pulsed Magnetron, which was successfully tested and used as a microwave source, to generate the required X-ray dose using a LINAC system for Cancer treatment. On July 14, 2020, the technology know-how for S-band Magnetron was transferred to M/s Panacea Pvt. Ltd., Bangalore, known for developing advanced radiotherapy systems for Cancer treatment.
- **Fluorescent Fibers and Ink for Security:** CSIR-NIIST has developed Fluorescent Fibers and Ink for Security. Invisible fluorescent fibers find important use for preventing currency/document/ consumer goods counterfeiting. Fluorescent ink formulations with unique fluorescent signatures has application for security printing.
- **Nutraceutical for Osteoarthritis:** CSIR-CDRI have developed a standardized nano-formulation from *Spinaceaoleracea* (Palak) for prevention and management of osteoarthritis by preventing cartilage damage. This nutraceutical has extra health benefits for osteoarthritic joints in addition to the basic nutritional value found in *Spinaceaoleracea*. It imparts no toxicity and is effective at lower doses with nano formulation. It has been launched with M/s Pharmanza Herbals Pvt. Ltd., Gujarat and its marketing partner namely, Aeran Lab (India) Pvt. Ltd., Thane for marketing, on March 13, 2018 as a Nutraceutical with brand name “Joint fresh”.
- **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. 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.
- **CSIR Aroma Mission and Floriculture Mission:** CSIR launched the CSIR-Aroma Mission in 2016 which 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. CSIR’s Aroma and Floriculture Missions have brought 27,500 hectares under cultivation of aromatic crops. CSIR has also developed entrepreneurship (110) through technologies that promote cultivation and processing of aromatic crops, value-added aromatic crops for high-end aroma chemicals and products. For the first time ever, Asafoetida (*Heeng*) cultivation has been introduced in India and Saffron cultivation has been widened. CSIR enabled the famed **Purple Revolution** by introducing Lavender Cultivation in 10 districts of J&K benefitting more than 1000 farming families. India from being one of the importers of Lemongrass essential oil a few years back, now becomes one of the largest exporters in the world. Indigenous development of Tulip bulb production in Lahaul & Spiti under the Floriculture mission helped reduce the import of planting material.
- **CSIR Cotton Mission:** CSIR initiated the Cotton Mission in 2019 to develop next

generation transgenic cotton for broad-spectrum resistance to field pests for yield protection. For the control of the devastating cotton insect pest whitefly, CSIR-NBRI has developed 33 GM cotton lines using its patented gene Tma12. These GM cotton lines show significant tolerance to whiteflies. The problem of pink bollworm (another major cotton insect pest) is being addressed by CSIR-IICT. For the control of whitefly vectored viral diseases in vegetable and horticultural crops, CSIR-National Botanical Research Institute, Lucknow has developed a new GM cotton. This GM cotton attracts whiteflies and kills them. It can guard several crops against viral diseases. The technology will enable farmers to grow crops without application of pesticides.

- **Seaweed Cultivation & Processing:** CSIR has provided hands on training on seedling preparation, farming, harvesting and post harvesting of biomass to more than 2500 farmers (95% women) from Tamil Nadu, Gujarat and Andhra Pradesh to encourage them for undertaking seaweed cultivation. Scale up of Zero Liquid discharge “ZLD” downstream processes for the production of valuable seaweed products have been performed. Seaweed processing plant (0.25 tons) has been handed over to Department of Fisheries, Govt. of Tamil Nadu. *Kappaphycus alvarezii* and Red Seaweed based formulations for improving productivity and health of dairy and poultry animals (technology transferred to AquaAgri Processing (P) Ltd).
- **Technological innovation Energy Storage devices:** Under CSIR’s Innovation Centre for Next Generation Energy Storage Solutions (ICeNGESS) project, CSIR-CECRI’s knowhow on Lithium-Ion Battery Technology was transferred to M/s. Tata Chemicals Ltd., Mumbai. The major objective of the project has been to develop next generation energy storage solutions with 100 MW Li-ion battery production facility creation and augmentation of existing facility to 1000 cells per day, the project also aimed for IPR & Technology development, scale up & production of battery materials, supply chain creation & indigenisation, sustainability of Lithium from Coal and to develop Public Private Partnership (PPP).
- **Gaon Ka Pani Gaon Mein:** CSIR has led a Mission mode project for developing Village Level Water Management (VLWM) Plans for augmenting water resources in selected villages. Mission on **High-Resolution Aquifer Mapping & Management in Arid Regions of North-Western India** has also been launched and implemented in association with the Ministry of Jal Shakti under Jal Jeevan Mission. Use of advanced Heliborne geophysical survey and other scientific studies have been initiated under the Aquifer Mapping Programme of the Mission. So far, 1 lakh Sq. Km Heliborne geophysical survey data has been collected in the states of Rajasthan, Haryana and Gujarat. This survey led into identification of water source at Munjasar, Lohawat Block, Jodhpur District, Rajasthan.
- **Launch of India's first indigenously developed Hydrogen Fuel Cell Bus:** India's first indigenously developed bus to run on hydrogen fuel cell been designed and developed by CSIR-NCL and CSIR-CECRI in collaboration with Sentient Labs. The 32-seater bus, equipped with central air conditioning facility, is designed to provide a range of 450 kilometres by utilising 30 kg of Hydrogen. The bus uses hydrogen fuel cells and air to generate electricity for power and can run for 600 km without stopping. The only emission from the bus is water, thus, making it the most environment friendly mode of transportation. The 'Made in India' hydrogen fuel cell bus was launched on 21 August 2022, in Pune.
- **Earthquake & natural disasters—developed technology for reducing property loss:** CSIR-CBRI and CSIR-SERC have been designing structures that can withstand earthquakes, and due emphasis and importance are being given to incorporate this aspect in all designs.

- **CSIR focuses 'Waste to Wealth' technologies to supplement the efforts of *Swachta Abhiyan*:** CSIR has developed many waste to wealth technologies and products such as spent wash from distillery, plastic waste to diesel, industrial solid waste, brine sludge, e-waste, coal-based power industry waste, biomass/agri waste, fertilizer industry waste, lime sludge, marble waste, etc. and these technologies are at various stages of implementation with MSMEs, industries and other partners.
- **Steel Slag Valorisation Technology for Conversion of Steel Slag as Road Making Aggregates:** CSIR developed the steel slag valorisation technology to convert waste steel slag as road making aggregates. Processed steel slag aggregates as developed through waste steel slag has been successfully utilized in the construction of India's First Steel Slag Road at Hazira, Surat. Around one lakh ton processed steel slag aggregates were utilized as 100% substitute of natural aggregate in steel slag road construction. For its unique design features Steel Slag Road built through CRRI technology has been inducted in INDIA BOOK of Records and ASIA BOOK OF RECORDS as First Steel Slag Road. Border Roads Organisation (BRO) using the CSIR-CRRI technology has laid a one km road in border area of Arunachal Pradesh.
- **Design and development of CSIR - TechnoS Raman Spectrometers (CTR Series):** CSIR developed and commercialized Raman spectrometers in a Public-Private Partnership, in a collaboration of CSIR-AMPRI, Bhopal and M/S TechnoS Instruments, Jaipur. Two models of high-end commercial grade Raman Spectrometers, CTR-300 and CTR-150 have been developed and approved for marketing by the industry partner, M/S TechnoS Instruments in January 2022.
- **Maiden flight of HANSA-NG:** CSIR-NAL designed and developed Hansa NG aircraft which is an all composite two seat light trainer aircraft to be used as an ab-initio flying training aircraft for the flying clubs in India, with significant modifications on Hansa 3 aircraft to make it more useful as a trainer aircraft. The newly developed Hansa 3 (NG) made its maiden flight on 3rd September 2021 after obtaining special flight permit by DGCA. The 20-minute sortie saw the first prototype of the Hansa 3 (NG) attain a maximum altitude of 4,000 feet and a speed of 80 knots before it made a successful touch down. Further, the aircraft has successfully completed the sea level trials at Puducherry between February 19 and March 5. The aircraft was flown to Puducherry, covering 140 nautical miles in one and half hours at a cruising speed of 155 km/hr, on 19th February 2022. Further, HANSA-NG Aircraft successfully completed in-flight engine relight test at DRDO's Aeronautical Test Range (ATR) facility, Challakere on 17th May, 2022. Flight test was carried out at an altitude of 7000-8000 feet with the speed range of 60 to 70 knots. The in-flight engine relight test is most critical and important milestone towards certification of the aircraft by DGCA.
- **Development of Indian National Footwear Sizing System:** CSIR-CLRI conducted a nationwide survey on foot dimensions of the Indian population using 3D Digital Imaging technique to establish the Indian Footwear Sizing System. Thirty numbers of 3D Foot Scanners ordered and installed during the last week of September 2021. Synergy Partners were identified, and MoU signed with Central Footwear Training Institute (CFTI), Chennai, CFTI Agra, Government College of Engineering and Leather Technology (GCELT), Kolkata and Muzaffarpur Institute of Technology (MIT), Muzaffarpur. Demographic locations (79 districts) finalized based on the recommendations of National Sample Survey Organization (NSSO). Hands on Training for 90 field staff on 3D foot scanner started on 5th October 2021. A total of 1,01,880 foot measurements have been carried out by the end of March 2022. The Indian National Footwear Sizing System that is being developed will help the populace to get well fitting shoes that adhere to the contours of their feet thus ensuring perfect fit and comfort and also prevent foot

debilitations.

- **Development of Mechanized Scavenging machine:** CSIR-CMERI designed and developed the Mechanized Scavenging machine for up to 5,000 people density i.e. best suitable up to 300 mm diameter and up to a 100 metre length of the sewer system. The scavenging system is very economical and it will help the manual scavengers to enhance their efficiency, performance and also safeguard them against intrusive pathogens. The system was demonstrated at the premises of the CSIR-NPL, Delhi on 27th October 2021. The system is rigorously tested in the National Institute of Technology, Durgapur, National Power Training Institute, Durgapur, DVC colony, DSP colony in Durgapur. The technology Know how has been transferred to 2 MSMEs.
- **mRNA Vaccine Development Platform:** CSIR-CCMB has set-up a working platform to develop mRNA vaccines, starting with identifying a candidate for COVID-19 vaccine. The mRNA vaccines are modular. In principle, the mRNA can be inserted to make a protein of a pathogen of concern in human cells. This can be used to train the recipient's immune system to evade the real pathogen, if it infects.
- **Technology of Nucleic Acid Staining Dye GreenR™:** The dye GreenR™ has been developed by CSIR-CDRI in joint collaboration with industry partner Biotech Desk Pvt. Ltd (BDPL), Hyderabad. The product GreenR™ provides an economical alternative to commercially available dyes that are used to stain DNA/RNA, which are currently imported. It binds to all nucleic acids including genomic DNA, PCR products, plasmids and RNA and fluoresces under blue light or UV exposure. This dye has varied applications in molecular diagnostics and life sciences research. The chemical synthesis of GreenR™ was standardized by CDRI team and the BDPL team has studied its biological applications in real-time PCR and DNA binding. CSIR-CDRI has transferred the technology of the nucleic acid staining dye GreenR™ to GenetoProtein Pvt. Ltd (GPPL), a Start-Up registered in Uttar Pradesh, and the company has already started sampling this product amongst researchers both in academia and industry. The development of this indigenous dye will offer the Indian researcher an alternative to expensive imported dyes and take India a step closer to 'Atmanirbhar Bharat'.
- **Medha Plus - A Novel Polyherbal Formulation for Alzheimer's Disease:** Available synthetic drugs only provide symptomatic reliefs targeting single molecule, hence, are unable to address the multi-factorial aspects in Alzheimer's disease (AD) pathogenesis. It is imperative to develop combinatorial drugs that address the multiple molecular targets in AD. CSIR-IICB has conducted experimental studies on a herbal medicinal formulation 'Medha Plus' (MP) which is a unique combination of aqueous extracts of six therapeutic plants indigenous to South-East Asia and hugely propagated across India - *Brahmi*, *Mandukaparni*, *Sankhapusphi*, *Yastimadhu*, *Kokilaksha* and *Shunthi*. Experimental studies performed at CSIR-IICB showed that MP is an incredible combinatorial drug that targets multiple molecular targets with exemplary neuroprotective properties. An array of behavioral studies showed that MP was able to recover AD-associated memory deficits in both sporadic and familial AD models. MP treatment reduced Amyloid plaques deposits and decreased apoptotic cell death in the hippocampus. Enzymatic assays demonstrated anti-oxidative and anti-acetyl cholinesterase properties of MP. An underlying improvement in synaptic plasticity was observed with MP treatment as well.
- **India's First Indigenously Developed Laser-cooled Caesium Atoms based Primary Frequency Standard:** CSIR-NPL indigenously developed India's first laser-cooled Caesium (Cs) atoms based primary frequency standard NPLI-CsF1. Only a handful of (less than 10) such primary frequency standards, developed worldwide, contribute to the maintenance of international reference time UTC. Apart from international timekeeping,

such accurate standard will provide self-reliance in the field of precise Time and Frequency measurement which has measurable economic and strategic implications in the areas of navigation (ISRO's NavIC), telecommunication, smart grids, financial security etc.

- **Laboratory Scale Facility creation of 3D printing (3DP):** Extrusion-based research scale 3D concrete printer, installed at CSIR-SERC, was used for development of 3D printable concrete mixes. About 30 trial mixes were prepared to arrive at a successful 3D printable mix which satisfies flowability, buildability, and open time. Various mixes were developed using different industrial by-products (fly ash, silica fume, GGBS) and different types of fine aggregates such as standard sand, river sand and copper slag. Initial setting time and final setting time of printed sample was less compared to companion cast-in-place samples. Grade of the concrete was achieved as M30.
- **CSIR "JIGYASA Initiative":** JIGYASA is one of the major initiatives taken up by CSIR at national level to widen and deepen CSIR's Scientific Social Responsibility (SSR) by connecting school students to scientists at CSIR. CSIR has signed MoU with Kendriya Vidyalaya Sangathan (KVS), Jawahar Navodaya Vidyalaya. More than 3,00,000 students have benefitted from the programme. Recently, CSIR has engaged with Atal Tinkering Labs of Niti Aayog and aims to adopt 295 Atal Tinkering Labs established by Atal Innovation Mission nationwide to spur STEM based research and innovation interest in students leveraging its scientists and labs. India's first Virtual Science Lab for children under CSIR Jigyasa programme was launched on 22 November 2021. More than 170 activities such as comics, infographics, videos, simulations, games, podcast etc. are available on the Jigyasa online portal. The major objective of Jigyasa 2.0: Virtual Lab integration program is to develop an inspirational science lab where students will play, simulate, experiment, read and have fun while carrying out experiments virtually from any part of the nation.

Recently CSIR-Jigyasa mobile app and Indian Sign Language (ISL)-enabled astronomy lab for divyangjan students located in Karnal under the Jigyasa programme have been launched. The Jigyasa mobile app will be a game changer and school students can directly connect with CSIR scientists and interact with them to enhance their scientific acumen. Students will also be made aware of the latest happenings under CSIR –Jigyasa initiative from various labs of CSIR. Indian Sign Language (ISL)-enabled astronomy lab will provide an opportunity to expose divyangjan students to science and stimulate their curiosity besides promoting innovative spirit.

- **Connect global Indian Scientific Community on Digital mode:** CSIR has developed a virtual platform - **PRABHASS** (Pravasi Bharatiya Academic and Scientific Sampark) Portal to connect with the global Indian S&T Diaspora for jointly addressing societal challenges/ problems. Database of over 6000 Diasporas from 47 countries are available.
- **CSIR 'Skill India Initiative':** In addition to the above, CSIR laboratories have been continuously providing training in diverse areas for undergraduates, post graduates and Research students. They are also engaged in conducting Industry oriented training/skilling programmes that have been well accepted by users. In order to encapsulate all CSIR skill/ training programmes under one umbrella that envisages to cater to a diverse cross-section of people at various levels beginning with school dropouts to farmers to ITI diploma holders to graduates, CSIR has launched the programme on 'Skill India Initiative' in 2016. The initiative also aims to equip young minds with the necessary technological skills through exposure to CSIR laboratories to address the critical needs

for the technical gap created by the enormous usage of advanced technology. The emphasis is to create a robust and sustainable identified training modules of existing and new skill/ training programmes of trans-disciplinary in nature for workforce generation for the industrial requirement. CSIR has already trained more than 2 lakh personnel, since the launch of the scheme, under the initiative.

- **Mission Karmayogi:** With an aim to transform the training ecosystem and make it more learners focused and create shared knowledge resources, CSIR has joined hands with the Capacity Building Commission (CBC) and Mission Karmayogi, launched by Department of Personnel & Training (DoPT). Under Mission Karmayogi, CSIR organise 'Learning Hour' in Lab/Instt. for enhancing learning on topics relevant to the concerned lab. and also on the 'Integrated Government Online Training' (iGOT)' courses.
- **Improved lotus variety 'Namoh 108':** CSIR-NBRI launched an improved variety of the national flower Lotus with 108 petals called 'Namoh 108' on 14th August 2023 during the inaugural of the One Week, One Lab campaign of CSIR-NBRI. The Lotus variety is more weather resilient and can flower from March to December. This lotus was brought by NBRI scientists from Manipur to conduct research on it. This is the first Lotus variety whose genome is completely sequenced. This plant will never be extinct or endangered like many other flowers and plants have become. CSIR-NBRI also released apparels made from lotus fibre and perfume 'Frotus' developed from Lotus plants in collaboration with FFDC, Kannauj.
- **CSIR-NAL Launches Q Plane: An All-Electric Hybrid UAV for Last –Mile Delivery and Surveillance:** In a significant step towards advancing the capabilities of unmanned aerial vehicles (UAVs) in India, the CSIR-NAL unveiled the Q Plane – a lightweight all-electric UAV with vertical-take-off-and-landing capability. during the curtain raiser of One Week, One Lab, on 2nd August 2023. Designed for autonomous flight, the UAV has a range of 30 kilometres and endurance of up to 70 minutes.
- **Launch of CSIR-NAL's JALDOST airboat:** JALDOST, an airboat that operates on water, is designed and developed by CSIR-NAL to remove excess aquatic weed and floating waste from water bodies. The JALDOST has a closed airtight pontoon type hull to make it inherently unsinkable. It has a hybrid propulsion system, comprising air propulsion and paddle wheel propulsion. CSIR-NAL has developed two versions of the airboat — JALDOST Mark-1 and an upgraded version JALDOST Mark-2. The JALDOST Mark-2 has been designed on the specifications given by BBMP and can be used to clean lakes in Bengaluru. It was launched on 2nd August 2023, during the curtain raiser of One Week, One Lab, of CSIR-NAL.
- **Leather made from Mango Pulp:** A company in India is producing an eco-friendly vegan alternative to synthetic leather by using mango fruits based on the technology developed by CSIR-CLRI. India produces 20 million tons of mango a year, making it the world's largest producer of mango. In India up to 40% of mangoes are abandoned in the fields because they do not meet regulatory and market standards, so they can be used to produce alternative material to leather. The new material is made of 50% mango and degrades faster than polyurethane leather.
- **CSIR's first battery recycling pilot facility commissioned in Jamshedpur:** The CSIR-National Metallurgical Laboratory (NML) has commissioned the first Battery Recycling Pilot Facility of the CSIR at Jamshedpur to extract critical metals such as Lithium, Nickel, Manganese and Cobalt. It encompasses 1 Ton per day (TPD) battery dismantling and cathode material separation setup, apart from the integrated large-scale hydrometallurgical facility for extraction and separation of those critical metals.
- **CSIR-NIO discover active submarine volcano in Andaman Sea:** CSIR-National Institute of Oceanography (NIO) has discovered an active submarine volcano (Crater

Seamount) in the Andaman Sea, which has been at the epicentre of the seismic zone since it was first observed in 2007. Crater Seamount has the potential to erupt at any time leading to earthquakes and even tsunamis in the Java-Sumatra region. The timing of the eruption, however, cannot be ascertained.

- **Flag Off of "Recycling on Wheels Smart-ER" to Promote Cleanliness and Environmental Responsibility under *Swachhata Hi Seva* (SHS) campaign from CSIR Headquarters in Delhi:** In alignment with the *Swachhata Hi Seva* (SHS) campaign, celebrated from September 15th to October 2nd 2023, Hon'ble Minister S&T, Dr Jitendra Singh inaugurated the "Recycling on Wheels Smart-ER" at CSIR Headquarters in New Delhi on October 2nd 2023. Dr Kalaiselvi, DG, CSIR and Secretary, DSIR, addressing during the inauguration of the Special Campaign 3.0 for institutionalizing *Swachhata* said that all the 37 CSIR labs across the country are engaged with both physical cleaning and e-cleaning that is processing and weeding out of obsolete files.
- **Research on ongoing declines for the world's amphibians:** A groundbreaking paper published in Nature on 4th October 2023 reveals climate change as a major driver of amphibian decline. Climate change was the primary threat for 39% of species pushed toward extinction since 2004. Dr Karthikeyan Vasudevan of CSIR-CCMB was a part of this global study. <https://www.nature.com/articles/s41586-023-06578-4>.
- **Oral Contraceptive Pill 'Levorneloxifene' :** DGCI approved the clinical trials of an oral contraceptive pill 'Levorneloxifene' jointly developed by CSIR-Central Drug Research Institute (CDRI) and the technology partner.
- **Biomedical Waste to Soil Additives:** CSIR-NIIST has developed a dual disinfection-solidification system that can spontaneously disinfect and immobilize pathogenic biomedical waste such as blood, urine, sputum, body parts, etc, and convert them into value-added soil additives within minutes. Laboratory disposables, plastics, glass, etc. are disinfected and prepared for direct recycling. An automated equipment has been developed that ensures minimal human intervention in handling biomedical waste.
- **Honey Profiling using NMR:** CSIR-NCL is developing critical Nuclear Magnetic Resonance (NMR)-based profiling methodologies and data analytics for a variety of unifloral and multifloral Indian honey. These techniques not only allow for identification of premium quality honey that is suitable for exports but also enables quantification of adulteration in commercial honey.
- **CSIR-CIMAP research lowers nicotine content in Tobacco plant:** The CSIR-Central Institute of Medicinal and Aromatic Plants (CIMAP) has successfully lowered nicotine content in the Petit Havana Tobacco plant variety by using a genome editing tool and reduced 60-70 per cent nicotine in it, compared to nicotine content in wild-type plants. CSIR-CIMAP further plans to lower nicotine in commercial varieties to help people quit the habit by working on tobacco plant varieties used in cigarettes, cigars, beedi.
- **Technology for addressing humidity issue of salt:** CSIR-CSMCRI has successfully completed a project for Tata Salt that addresses the issue of yellowing of salt.
- **Release of *Bharatiya Nirdeshak Dravyas* (BNDs):** CSIR-NPL has released more than fifty BNDs since 2014 developed under the in-house BND Program of NPL and also in collaboration with other agencies. A few significant ones have been the release of Gold and Silver BNDs with different purities, release of Water BNDs to make India self-sufficient in water CRMs and release & export of Cement BNDs.
- **A new multi-component alloy-based catalyst designed for efficient production of Green Hydrogen:** Scientists from the Centre for Nano and Soft Matter Sciences (CeNS), Bangalore, and the National Chemical Laboratory (CSIR-NCL), Pune, have developed a promising catalyst for the hydrogen evolution reaction (HER), a crucial step in water

electrolysis for producing hydrogen. This newly designed catalyst, a mixture of cobalt, manganese, and tin known as Co-Mn-Sn alloy, has shown better efficiency and stability in generating hydrogen as compared to the individual metals or binary (Co-Mn, Mn-Sn or Co-Sn) alloys. The presence of manganese and tin in the alloy played a synergistic role in boosting its performance. As the Co-Mn-Sn alloy does not contain any platinum group metal it offers exciting prospects.

- **CHENANI-NASHRI Highway Tunnel Project:** The Chenani - Nashari tunnel project was completed in March 2017 and was dedicated to the nation in April 2017 by Hon'ble Prime Minister of India. CSIR-CIMFR has contributed in a significant way in this Highway Tunnel Project.
- **Establishment of a National Calibration Facility for PM1, PM2.5 and PM10 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 PM1, PM2.5 and PM10 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 PM2.5 sampler, has been developed and patented by CSIR-NPL. The technology has been transferred to M/s Environmental Solutions. The then 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.
- **State-of-the-art WHO cGMP Plant at CSIR-IIIM, Jammu:** State-of-the-art WHO cGMP Plant has been set up at CSIR-IIIM, Jammu for extraction, formulation, packaging of medicinal plant based phytopharmaceutical drugs under internationally accepted GMP guidelines. This is first such national cGMP facility established in the public sector in India. The state-of-the-art facility is first of its kind in public sector in India and has been issued a manufacturing license by Drug & Food Control Organization, Jammu & Kashmir.
- **Sickle Cell Anaemia:** Sickle cell anemia (SCA) is the most common blood related disorder in India with a high prevalence among ethnic groups that have a socio-economic disadvantage, such as tribal populations. Following directions of Hon'ble Prime Minister, CSIR is implementing a Mission Mode Project since 2017. Focusing on two states, Maharashtra and Chhattisgarh, CSIR mission has developed a comprehensive screening model by taking a multi-pronged approach of population screening, especially focusing on school-going children, antenatal screening of pregnant women and new born screening. Close to 25 lakh children have been screened in the two states and patients and carriers have been provided support. Hundreds of target couples were identified and through prenatal diagnosis and counselling, birth of affected kids has been prevented. With the success of the model, the same has now been extended to certain regions of Madhya Pradesh and plans are on for covering the state of Jharkhand in near future.

Hydroxyurea (HU) is one of the cheapest and most commonly used alternatives for long-term management of SCA patients. Under the Mission, the CSIR-IIIM generated relevant literature and data on its utility and in association with M/s Cipla Ltd., got its approval from CDSCO/DCGI for its marketing for specific use in SCA children, post Phase-IV studies. This has now set the stage for developing paediatric HU dosages and formulations with M/s CIPLA Ltd., which will increase the compliance for treatment. In addition, CSIR-CCMB has developed a simple, robust and economical point-of-care

procedure and devices (namely Direct blood/dried blood spot-based ARMS-PCR) to differentiate between patients, carriers and normal subjects. This cheap genetic testing protocol costing about Rs 50/- per test, can obviate the need for sophisticated tests. Further, it has the potential for use in testing for several monogenic genetic disorders. The leads from the CSIR Sickle Cell Anemia Mission on genome editing technology has now led to CSIR-IGIB getting a multi-centric 5 year preclinical/clinical trial for ex vivo and in vivo gene editing approved by DST in association with the Ministry of Tribal Affairs. CSIR-IGIB is implementing the project in collaboration with few national and International organizations.

- **Novel Therapy for Management of Sepsis:** In the partnership of M/s Cadila Pharmaceuticals Ltd. and PGI, Chandigarh under a 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 clinical trial report was submitted to DCGI which has approved the drug for use. With the success of the trial, Cadila Pharmaceuticals has launched the product, “Sepsivac” which is poised to resolve the unmet medical need of the world by gram negative bacterial infections.
- **CSIR signs MoU with Unnat Bharat Abhiyan-Indian Institute of Technology, Delhi(UBA-IITD) and Vijnana Bharti(VIBHA), New Delhi:** A Memorandum of Understanding (MoU) was signed between Council of Scientific and Industrial Research (CSIR) New Delhi, Unnat Bharat Abhiyan-Indian Institute of Technology, Delhi(UBA-IITD) and Vijnana Bharti(VIBHA), New Delhi. The MoU is expected to lay the foundation for cooperation and joint action in the area of Unnat Bharat Abhiyan (UBA) for rural development of India through CSIR technologies and related knowledge base in tune with the people’s aspirations in furtherance of the Government of India’s initiatives like Vijnana Bharati(VIBHA). The Unnat Bharat Abhiyan (UBA) is a flagship national program of the Ministry of Human Resource Development (MHRD), Government of India, envisioning the transformational change in rural development processes by leveraging knowledge institutions to help build the architecture of an Inclusive India. The purpose of this Memorandum of Understanding is to provide access to CSIR rural technologies for Unnat Bharat Abhiyan (UBA).
- **Indian air quality Interactive Repository or IndAIR launched:** CSIR-NEERI, Nagpur launched the Indian air quality Interactive Repository or IndAIR which has archived approximately 700 scanned materials from pre-internet era (1950-1999), 1215 research articles, 170 reports and case studies, 100 cases and over 2,000 statues, to provide the history of air pollution research and legislation in the country. Such a repository on the subject of air pollution is one of the first in the world.
- **Aerospace Grade Autoclave Technology (Industrial and Lab Scale sizes):** Autoclaves are used to manufacture airworthy composite components under suitable settings of pressure, vacuum and temperature. CSIR-NAL has successfully developed state-of-art Indigenous Autoclave Technology for processing advanced light weight composites that are integral to modern day civil and military airframes. The size of autoclaves developed range from smaller lab scale to very large sizes up to 5m working dia and 12m working length. The operating temperatures can be as high as 425 Deg C and pressures up to 15 barg. This will meet the requirements of Aerospace Industry, Research and Educational Institutes. The technology has been transferred to two private industries. In the last 7-8 years several autoclaves have been supplied to various organisations in the strategic sector as well as academic institutions. The autoclave

technology has been largely successful in promoting the local eco-system, mitigating imports and creating millions of employment man-hours within the country.

- **Electronics Augmentation on Bullet Resistant Bunker (BRB) Vehicle:** CSIR-CMERI electronically augment BRB vehicle of CRPF. The augmented features includes: Display with Wide Coverage to achieve a Wide FOV (Field of view) over a High Range; High Speed Video Transmission to Remote Location with Dynamic Cellular Network Assignment via Channel Bonding for High Speed Video Transmission; Public Addressing System (PAS) with Siren to help address the mob from vehicle; Search-cum-spot light aids operations during night or low light scenarios: Range 100-150 m and GPS aided navigation & tracking system - allows the authorities to get the locational update of the vehicle with tracker accuracy upto ± 10 m. The augmented vehicle was handed over to CRPF on July 18, 2019 in the presence of DG, CSIR and DG, CRPF. The vehicle was during Shri Amarnath Ji Yatra 2019.
- **Hydrogen Standard in Steel:** Certified reference material (CRM) used for determination of hydrogen in steel by hot fusion technique is cumbersome in terms of both cost and time as it an import product to India. CSIR-NML has developed an indigenous hydrogen standard (CRM) in steel as an import substitution. The CRM developed are cost effective ($\approx 50\%$ reduced cost) compared to available import standard. CSIR-NML is in advance stage in commercializing the hydrogen standard in steel as an indigenous product for the Indian customers.
- **Technology for Organic Farming:** CSIR-National Chemical Laboratory (CSIR-NCL), Pune, has signed a Technology Licensing Agreement with Greenvention Biotech Pvt. Ltd, Pune, for integrated pest and pathogen management in agriculture using fungi and their metabolites , on 12th June 2019. Eco-Friendly, integrated pest management in agriculture approach has been developed at CSIR-NCL as a technology using microorganisms such as fungi and their products. An eco-friendly, cost-effective, integrated pest management shall be useful to the farmers having small land holdings as well as to the farmers who export agricultural produce that has no chemical residues. Greenvention Biotech Pvt. Ltd is a start-up from Uruli-Kanchan (Pune) works on several agriculture-related products.
- **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.
- **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.
- **Salt Free Tanning Technology:** Enabling the Indian leather industry for global competitiveness at reduced environmental impact, more than 10 million square feet of leather processed based on CSIR-Central Leather Research Institute (CSIR-CLRI) developed technologies. The UNIDO, Vienna joined hands with CSIR-CLRI to establish UNIDO-CLRI Centre for Salt Free Tanning;
- **Development and licensing of affordable Water Disinfection System Oneer™ :** CSIR-Indian Institute of Toxicology Research (CSIR-IITR), Lucknow has developed

technology for “Drinking Water Disinfection System” with Trade name “Oneer™”. It is useful for continuous treatment of water. The technology of “Drinking Water Disinfection System” was transferred to M/s Bluebird Water Purifiers, New Delhi. Oneer developed by CSIR-IITR will provide safe and clean drinking water at a cost of just 2 Paise / Ltr. The Community level model is of 450 LPH capacity. It can be scaled up to 5000 to 1 lakh L/day.

- **Waterless Chrome Tanning Technology- a Game Changing Technology:** Chromium is the most sought after tanning agent with about 2.0 billion sq. ft. of leather being made in India. About 20 thousand tons of chrome tanning agent is discharged in the wastewater. In order to overcome the problem, CSIR-CLRI has developed waterless chrome tanning technology. The waterless tanning technology has now found PAN INDIA acceptance, with tanners in all clusters enrolling for its adoption. The technology has been put to use in about 50 tanneries in the country. This is truly a game changing technology that has emerged from the CSIR through CLRI.
- **High Grade Gelatin from and Protein Hydrolysate from Raw Hide and Skin Trimming Wastes:** Gelatin is widely used in the pharmaceutical industry to make capsules for drugs as well as in the food industry to make jelly candies, ice cream, and as thickening agent in cakes and soups. Leather processing generates huge amount of raw trimming wastes. CSIR-CLRI has developed technology for making high grade gelatin from waste material-trimmings of raw hide. The technology developed by CSIR-CLRI is towards complete utilization of proteinous constituents present in the trimmings. This technology is exclusively licensed at a cost of Rs. One Crore to M/s Anipro Manufacturing Company for making gelatin and protein hydrolysate within India.
- **Coal dust collecting and briquetting system:** It is pertinent to collect the dust from mine roads and put it to alternative use not only for reducing air pollution but also for improving the health of local populace. Road dust collecting system has been developed. CSIR-CIMFR has transferred the patented technology to M/s Tata Motors Limited, Mumbai.
- **Phytopharmaceutical for Glucocorticoid-induced Osteoporosis:** Globally glucocorticoid is the third biggest cause of osteoporosis. CSIR-CDRI has developed a standardized fraction of *Cassia occidentalis* Linn. for the treatment of glucocorticoid-induced osteoporosis and muscular atrophy. Technology licensed to M/s Pharmanza Herbals Pvt Ltd., Gujarat for further development and commercialization as a Phytopharmaceutical drug. The product is under development in Phyto-pharmaceutical mode and would be available in Indian and the U.S. market after completing necessary studies as per the regulatory guidelines
- **Safe Disposal of Municipal Solid Waste utilising high temperature plasma:** The technology has been developed for effective & eco-friendly disposal of municipal solid waste material generated on daily basis and generation of fuel gas containing predominantly CO and H₂ utilizing high temperature (>3000 °C) Plasma arc. The technology has been licensed to M/s Positronics Innovation Pvt. Ltd, Kolkata, WB for commercialization on non-exclusive basis for a period of 5 years.
- **Indigenous Nano-Materials for Construction:** CSIR-CBRI has developed cost effective nano-silica (n-SiO₂) for high performance concrete to replace silica fume, an imported material. The prepared SNPs are amorphous, powdered, spherical and particle size ranges from 20-50 nm. Pilot Plant for preparation of SNPs has been installed and running successfully. The developed nano-silica will result in speedy construction with higher performance and enhanced durability. It can be used as an admixture in cement/concrete.

- **Salivary Fluoride Detection Kit:** The indigenous salivary fluoride level detection kit and sensor station is unprecedented in its kind towards diagnosis of salivary fluoride level for the welfare and betterment of the society. It protects from Dental Caries; helps in remineralization; protects against tooth decay; and helps prevent premature tooth loss. The Technology has been transferred to two Indian Industries for commercialization for a period of 5 years.
- **CSIR technologies and products for Medium, Small & Micro Enterprises (MSMEs) - Catalysing upgradation, promotion & development:** A directory of CSIR technologies (642 in number) has been created and shared with DC, MSME. Technology/product demonstration and awareness raising events have been organised on Medicinal & Aromatic plants, Leather, Electrochemical Technologies and Food & Food Processing.
- **Anti-diabetes Herbal Drug Launched: Focused efforts towards Affordable Healthcare** - The CSIR constituent laboratories CSIR-National Botanical Research Institute (CSIR-NBRI) and CSIR-Central Institute for Medicinal and Aromatic Plants (CSIR-CIMAP) have jointly developed an anti-diabetic herbal formulation from a combination of natural extracts derived from six plant species mentioned in ancient Ayurveda texts. The drug, BGR-34, was approved by the Ministry of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homoeopathy (AYUSH) after it was tested on patients over a period of 18 months across the states of Delhi, Himachal Pradesh, Haryana, Punjab and Karnataka. The drug, to be taken as an add-on or adjuvant to existing diabetes treatment, helps in maintaining normal blood glucose levels, in addition to improving the immune system, releasing antioxidants and checking free radicals. About 67% patients showed normal blood sugar levels within 3-4 days of drug usage. The drug has been licensed to Delhi-based Aimil Pharmaceuticals Pvt. Ltd. for commercialization. The herbal drug costs Rs. 5 per pill, and has been launched in parts of North India.
- **Certification of Coal used in Power Plants – Supporting Stakeholders** - CSIR entered into an MoU with Coal Supplying Companies and Power Utilities for quality analysis of coal being supplied to power utilities by coal supplying companies. This collaboration will enhance efficiency of use of coal by power sector. The MoU was signed on June 28, 2016 at Anusandhan Bhavan, New Delhi, in the august presence of Dr. Harsh Vardhan, the then Hon'ble Minister of Science & Technology and Earth Sciences and Vice President, CSIR and Mr. Piyush Goyal, the then Hon'ble Minister of State (IC) of Power, Coal and New and Renewable Energy. As a part of the MoU, CSIR-CIMFR would make use of its knowledgebase support in maintaining the quality of coal at national level for the entire power sector. The certification helps power plants to use coal appropriate to the machinery and technology available in the plant and contribute to efficient use and, in the long run, reduce emissions. It provides a robust mechanism for proper inspection of coal and overtime [and has led to an improvement in the quality of coal.
- **CSIR technologies and products for Medium, Small & Micro Enterprises (MSMEs) - Catalysing upgradation, promotion & development:** A directory of CSIR technologies (642 in number) has been created and shared with DC, MSME. Technology/product demonstration and awareness raising events have been organised on Medicinal & Aromatic plants, Leather, Electrochemical Technologies and Food & Food Processing.
- **Streptokinase: From Natural to Recombinant to Next-generation Drugs** - CSIR has developed a portfolio of Streptokinase technology, a vital, life-saver injectable protein cardiovascular drug. Natural and recombinant streptokinase developed by CSIR is already in the market benefiting the people of the country. CSIR has also designed a

state-of-the-art clot buster protein (Clot Specific Streptokinase) which shows strong promise as a 'clot-specific' thrombolytic drug has received clearance from DCGI and is currently in Phase II clinical trials. Further, it has developed new generation of clot-busters comprising clinically beneficial thrombolytic molecules with enhanced half-lives so that lower doses can be given in a single-shot bolus as well as target (fibrin/clot) specificity.

- **Vaccine against Johne's disease** - Johne's disease (JD) is progressive granulomatous enteritis of ruminants characterized by untreatable, profuse, chronic diarrhoea, weight loss, and emaciation. JD may be the major cause of reduced productivity in Indian animals, which number over 200 million. JD is endemic in the ruminant population of India and has also been reported from human beings. Two formulations of vaccine i.e. JD Oil and JD Gel have been developed under the CSIR-NMITLI Scheme with M/s Biovet Private Limited, Bengaluru. The vaccine is the first indigenous vaccine against Johne's disease affecting ruminants. The Drugs Controller General of India (DCGI) has approved and State Drug Authority, Karnataka has issued drug manufacturing license for manufacture of the vaccine developed.
- **Anti-diabetes Herbal Drug Launched: Focused efforts towards Affordable Healthcare** - The CSIR constituent laboratories CSIR-National Botanical Research Institute (CSIR-NBRI) and CSIR-Central Institute for Medicinal and Aromatic Plants (CSIR-CIMAP) have jointly developed an anti-diabetic herbal formulation from a combination of natural extracts derived from six plant species mentioned in ancient Ayurveda texts. The drug, BGR-34, was approved by the Ministry of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homoeopathy (AYUSH) after it was tested on patients over a period of 18 months across the states of Delhi, Himachal Pradesh, Haryana, Punjab and Karnataka. The drug, to be taken as an add-on or adjuvant to existing diabetes treatment, helps in maintaining normal blood glucose levels, in addition to improving the immune system, releasing antioxidants and checking free radicals. About 67% patients showed normal blood sugar levels within 3-4 days of drug usage. The drug has been licensed to Delhi-based Aimil Pharmaceuticals Pvt. Ltd. for commercialization. The herbal drug costs Rs. 5 per pill, and has been launched in parts of North India.
- **eSkIN – An *in silico* Platform for Skin Data Analysis** – Under the CSIR-NMITLI project CSIR-IGIB and CSIR-NCL in collaboration with NII, JNU and Persistent Systems Ltd., has developed and launched “eSkIN”, a first- of- its- kind computational platform that converts large scale high-throughput omics data into biomedical knowledge. It empowers skin researchers to predict the effects of their compounds on human skin in a cost and time - efficient manner with reduced animal testing.
- **Mercury-free UV lamps for Water Purifiers – Green Solutions for Societal Problems** - The CSIR-Central Electronics Engineering Research Institute (CSIR-CEERI), Pilani has developed mercury-free plasma (MFP) UV-lamp for water disinfection systems which would provide water free of environmentally and health hazardous mercury. The developed MFP-UV-lamp is a better alternative for mercury-based UV lamps and has been well-tested in the household water purifier systems. This is a first of its kind worldwide. The technology can also be used for sterilization of food, medical equipment, surfaces, ill-skin conditions, air-conditioners and air fresheners for hospitals, etc. The technology has been transferred to two companies for its mass production.
- **Environment-friendly process for conversion of ilmenite to titanium feedstock: Niche technologies for “Make in India”** - Ilmenite is a natural mineral present in the beach sands of Kerala and Tamil Nadu. The environment-friendly process technology

developed by CSIR-NIIST, Thiruvananthapuram involves the conversion of ilmenite to beneficiated titanium feedstock, which is the base material for production of titanium metal and titanium dioxide, two critical products used in the aerospace, automotive, medical, sports, cosmetics and paint industries. The new process developed involves a 70 per cent reduction in acid consumption and the bulk of the iron values are removed in the form of oxides free of excess acidity and chloride contamination. The laboratory has joined hands with the Tamil Nadu-based V.V. Minerals for demonstrating the process at a pilot plant to be established at Gummidipoondy, near Chennai. The plant would produce 100 tonnes of beneficiated ilmenite per day for test marketing, consumer feedback and generation of sufficient engineering and process data for the design of a commercial production unit.

- **Anaerobic digester to convert household organic kitchen waste to biogas: Interventions for Swachh Bharat** - Biodegradable wastes from kitchen contribute significantly to pollution, which demands immediate management and treatment. The technology for converting household organic kitchen waste to biogas was developed by CSIR-National Institute for Interdisciplinary Science and Technology (CSIR-NIIST), Thiruvananthapuram. Each anaerobic digester has a capacity to convert up to 3kg per day bio-degradable kitchen waste which will be converted to 400 litre biogas which can be used as fuel. In the process, it will discharge about 2.5 litres of manure which can be used for kitchen garden. The technology has been transferred to Pune based company, Mailhem Ikos Environment Pvt Ltd and will also be utilised by Thiruvananthapuram Corporation.
- **CSIR-Centre for Strategic Urban Management (C-SUM) - Interventions for Swachh Bharat** - CSIR-National Environmental Engineering Research Institute has established a Centre for Strategic Urban Management (C-SUM), which aims to involve urban local bodies and stakeholders for building smart sustainable cities. C-SUM will provide the solutions to improve the city's environmental quality and reduce carbon footprint. It will also address the local environmental issues on priority to better achieve sustainable urbanization with appropriate environmental planning, management capacity and policy application. C-SUM will form a nation-wide network for implementation of effective strategies with respect to water and waste water management, management of urban flooding, storm water and sanitation. Innovative technological solutions will be provided for the site-specific sewage and waste water treatment. C-SUM will also suggest waste management strategies for betterment of environment and health.
- **Carbonated Fruit Juices as an Alternative to Soft Drinks** - CSIR-Central Food Technological Research Institute (CSIR-CFTRI) has developed the technology for carbonation of fruit juices. The laboratory has created standardized carbonated drinks based on grape, pomegranate, sweet lime, sugarcane and neera (coconut palm sap) flavours. The fizzy fruit juice formulations, promoted as 'healthy' and 'nutritious' drinks are suitable for all age groups, and particularly suited to the carbonated preferences of the younger generation of consumers. The products have a shelf life of about 2-4 months at room temperature.
- **Broad Spectrum Confocal Microscope, A World Class 'Made in India' High-end Product based on Supercontinuum Light Source launched** – Under the CSIR-NMITLI Programme, CSIR has indigenously designed and developed a complex Broadband Confocal Microscope in partnership with M/s Vinvish Technologies Pvt. Ltd., Thiruvananthapuram and CSIR-CGCRI, Kolkata. The confocal microscope uses a Supercontinuum light generating source based on a patented photonic crystal fiber (PCF) technology developed by CSIR-CGCRI. Further, the system has been integrated together as a plug and play system, into the Broadband Confocal Microscope developed

by the collaborating partners. This is a first of kind Reflective Confocal Microscope based on its own supercontinuum light generating source in the world.

- **Simultaneous Production of US Grade Gasoline and Pure Benzene from FCC C6 Heart Cut – Plant Commissioned by Industry -** CSIR-Indian Institute of Petroleum (CSIR-IIP), Dehradun carried out substantial experimental and simulation studies with feedstock provided by M/s Reliance Industries Limited (RIL) and demonstrated that US grade gasoline and pure benzene can be simultaneously produced from a FCC C6 heart cut stream using extractive distillation (ED) route with aqueous NMP as the solvent. The gasoline thus produced has sulphur content <10ppm and benzene <0.3%. As per the Environmental Protection Agency (EPA) in the US, it is mandatory to meet an annual average gasoline benzene content standard of 0.62 volume per cent for gasoline, both reformulated and conventional. The technology has been transferred to RIL which had set up 600,000 MTPA unit costing Rs.160.00 crore. The unit based on this technology was successfully commissioned in RIL Jamnagar DTA site under J3 Expansion Project in May 2016, and is under smooth operation with design throughput. The on specification raffinate product (less than 0.2 vol.-% Benzene) from the plant was sent to storage for blending and sales.
- **DHVANI, a state-of-the-art marksmanship training system approved for induction into the Indian Army -** DHVANI - Detection and Hit Visualization using Acoustic N-wave Identification system has been developed by CSIR for perfecting marksmanship skills by accurately determining the location of bullet impact and providing real-time feedback. After rigorous field trials at Army ranges in Bengaluru, Secunderabad, and Infantry School Mhow, the well validated training system has been approved for induction into the Indian Army in July, 2014.
- **Setting up of India’s first Micro Air Vehicle Aerodynamics Research Tunnel:** CSIR has set up a Micro Air Vehicle Aerodynamics Research Tunnel (MART) at the CSIR-National Aerospace Laboratories (CSIR-NAL) campus, Bengaluru. The tunnel, first of its kind in India, will be used to test the fixed-wing, flapping-wing and rotary-wing MAVs in the 500 mm wingspan category. The tunnel was set up under the National Programme on Micro Air Vehicles (NP-MICAV). The project is jointly coordinated by CSIR, the Defence Research & Development Organization (DRDO) and the Department of Science & Technology. The state-of-the-art tunnel would address all the aerodynamic, propulsion and aero-elastic issues related to MAVs.
- **Low temperature co-fired ceramics (LTCC) for Strategic applications:** CSIR-CEERI has developed five different versions of Low temperature co-fired ceramics (LTCC) micro-hotplates. These micro-hotplates have achieved a temperature of 300°C with power consumption less than 1 watt and size 3.5x3.5 mm². These micro-hotplates have high temperature stability, are reliable and ruggedized for harsh adverse environment. These are being used by Solid State Physics Laboratory (DRDO), Delhi, CSIR-CGCRI, and CSIR-CSIO for various sensor applications. Armament Research Board of Ministry of Defence, Government of India has issued an appreciation letter to CSIR-CEERI recognizing the contributions.
- **Hydrofluorocarbons Manufacturing Technology for Refrigerators: Towards ‘Make in India’:** A technology to manufacture hydrofluorocarbons used in refrigeration systems as a coolant to reduce global warming has been developed by the CSIR-IICT, Hyderabad. The technology has been denied by MNCs in the US, UK, France, Japan and China, which have vested interests of only selling the gas for a high price. The indigenous technology so developed has already been transferred to two industries that have funded the research, with one industry already setting up a manufacturing plant producing 50 per cent of the need of the country. The gas is sold to refrigerator manufacturing companies

for use as a coolant.

- **Plasma Gelsolin Diagnostic Kit for Prematurity and Sepsis – Focus on Affordable Disease Diagnostics:** Plasma gelsolin, a circulating actin-binding protein serving a protective role against tissue injuries is fast emerging as a health condition biomarker. Depletion of plasma gelsolin in systemic inflammation contributes to adverse outcomes. Plasma gelsolin repletion in compromised cases is under Phase 1 and 2 trials. CSIR-IMTECH, Chandigarh has developed two mass-production ready plate based kits to estimate plasma gelsolin levels in humans. While, most other labs including commercial set-ups are focusing on improving bulk production of this protein, CSIR-IMTECH has developed bonsai versions of this protein by structure-based insights. Further, CSIR-IMTECH has successfully demonstrated the anti-sepsis properties of the miniaturized versions in LPS-induced sepsis model of mice. The kits thus developed will help in determining a quantitative measure of sepsis. The laboratory is also testing the kits viability in predicting cases of preterm birth. The kits come with a cell phone based application for measuring the gelsolin value and providing a prognosis on the patient status. The novel inventions have been patented.
- **Whole Genome Sequencing of Holy basil (Tulsi) – Using modern biology tools to better understand traditional knowledge:** CSIR has published whole genome sequence of *Ocimum sanctum*, the sacred plant of Hindu tradition. The nuclear genome of Holy basil is the smallest (386 Mb) in the family Lamiaceae while the chloroplast genome (142,245 bp) is the smallest in the order Lamiales. This is the first report of complete genome sequence of the holy basil, using a composite next generation sequencing technologies. The whole genome sequencing of the species paves way to understand and further unravel its secrets so as to provide scientific validity to the traditional claims of its utility in diverse medicinal usage. All parts of this ancient herb such as dried leaf, dried seed, and dried whole plant are used in several systems of traditional medicine, including Ayurveda, Greek, Roman, Siddha, and Unani. The availability of the genome sequence also opens the possibility to identify genes involved in producing therapeutic molecules and to produce them in vitro. This will also facilitate identification of not yet identified genes involved in the synthesis of important secondary metabolites in this plant. In addition, specific pathway related genes identified or mined in this genome could be used for the production of secondary metabolites following synthetic biology approaches.
- **Mobile Bridge Inspection Unit (MBIU) and Pothole Repairing Machine (PATCHFILL)** licensed to seven industries for commercialization: The CSIR's technologies are for unmet needs and are an effort towards 'Make in India'. The MBIU is an electro-mechanical device mounted on a truck that provides access to intricate part of bridges within a short period and facilitates structural engineers to conduct Visual/Non-destructive testing inspection of road bridges. PATCHFILL is a compact machine for quick, safe and economic repair of potholes using cold mix with efficiency matching to giant machines serving the same purpose.
- **Process flow sheet for beneficiation of low grade Iron ore sample from Shire-Mentebteb, Ethiopia:** About 500 million tonnes of iron ore resources are located in Shire-Mentebteb region of Ethiopia. The deposit is a lean grade goethitic ore and it is to be concentrated to a level suitable for utilization through blending with high grade concentrate for iron and steel making. CSIR-NML has developed a process flow sheet for beneficiation of the low grade iron ore as saying 33.17% Fe to produce concentrate with 51% Fe.
- **Exploration of natural resources for oil and gas** – Collaboration of CSIR and Oil and Natural Gas Corporation Ltd., (ONGC) to collect geophysical data from ONGC oil fields

in the Krishna Godavari basin off the east coast of India has been established.

- **Environmentally-benign Inorganic Pigments** - CSIR has developed non-toxic IR reflective blue, yellow and green inorganic pigments based on rare earths which provide more than 90% reflectance of heat inducing near infra-red radiations from the sun. The potential utility of the nano-pigments as “Cool Pigments” was demonstrated by coating on to a building roofing material like cement slab and PVC coatings. The synthesized nano-pigment formulations were also evaluated for use in automobile and electrical cable industries. The technology of non-toxic solar heat reflecting inorganic blue pigment has been transferred to Cera Décor India Ltd., New Delhi.
- **Mobile Pilot Plant for Toxic Emission Monitoring for Small and Medium Scale Industries** – The developed intervention is for undertaking flue gas emission monitoring and control studies in various industries including Small and Medium Scale Industries (SMEs). The performance in terms of techno-economic feasibility will be checked and a system for control of emissions will be provided in the pilot scale which can be scaled up for full scale installation.
- **E-Nose to Detect Toxic Fumes – Sensors based Innovative Solution for Monitoring Environmental Pollution:** The CSIR-NEERI, Nagpur and the Centre for Development of Advanced Computing (C-DAC) have jointly developed the first indigenous “electronic nose” that can sniff out volatile organic compounds (VOCs) potentially harmful to human life in a very short time. The portable instrument measures odour concentration and intensity, besides identifying individual chemicals causing the foul smell. This has been the first attempt in India to develop such a product using odour sensors that make use of intelligent software to identify odorous molecules. The E-nose has been successfully put to use at Mysore Paper Mills, Bhadravathi, Karnataka, Tamil Nadu Newsprint and Paper Mill, Karur and International Paper Private Limited, Rajahmundry, Andhra Pradesh.
- **Improved Variety of Ashwagandha Released – Enhancing Livelihood of Farmers:** Ashwagandha (*Withania somnifera*), the Indian ginseng or Winter Cherry forms essential constituent or whole of >100 traditional medicine formulations. Under the CSIR-NMITLI Scheme, a new improved high yielding variety of Ashwagandha, NMITLI-101 has been developed through the strong collaborative efforts of four CSIR laboratories namely, CSIR-NBRI, CSIR-CIMAP, CSIR-CDRI and CSIR-IICB. The chemotype, NMITLI-101 is an improved variety rich in major withanolides (active compounds) such as withaferin A, withanone and withanolide A. The average root yield from NMITLI-101 crop is about 25 quintal/hectare and the seed production from the variety is up to 3 quintal/ha, under optimum conditions. The roots of the variety have excellent immunomodulation activity responsible for its medicinal properties. During the 73rd CSIR Foundation Day in September 2015, the variety NMITLI-101 was released by Hon’ble Minister, S&T and ES. During the function, the team has also created a comprehensive knowledge resource which contains information on the genomic resources, value added germplasm, pharmacological research results and agro-technologies developed for the improved varieties of Ashwagandha. This comprehensive knowledge resource is assimilated in the form of a dedicated and interactive website.
- **Spin-offs, knowledge equity, technology incubation centres and scientific entrepreneurship: Towards boosting creation of knowledge enterprises** - A start-up company (BIOLMED Solutions Pvt. Ltd.) has been setup at the CSIR-NCL Venture Center. This company, developing silk based scaffolds for biological applications, has been selected to receive funds through the Biotechnology Incubation Grant (BIG) administered by Biotechnology Industry Research Assistance Council (BIRAC) of DBT.
- **International Collaborations**

- **Training for SAARC countries:** CSIR is involved in training of Researchers and government officials from SAARC Countries in the area of Coastal Zone & River Basin Management. This is being sponsored by the SAARC Centre for Coastal Zone Management, Maldives. CSIR has initiated a dialogue with the SAARC Secretariat, Kathmandu to take up socially relevant collaborative S&T projects. Two of the relevant areas identified were arsenic free drinking water for rural masses and developing marketable products from medicinal and aromatic plants through regional value chains. CSIR is also helping some SAARC and African countries towards the human resource development (HRD) of their young scientists through attachment training programmes in CSIR laboratories.
- **Signing of MoU with MIDI, Ethiopia and Visit of Ethiopian Delegates:** A letter of Intent (LoI) was signed between the Council of Scientific & Industrial Research (CSIR), India and the Metals Industry Development Institute (MIDI), Ministry of Industry, Federal Democratic Republic of Ethiopia (FDRE) on August 6, 2014. five-member Ethiopian Delegation led by H. E. Mr. Tadesse Haile, Hon. State Minister, Ministry of Industry visited CSIR, New Delhi and a few constituent laboratories of CSIR to enter into a new twinning arrangement with CSIR, India for capacity and capability building of “Ethiopian metals and engineering sectors” through the Metals Industry Development Institute (MIDI), Ministry of Industry, FDRE.
- **Working programme between CSIR and Vietnam National University:** A “Working Programme” between CSIR and the Vietnam National University (VNU), Hanoi, Vietnam for the years 2014-16 was signed for S&T collaboration in the areas of Chemical Science & Technology and Geosciences, Oceanography and Climate Change. This was in continuation with the MoU signed between CSIR and VNU during the state visit of H. E. Mr. Nguyen Phu Trong, General Secretary, the Communist Party of Vietnam on November 20, 2013.
- **Under India’s G20 Presidency, CSIR organized G20 RIIG Conference on Materials for Sustainable Energy gets underway in Ranchi during 02-03 March 2023:** CSIR organized the Research and Innovation Initiative Gathering (RIIG) Conference on “Materials for Sustainable Energy” during 02-03 March 2023 at Ranchi under India’s G20 Presidency. Various facets of ‘Materials for Sustainable Energy’ were discussed under three sessions, viz., (i) 21st Century Challenges Related to Energy Materials & Devices, (ii) Solar Energy Utilisation and Photovoltaic Technology, and (iii) Materials and Processes for Green Energy. Leading experts were drawn from institutions such as IITs, IISERs, CSIR Labs; industries; think tanks including NITI Aayog; and Indian Energy Storage Alliance. Twenty foreign delegates from ten G20 member countries, six invited guest countries and an international organisation joined the two-day conference. From India, 38 delegates and special invitees from scientific departments, research and academic institutions and industry participated in the RIIG Conference.
- **MoU between CSIR, India and BCSIR, Bangladesh:** In an important milestone in S&T Cooperation between India and Bangladesh, an MoU between CSIR, India and Bangladesh Council of Scientific and Industrial Research (BCSIR) was concluded on 6 September 2022 to establish a broad framework to promote scientific and technological cooperation. The MoU, signed by Dr. N. Kalaiselvi, DG, CSIR and Dr. Md. Aftab Ali Shaikh, Chairman, BCSIR, was exchanged at New Delhi in the presence of Hon’ble Prime Minister of India, Shri Narendra Modi and Hon’ble Prime Minister of Bangladesh, Ms. Sheikh Hasina.

- **MoU between CSIR, India and AMEXCID, Mexico:** In a landmark milestone in S&T Cooperation between India and Mexico, an MoU on Research, Technology & Innovation cooperation was signed between CSIR, India and the Mexican Agency for International Development Cooperation (AMEXCID) of the Ministry of Foreign Affairs of the United Mexican States. The MoU shall facilitate cooperation in the areas of research, technological development/deployment, innovation and capacity building, with an objective to expand knowledge and strengthen Intuition capacities in both the countries. The collaboration would focus in the areas of Aerospace, Electronics Instrumentation & Strategic Sectors; Civil, Infrastructure & Engineering; Ecology, Environment, Earth, Ocean Sciences & Water; Mining, Minerals, Metals & Materials; Chemicals & Petrochemicals; Energy & Energy Devices; Agriculture, Nutrition & Biotechnology; and Healthcare. Special focus on technology and industry collaboration has been structured in the MoU (supporting start-up ecosystem and existing industry through technology partnerships, tailoring each other's technologies/products and demonstration/deployment, establishing joint outreach centres and capacity building centres).
 - **MoU between CSIR, India and Institut Pasteur, France:** CSIR, India and Institut Pasteur, France signed an MoU on January 25, 2022 for jointly researching and focusing on emerging and reemerging infectious diseases and inherited disorders and enable delivery of effective and affordable healthcare solutions not only for the people of India and France but for the global good. The MoU provides for developing potential scientific and technological cooperation and networking in advanced and emerging areas of Human Health between scientists and institutes/laboratories of CSIR and Institut Pasteur and its international network.
 - **Access Agreement signed with new foreign patent offices:** CSIR-TKDL has signed TKDL Access Agreement with Institut National de la Propriété Industrielle (National Industrial Property Institute), France and Eurasian Patent Organization (EAPO) on 16 Sep 2022 and 21 Feb 2023, respectively. With these agreements, 16 patent offices worldwide have now access to TKDL database as prior art related to Indian traditional knowledge for the purposes of patent grant procedure.
- **CSIR's contributions towards mitigation of SARS-CoV2 pandemic:** The unprecedented situation arisen due to the COVID-19 pandemic has posed multifarious S&T challenges. CSIR has responded to the situation with a well-coordinated and integrated approach in cooperation with all relevant stakeholders. CSIR extended all possible R&D support to the industry and also aligned to the Government's strategy of mitigation of outbreak. Within the constraints of the lockdown in the country, CSIR took initiatives under five verticals: Digital and Molecular Surveillance; Rapid and Economical Diagnosis; Development of new drugs/repurposing of drugs; Hospital Assistive Devices and PPEs; and Supply chain and logistics. CSIR has developed 100+ technologies under these technology verticals. Some of the significant technologies and processes developed by CSIR are as under:
 - CRISPR/ Cas based paper diagnostic test (FELUDA)
 - Dry-Swab-Direct-RTPCR Diagnostic
 - Clinical Trials of Ayurveda based drugs
 - CSIR-IICT assisted and helped in fulfilling “vaccine for all” motto by developing scalable and cost-effective synthetic process for **Adjuvant molecule** for **Covaxin** – an indigenously developed vaccine for Covid-19 mitigation by Bharat Biotech

International Ltd.

- SwasthVayu Non-invasive Ventilator developed by CSIR-NAL.
- Oxygen Plants set-up by CSIR-IIP
- Make-Shift Hospitals for Covid-19 patients developed by CSIR labs
- UV Disinfection Systems installed at the four sensitive locations in Parliament House Complex: Lok Sabha Chamber; Central Hall of Parliament; Committee Room No. 62 & 63
- Air surveillance for SARS-CoV2 in hospitals and home settings
- Octacopter drones for Vaccine delivery
- PPE Coveralls developed by CSIR-NAL
- A cost-effective process of Favipiravir for the treatment of COVID-19 patients has been developed by CSIR-IICT. CSIR-IICT developed the process using locally available chemicals to synthesise this Active Pharmaceutical Ingredient (API) and transferred the technology to Cipla. Cipla has launched this in the market as Ciplenza.

Significant measures/ initiatives undertaken in the domain of Medical Imaging Solutions

Council of Scientific and Industrial Research (CSIR)

The CSIR being in role of technology provider for the industry, has operationalized desired mechanisms to boost entrepreneurship, which could lead to enhanced creation and commercialization of radical and disruptive innovations, underpinning the development of new economic sectors. CSIR continuously supports for development of technological solutions through its network of national laboratories and is also making efforts for development of medical technologies including medical imaging solutions, to facilitate affordable and reliable access. Significant initiatives undertaken by CSIR in the domain are as under:

1. **Vascular sclerotherapy guidance and assistance tools for clinical diagnostics and treatment of venous malformations (Vascu-Guide):** Infrared imaging-based image-guided approach to map and examine the deep and superficial venous to pinpoint the treatment point location during Vascular sclerotherapy. Imported vein visualization devices are of low resolution, having limited use for sclerotherapy. Proposed technology aims to develop AI powered, hands-free vein visualization and guidance functionality to the assist vascular surgeons during the treatment of venous malformations. The unique features of the technology include hands-free and non-contact visualization and guidance functionality for the vascular surgeons during the treatment of venous malformations. It is an alternative to the conventional low-resolution ultrasound imaging that limits the vascular surgeon to accurately see and treat minute veins, bifurcations or clots. It gives high-resolution vasculature information map on large-screen with assistive software tools for detection of the morphological characteristics of problematic and non-problematic veins for clear visualization and classification useful for vascular surgeon towards treatment planning with recording facility.

Current Status: Clinical data collection, assistive software tools and algorithm fine tuning towards detection and visualization of vein morphological characteristics is in progress.

2. **Thermal imaging based non-invasive technique for diagnosis of musculoskeletal disorders (MSD):** The technologies used as gold standard for Knee OA severity prediction are X-ray (Radiography), MRI or CT scan that collects information from the target by emitting some waves, energy or radiation towards it. These approaches have certain drawbacks i.e. CT or X-ray scan uses ionizing radiations may have harmful effects if frequent scans are required. In case of MRI it cannot be used if patient is using implants pacemaker etc. Here thermography is used, a technique which ‘captures’ infrared thermal emissions from subjects. Therefore, there is no harmful radiations or energies are being used for scanning; this is a non-invasive and non-contact based system. Hence, this system can be used as the first step of diagnosis of Knee OA as an adjunctive tool.

Current Status: CSIR-CSIO Chandigarh, is engaged in design and development of a computer-aided diagnosis system utilizing thermal imaging techniques. Through collaborative efforts with PGIMER, the prototype for non-contact and noninvasive systems for the diagnosis of knee arthritis and compartment syndrome is developed. The developed system is undergoing trials with the participating hospital PGIMER.

- 3. DRISTISCOPE - Surgical Microscope:** Dristiscope-an operating microscope developed at CSIO, is primarily a medical instrument to assist the doctor in cataract surgery and other ophthalmic surgeries. It is used for precision surgical applications like keratoplasty, keratoprothotics, and cataract operations. The design is on the principle of a telescopic magnifier and five steps of magnification. The salient features of the Dristiscope are, five step magnification; large working distance between operation field and microscope; adequate contrast and resolution; brilliant & uniform illumination; provision of blue & yellow filters; adjustable inter binocular distance (56mm to 75mm); low BOM cost i.e. 50% as compared global bands etc.

Current Status: Two prototypes have been fabricated and demonstrated to eye surgeons, results are encouraging and Ethical clearance is yet to be obtained and the same is under progress. Expression of Interest has been raised for technology transfer and future production.

- 4. Image-Guided Vascular Vein Visualizer:** Vein-Viz is an indigenous, affordable, non-contact and portable device for vascular vein detection and visualization in real-time through infrared imaging technique useful for precise catheter insertion or piercing of peripheral veins for persons with hidden and difficult to access vein. It is useful towards finding and visualizing clinically relevant difficult to access veins in children, obese and elderly. This device could assist Phlebotomists and healthcare workers improve patient experience by reducing number of sticks, lower catheter dwell time, and precise venipuncture avoiding associated complications.

Current Status: Prototype is ready, clinical data acquisition and clinical trials for performance optimization is under process at GMCH, Chandigarh.

- 5. Embedded vision based intraoral scanner for dental diagnostics:** Non-ionizing and portable intraoral scanner device based upon multispectral /multi-dimensional illumination and embedded vision to detect and identify different aspects of tooth structures and its damage due to caries quantitatively. The proposed dental scanner device is ideal for children, pregnant women, and patients where X-Ray exposure needs to be avoided. It is convenient, inexpensive, and rapid way to evaluate the dental structures, its anatomy, abnormalities, and diseases.

Current Status: The Prototype is under development

- 6. Artificial intelligence based Automated interpretation of echocardiographic image from Hand held echocardiography (HHE) devices:** Technological advancements have resulted in the emergence of miniaturized handheld echocardiography equipment so echo

can be readily performed at the point of care with acceptable image quality. Though hand held echocardiography with low cost, simplicity of use, bedside availability and easy transportability has encouraged physicians to use these devices for prompt medical decision making and screening, their full potential is still unrealized. Despite clinical evidence supporting the use of handheld devices in various clinical settings and by different medical practitioners, proficiency in point-of-care ultrasound requires dedicated training in both performance and interpretation of echo image. Development of AI based automated echocardiography image interpretation and pathology recognition would help a technical person to interpret the scan as abnormal and provide tertiary care referral. Thus, the facility can be extended to rural/remote areas where cardiology expertise is not available, significantly decreasing the cost of health care and allowing patient follow up. This proposed system is an AI based Software tool for automatic echocardiographic image interpretation such as Quantification of Structural and Functional parameters and classification for disease detection of heart.

Current Status: The project has been approved by ICMR-DHR and the funding will be released soon for carrying out this research work in collaboration with PGIMER, Chandigarh

- 7. AutoCEPH - Cephalometric Analysis Software:** AutoCEPH© is a 2-D cephalometric analysis software to assist orthodontic and maxillofacial surgeons perform analysis for their patients. It has been developed by CSIR-Central Scientific Instruments Organisation, Chandigarh, India in collaboration with Centre for Dental Education and Research (CDER), AIIMS, New Delhi, India.

Current Status: It is available over the web as a service delivery model inspired from a cloud based architecture. AutoCEPH provides maxillofacial surgeons to perform 16 lateral analyses.

Department of Science and Technology (DST)

DST is running a programme on Biomedical Device and Technology Development (BDTD) since year 2016 with a focus on development of devices and related technologies. The mandate of BDTD is to evolve and support projects for design & development of devices for:

- Early-Stage Prototype Development: (The integration and testing of basic components in a laboratory environment);
- Late-Stage Prototype Development (Fabrication of compact prototype for testing and validation); and
- Pilot Scale Testing and validation: (Upon completion of the technology's design, fabrication final testing with limited number of prototypes) with mandatory manufacturer industry participation.

The targeted categories include screening, diagnostic, surgical and life support equipments for clinical applications in healthcare sector. The following activities are considered:

- Evolving, supporting and monitoring R&D projects for design & development of devices

- Supporting capacity building activities such as Training Programmes, Workshops/Seminars/ Symposia, brainstorming sessions, industry-academia interactions.
- Infrastructure creation to promote device development activity.

Under the programme, the DST has also established Biomedical-hubs which house sophisticated facilities to assist as the translational platform used for technology up-scaling or prototype development or development of devices in substantial number for market validation. The facility is available to the members striving towards a common goal on sharing basis. At present, 3 hubs have been established at Chandigarh, Chennai & Delhi.

Department of Biotechnology (DBT)

DBT through its Public Sector Unit Biotechnology Industry Research Assistance Council (BIRAC) promotes innovation and research in the field of biotechnology across the country through various programs under its PPP schemes and encourage Make-in-India products.

DBT-THSTI (a research institution of DBT), through the Garbh-Ini cohort project, has developed artificial intelligence-based tools to provide medical imaging solutions.

Under the supported projects of the Mission, the first Made in India MRI scanner by Voxelgrids Innovations Pvt Ltd. received commercial sale and manufacturing license from CDSCO, Govt of India. This is a compact, lightweight, full body 1.5 Tesla MRI scanner capable of being used in both stationary and mobile configuration, transportable to any location in India, and potentially take medical imaging to the underserved parts.
