सत्यमेव जयते

Ministry of Education

Government of India

COVID-related Research & Development Work

by

Centrally Funded Technical Institutes (CFTIs)

February 2022

सत्यमेव जयते

प्रधान मंत्री

Prime Minister

MESSAGE

It is heartening to learn about the e-booklet prepared by Ministry of Education on COVID-related Research and Development work done by Centrally Funded Technical Institutions.

India's fight against the once-in-a-century pandemic has been powered by the collective spirit, unwavering determination and combined efforts of 130 crore citizens. Our pre-emptive, proactive response to the pandemic has been appreciated globally.

From research and development of vaccines to leveraging technology, our emphasis has been on capacity building and strengthening our health infrastructure to make it future-ready.

India's fight has been science-born and science driven. World's largest and fastest vaccination drive in India is a remarkable example of 'Sabka Saath, Sabka Vikas, Sabka Vishwas, and Sabka Prayas'. Taking everyone along, we are marching ahead with the campaign of 'Vaccine for all', 'Free Vaccine'.

Reflective of the potential of the country, today there is belief and enthusiasm in every section ranging from society to economy. In the midst of Amrit Mahotsav of Independence, the nation is moving forward with new resolutions.

It is satisfying that stakeholders from various sectors are integrating their efforts with the national goals. I am sure that the e-booklet compiling the COVID-related research will showcase innovative solutions for larger good. The efforts of the academic fraternity in this context are laudable.

Best wishes for all success of the e-booklet.

(Narendra Modi)

New Delhi
माघ 26, शक संवत्, 1943
15th February, 2022

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MESSAGE

Ever since the pandemic broke out in India, frontline workers across the Country have been working hard to combat the spread of the COVID. Apart from these frontline warriors, the efforts of Indian Government was also augmented from Centrally Funded Technical Institutes (CFTI). During the time of the pandemic, all IITs, NITs, IISERs, and IIITs in the country have done a remarkable job, and have played a crucial role by way of their innovative products & amateur inventions duly mentored by respective faculty members.

The works of CFTIs during the pandemic times have not only augmented the efforts to fight against COVID, it has also resulted in successful patenting and commercialization of few research products at affordable cost by select startups. Some of these have also enabled to reduce dependence on imports, thus helping the Nation to nurture & proliferate indigenous capability and also fostering the 'Make in India' programme as well.

Using their innovative thoughts, CFTIs have successfully produced three-layered masks, PPE kits, sanitizers, hand wash, thermal scanners, low-cost ventilators & many such products. These efforts from the young minds in our Country strongly hints at the fact that India can successfully combat any challenge & quickly rebound with greater strength.

A compilation of the efforts of the young students from the CFTIs in form of this book shall help spread awareness and share their ideas with the industry, academic institutes and other entrepreneurs / investors across the world. I wish & hope that innovations from these CFTIs reach far & wide across the world to provide relief to those affected by COVID pandemic.

(Dharmendra Pradhan)

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25th February, 2022

MESSAGE

The Centrally Funded Technical Institutes have done an admirable job during the times of COVID. Students from IITs, NITs, IISERs, and IIITs have been successfully contributing to India's fight against COVID.

At a time when India had little know how, the CFTIs have embarked on cross domain multi-disciplinary research on providing effective solutions to some of the hard hitting problems faced by frontline health workers such as those of medical oxygen generation, robotic disinfection units, indigenous portable oxygen concentrators and such other equipment. It is also noteworthy that the CFTIs also rose to the occasion and extended their assistance to the local administration by sharing their resources to include medical staff, on campus hospital/ dispensaries, laboratories and other infrastructure.

It also laudable that the CFTIs have continued to pursue in their scientific pursuits by devising new ways of working by devising SOPs for research labs and incubation centers. The industry academia connect has also witnessed greater participation. Some of the successful prototypes have been taken up for commercialization by industrial establishments and new products have been launched into the market at affordable costs for masses. New startups have also been initiated which are being supported from investors & industries and it is expected to see more new products being launched in near future.

I personally extend my gratitude to all the young students & their mentors in the CFTIs who have been part of these projects. It is quite re-assuring to see the compilation of ideas from these CFTIs which inherently indicates our collective strength & resilience to face & overcome any challenges.

(K. Sanjay Murthy)

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Executive Summary

Government of India has established IITs, NITs, IISERs and IIITs as Institutes of National Importance to impart higher education in Science and Technology and promote the temper of scientific research and instruction. Apart from these, IISc Bangalore, established in 1909, has created a niche for itself as a premium institute for advanced scientific and technological research. Over the years, these institutes have become pioneer in research and development of products that is useful to the community and the planners. They have been internationally acclaimed and their students have a high standing in research and development all over the world.

The indigenous scientific and technological research kindled by these institutes requires adequate budgetary support. Acknowledging this need, Government has launched new schemes viz., IMPRINT (Implementation of Research and Innovation in Technology), Startup India Initiative for Higher Educational Institutions (Research Parks), SPARC (Scheme for Promotion of Academic and Research Collaboration), STARS (Scheme for Transformational and Advanced Research in Sciences, PMRF (Prime Minister Research Fellowship), etc. Apart from these schemes of Ministry of Education, other scientific ministries of Government of India viz. Departments of Science and Technology, Biotechnology, Earth Science, etc. have also been extending generous support to the academic institutions in their research work. Incubation Cells and Start-ups in collaboration with researchers in these institutes have yielded the desired results and helped in successful patenting and commercialisation of research products at affordable cost. This has also reduced the dependence on transfer of high cost technology and technical products from foreign countries.

COVID-19 - Research and Extension by Centrally Funded Technical Institutes

The pandemic COVID-19 triggered a demand for safety product like Masks, PPEs, Sanitizers, Hand Wash etc. Besides these common products, the demand of the medical community for major medical devices like RT-PCR Testing Kits, Ventilators, Oxygen Supplement, beds, mobile units was phenomenal due to vast spread of the virus across the country. Most of these products were not adequately available. In addition, there was an urgent need to develop alternative technology and products to meet the new challenges posed by COVID-19

Keeping in view the urgent need of the society and the medical community, the Department of Higher Education took stock of the research activities in CFTIs as early as in March 2020 and urged the Institutes to come up with their new research products and innovations to meet the challenges thrown by the COVID-19 and to meet the demand of the society.

Low Cost Ventilators, Indigenous RT-PCR kits, low cost Oxygen supplementing products, automatic screening equipments, mobile medical units have been successfully brought out by these institutes. Many of these were commercialised by the Start-ups in these Institutes or placed at the services of State Government/local administration.

Besides, start-ups under CFTIs have produced low-cost three-layered masks, PPE Kits, sanitizers, hand wash, thermal scanners, oximeters as a market-interventions strategy in a short span of time to check the rising cost of these products in the market. These Institutes made available these items to the local administration for their use on daily basis.

Apart from the innovative research and its successful extension, these CFTIs have also given medical assistance to the State Administration through their hospitals and dispensaries. The campuses were also handed over for establishment of COVID Care Centres by the State Administration with all necessary infrastructures.

While details of research and development by these institutes are provided in subsequent chapters, a glimpse of some of the important and highly relevant works is provided here.

Indian Institute of Science (IISc), Bangalore

Research related to COVID-19 at IISc includes a Swing absorption based medical oxygen generation system for small and medium capacity hospitals. The project addresses a containerized solution for less than 30 bed hospitals which are in large numbers across the country. Global TM COVID-19 RT-PCR Kit is a multiplex TaqMan probe based, single step real-time reverse transcription polymerase chain reaction (RT-PCR) test intended for the quantitative detection of SARS-CoV-2 nucleic acid in human samples. ICMR approval has also been received and it is in the process of getting commercialised. The Institute conducted a proteo-genomic study that focusses on the mutations observed in SARS-CoV-2, their impact on the proteome of the virus, and the proteomic host response to SARS-CoV-2 infection. A low-cost Collaborative Robot has also been developed to help doctors and nurses to record vital parameters maintaining social distancing with the patient. Scaled down prototype is ready. Indigenous portable Oxygen (1-10lpm) Concentrator has been designed and developed by the Institute.

The institute developed Molecular Diagnostics Laboratory on wheels to perform end to end RT-PCR tests in remote parts of the country to help reduce turnaround time and increase access to RT-PCR tests. First set including 3 satellite labs and 1 nodal hub deployed across Bangalore and Delhi. Portable thermal cycler and fluorescence reader instruments to enable molecular diagnostic tests for COVID-19 and other infections is in the process of development. Clinical design with 200+ samples at IISc CIDR has been done. Pre-compliance testing and regulatory approvals is in progress.

IISc has also conducted various research studies in Bangalore city and Mumbai suburban local trains to study the pattern of spread of virus, which will be useful in future modelling of strategy for crowded cities and its outskirts.

Indian Institutes of Technology (IITs)

During COVID-19, despite the lock-down in the campus, the Incubation Cells and Start ups in IITs have produced low-cost face shields, face masks, low-cost ventilators, PPE Kits, RT-PCR kits etc.

Some of the other important research products are given below.

IIT Bombay developed and introduced apps for use by administration. Other research products like ICU ventilators (Vi-SWAAS), robotic disinfection unit etc to combat with COVID-19 have been designed, developed and commercialised.

Corona testing kit, "Corosure", of IIT Delhi has been successfully patented and approved by ICMR and has been into commercial production at low cost. IIT Delhi has also brought out a research paper on efficacy of "Ashwagandha" for COVID-19 patients, a traditional medicine used for immunity and strength in Ayurveda.

Ubiqare developed by IIT, Madras enables doctor-driven speciality care to patients at home, reducing hospital visits and stays. These were successfully introduced in clinical trials.

IIT Kanpur played central role in the national project of developing SUTRA model for predicting Covid-19 trajectory. Under the IIT Kanpur incubator's initiative, Mission Bharat O2 (MBO2), its incubated companies are working to strengthen the healthcare infrastructure in India. In 2020 as the first wave of COVID-19 hit, IIT Kanpur's incubated company, Noccarc Robotics, developed an ICU ventilator, Noccarc V310, in just 90 days. The product has been working in more than 2500 hospitals across the country. IIT Kharagpur has brought out a kit named COVIRAP, a nucleic acid based detection of disease, and COVICUBE device for checking oxygen and breathing saturation, which has been successfully commercialised.

IIT Roorkee has made available low-cost ventilators and other products to State Administration. IIT (BHU) Varanasi is also working on various projects related to COVID-19, including one funded by Department of Science and Technology (DST), Government of India. The Institute is also participating in UP Government's initiatives related to oxygen audit and also involved in various outreach activities during COVID period.

Second Generation IITs especially IIT Mandi, IIT Indore, IIT Ropar have made remarkable inventions and brought out their products to deal with COVID-19 situation. IIT Ropar has worked on a portable eco-friendly mobile cremation system. If commercialised and supplied to Local Administrations, it could be a breather to the community, which is facing hardships in performing last rites with tradition and dignity. Third Generation IITs, especially IIT Palakkad, IIT Tirupati, IIT Bhilai have also contributed in research and its extension services to State Administration.

Indian Institutes of Science Education and Research (IISERs)

IISER, Pune developed a laboratory prototype of a low-cost, mass-producible ICU ventilator with features comparable to commercially available ventilators. The institute is engaged in translating the technology along with an industrial partner. The institute has also demonstrated a chemical oxygen generator which can produce oxygen at a rate of 5-10 lt per min by mixing easily available chemicals. It can produce enough quantities of breathable oxygen in sufficient flow rates without the requirement of electricity and can be utilised at home or while transporting the patients or as a stop-gap arrangement in emergency situations

IISER, Kolkata is working on the use of the Neem bark extract to ameliorate COVID infection in mouse and human cell line. It was observed that there is a strong antiviral and protective activity of Neem bark extract when administered nasally in the mouse.

IISER Mohali is working on various projects including generation of neutralizing monoclonal antibodies for SARS-COV2, development of urea derivative compounds as potential drugs against SARS-CoV-2, synthetic reconstruction of an attenuated SARS-CoV-2 virus for vaccine development.

IISER Bhopal has been working on six research COVID-related projects, including a low cost oxygen concentrator (Oxycon) and design and development of an alerting system "Co-Alert" to maintain social distance in large meeting places and in campus.

IISER Tirupati collaborated with IIT Tirupati in the development of a Blower Aided Air Steriliser (BLAAST) to sterilise the air in closed environment (patent submitted), N95 mask and PPE steriliser using optical cavity.

IISERs at Thiruvanathapuram and Berhampur have also been working on various COVID-related research projects. IISER Berhampur's research projects include development of fluorescent human transmembrane serine protease 2 (TMPRSS2), study of binding insight of clinically oriented drug Famotidine with the identified potential target of SARS-CoV-2.

National Institutes of Technology (NITs)

A few important works of some of the NITs are mentioned below.

Motilal Nehru NIT, Allahabad has filed for patents for Deep learning and lungs X-Ray image based detection system for Covid-19, anti-microbial herbal formulation, VIRALYSER 1.0, and a Portable Box to Sanitize Inanimate Items, The Institute has also developed AMRIT (Assessment, Monitoring, Reporting and Intelligent Tracking) App. It is a mobile based application to track patients having cough, cold, fever or breathing problem and is currently being used by the local administration, chemists, medical practitioners and Asha Worker.

MANIT, Bhopal developed file sanitation machines/rack shelf that sanitizes the files in 10minutes. Patho

Wrecker Device for disinfecting air and surface. NIT, Calicut has developed reusable Aerosol Boxes for treating COVID19 Patients, Nasal Air filter, and UV based disinfection systems. NIT, Durgapur has developed a low-cost indigenous Oxygen Concentrator (PRANAYAM) and an affordable, plug-and-use, easily maintainable semi-automatic ambu-bag ventilation system (PRANESH). NIT, Jalandhar has developed a service robot, capable of delivering food, medicine and other materials, to serve the Covid infected patients. Visvesvaraya NIT, Nagpur has developed a two-way ventilator splitter and restrictor prototype which have been tested successfully on artificial lung model and handed over to IGGMC Hospital. NIT, Warangal has developed a multi-purpose, chemical-free and eco-friendly sterilisation system named 'OzoNIT'.

Other NITs have also developed sanitizers using different disinfection technologies, ventilators, oxygen generator systems, mobile apps and are working on other COVID-related research projects.

Indian Institutes of Information Technology (IIITs)

IIITD&M Kancheepuram has developed UV sanitizer designed for grocery shops and supermarkets. The Product has been commercialized by VLOG Innovations LLP, Chennai and is already in the market.

IIIT Nagpur has signed an MOU with AIIMS, Nagpur for facilitating Research Collaboration. Under this MOU, the Institute has already developed a device for effective tracking & monitoring of the COVID-19 Patients.

With the help of their start-ups, IIIT Sri City Chittoor developed products like Air Quality Monitor & Purifier, Smart Intravenous Dripper (SID) and Negative Pressure Wound Therapy with Remote Monitoring.

IIIT Bhagalpur has developed a hand-held device which uses an AI-based software to detect COVID-19 by analysing X-Ray/CT Scandigital input.

Other IIITs, like IIIT Jabalpur, IIIT Ranchi, IIITSonepat, IIIT Kota and IIIT Guwahati have also undertaken research projects on COVID-19.

Conclusion

COVID has thrown many challenges before us. Our institutions accepted these challenges in their own stride and, despite the fact that number of students and researchers in the campus was very low over the last one year, they worked on research and development projects to meet the new challenges. Most of these research products are successfully tested and prototype ready for transfer to industries for commercial production. Some of the products have already been commercialised. These Institutes also contributed towards making available indigenous good quality products at affordable cost, which was a big challenge before us during these trying times. Carrying out these works during the pandemic was a big challenge, for which CFTIs came up with SOPs for working in the research labs, incubation centres and Start-ups. Apart from research and development, they have immensely supplemented the efforts of state governments and local administration by extending their campus for COVID care facilities.

A brief description of COVID-related research and development works undertaken by CFTIs is provided in the booklet. These institutes need full support of various agencies in granting the necessary approvals on priority basis so that their products are successfully patented and commercialised for mass production. These products also need to be popularised by organising fairs, e-fairs to begin with, and enhancing institutes' interaction with industry chambers.

Indian Institutes of Science (IISc) & Technology (IITs)

IISc Banglore

IIT Bombay

IIT Delhi

IIT Madras

IIT kanpur

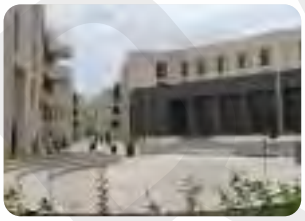
IIT Kharagpur

IIT Guwahati

IIT Roorkee

IIT (BHU) Varanasi

IIT (ISM) Dhanbad


IIT Gandhinagar

IIT Bhubaneshwar

IIT Hyderabad

IIT Jodhpur

IIT Patna

IIT Indore

IIT Ropar

IIT Mandi

IIT Palakkad

IIT Tirupati

IIT Jammu

IIT Bhilai

IIT Goa

IIT Dharwad

Indian Institute of Science (IISc) Bangalore

- **Development of 3-ply masks having antiviral properties:** The Institute has conducted a study on the development of 3-ply masks with cotton fabrics sandwiching an fibrillar microporous layer (produced by spray coating). Lab prototype has been developed and discussions are on with 3 startups/ companies for licensing. Cost of such a mask will be Rs 30.
- **Swing adsorption based medical oxygen generation system for small and medium capacity hospital:** The project addresses a containerized solution for less than 30 bed hospitals which are in large numbers as PHC and CHC in the country. It is intended to be low power and IoT enabled system. Scale-up to large hospitals has been developed.
- **Development of Global COVID-19 RT-PCR test:** Global TM COVID-19 RT-PCR Kit is a multiplex TaqMan probe based, single step real-time reverse transcription polymerase chain reaction (RT-PCR) test intended for the quantitative detection of SARS-CoV-2 nucleic acid in human samples. ICMR approval has been received. And is in process of commercialisation. Cost of the project is Rs. 25 lakhs.
- **Development of COVID-19 Rapid Ag Test device:** The Institute is working on COVID-19 Rapid Ag Test Device. Its Validation in progress.
- **Proteo-genomic analysis of SARS-CoV-2:** A proteo-genomic study was carried out that focused on the mutations observed in SARS-CoV-2, their impact on the proteome of the virus, and the proteomic host response to SARS-CoV-2 infection.
- **COVID-19 data visualisation through automatic phase detection:** The Institute has developed a website that automatically divides the duration of spread of the disease based on rate of increase in new cases and shows a set of three graphs which are easier to interpret and extrapolate than a single exponential graph.
- **CoBot for OPD:** A low-cost Collaborative Robot has been developed to help doctors and nurses to record vital parameters maintaining social distance with patient. Scaled down prototype has been developed (Figure-1). Cost of the project is Rs. 2 Lakhs.
- **Development of Portable oxygen concentrator (1-10 lpm):** An indigenous Oxygen Concentrator was designed and developed in the Indian Institute of Science. Cost of the first prototype is Rs. 16 lakhs.
- **Karnataka COVID-19 Sero surveillance:** Estimate the burden of active infection in Karnataka in three rounds.
- **Serosurvey designs in the middle of pandemics:** Identify optimal design of serosurvey for disease burden estimation.
- **Development of Workplace readiness calculator:** The institute has developed Self assessment tool of workplace readiness to enable safe opening of workplaces.
- **Development of City-scale agent-based simulator:** The institute has developed an agent-based simulator for scenario analysis pandemics. Cost of the project is Rs. 35 lakhs. Software has been released on Github.
- **Development of Campus Rakshak:** The institute has developed Campus Simulator for safe opening of campuses. Its software is under beta test. Cost of the project is Rs 10 lakhs
- **Development of User interface for city-scale simulator:** The institute is working on development of a user interface for city-scale simulator enabling adoption of the city scale simulator via simpler GUI. Its software is under development. Cost of the project Rs 35 lakhs.
- **Interplay of NPIs and Vaccinations:** The institute has made a research study of various vaccination prioritisation protocols, capacities, and NPIs.

Figure 1: CoBot for OPD

- **Drug repurposing using graph neural networks for SARS-CoV-2:** Tools from artificial intelligence have been applied to repurpose already approved drugs for the 2019 novel coronavirus diseases (COVID-19). The proposed graph neural network model learns from known treatments of many diseases and complex interactions between the four entities and successfully predicts unknown links between approved drugs and novel diseases, such as COVID-19. Cost of the project is Rs. 5.5 Lakhs
- **Rapid identification of Covid-19 biomarkers in blood plasma using Raman spectroscopy and artificial intelligence:** Proposal is directed at identifying COVID-19 biomarkers in the blood plasma of infected patients. Spectra collected from infected COVID-19 patients and healthy controls will be used for training and building robust classification models. This study has been funded by a grant from SERB/DST. Cost of the project is Rs. 60 lakhs.
- **Protective roles of flu infections and BCG vaccination in lowering COVID-19 mortality:** This is an epidemiological study performed to address the high numbers of deaths in some countries but not others due to COVID-19 in 2020. It has been shown that countries with high number of flu or tuberculosis deaths displayed less deaths due to COVID-19
- **Sero-Cov-ID:** The institute has developed ELISA based assay for detecting the levels of IgG and IgA antibodies against SAR CoV2 spike protein. It has been licensed to NeoDx Pvt Lat, Bangalore. Cost of the project is Rs 29 lakhs.
- **Development of a recombinant subunit vaccine for SARS-CoV-2:** Mynvax Private Limited, a start-up vaccine biotech company incubated at the Indian Institute of Science (IISc), Bangalore, in collaboration with IISc has developed a recombinant subunit vaccine for protection against SARS-CoV-2, the causative agent of COVID-19. Final formulation for clinical development is ready. Process development is being initiated. Cost of the project is estimated to be Rs. 30 cr until completion of Phase III trials.
- **Direct Numerical Simulation of cough and speech flows to understand transmission dynamics of COVID-19 infections:** In this work, the institute caries out DNS of human respiratory flows that play a critical role in the transmission of COVID-19 type contagion. One paper has been published. The cost of the project is Rs 12 lakh towards running the simulations on the CRAY supercomputer.
- **Development of PCR-free SARS-CoV-2 RNA detection test based on isothermal nucliecacid amplification:** The institute is in the final stages of developing a highly sensitive and specific nucleic acid amplification test for SARS-CoV-2, that can be conducted without a PCR machine. Prototype is ready and is about to be sent to an ICMR-certified lab for validation. Cost of the development is Rs 27 lakhs.
- **Development of an app Go Corona Go:** Privacy Respecting Contact Tracing for COVID-19 Management: Go Corona Go (GCG) is a digital contact tracing app for COVID-19 for institutional use. It uses Bluetooth Low Energy (BLE) to advertise and collect a random device ID of other nearby GCG users. It has been deployed in 3 campuses at IISc, IIT-Jodhpur, and IIIT-Hyderabad, with over 2000 users. Being packaged as part of DST ICPS Campus RAKSHAK solution that will be scaled out and commercialized in the next 3 months.
- **Development of Antimicrobial Surface Coatings with Nanofibers:** An antimicrobial surface coating was developed using electro spun nanofibers. These nanofibers with biodegradable polymer exhibit an excellent antimicrobial activity. Commercialization of nanofiber mask was carried out with a garment manufacturer and 100 Nos of Nanofiber masks were developed. The

technology was promoted by Shanmukha Innovation (SID, IISc). A detailed report was available in this link https://covid19.iisc.ac.in/antimicrobial-surface-coatings-with-nanofibers/.Its Prototype ready for commercialization. Cost of development is Rs. 2 lakhs.

- **Development of Mobile Infection Testing and Reporting (MITR) Labs:** The institute has developed Molecular Diagnostics Laboratory on wheels to perform end to end RT-PCR tests in remote parts of the country to help reduce turnaround time and increase access to RT-PCR tests. Enquiries from multiple state governments have been received - require support for delivering additional units against these enquiries. Cost of development is Rs. 2.2 cr.
- **Development of Portable PCR System:** The institute has developed Portable thermal cycler and fluorescence reader instruments to enable molecular diagnostic tests for COVID-19 and other infections. Clinical design with 200+ samples at IISc CIDR has been done. Pre-compliance testing and regulatory approvals is in progress. Technology licensed to IISc incubated startup - ShanMukha Innovations for commercialization. Three partners with novel test kits are engaged to discuss and close on market launch strategy. Cost of development is Rs 1 cr.
- **Modelling the population-level protection conferred by COVID-19 vaccination:** The institute mimicked responses of individuals by sampling NAb subsets of known sizes from the landscape and found that they recapitulated responses of convalescent patients
- **Development of Oxygen concentrator:** An oxygen concentrator is an apparatus that separates oxygen from air under pressure using certain zeolite materials. Its prototype has been made and is under Clinical trials. Cost of development is Rs. 10 lakhs
- **Development of Ventilator:** After assessing various models of ventilators in the market mostly imported, it was realized that technology is all about building optimised algorithms for ventilator to respond for various demands of patient. IISc is developing the algorithm, which is critical to succeed in this development. Its prototype has been made and is under Clinical trials. The cost of development is Rs. 10 lakhs.
- **Development of Antiviral coatings:** The institute is working to provide an alternate filter material that can be used with any fabric mask to bring its efficiency as close to N95 filters as possible. Development of its pro type is under progress. Cost of the development is Rs. 10 lakhs.
- **Development of Antiviral room air purifiers:** The institute is in process of development of an antiviral room air purifier. Ioniser is a device that uses high voltage to ionise (electrically charge) air molecules. Cost of development is Rs. 10 lakhs.
- **Quick-deploy Isolation wards:** The institute has developed a modular array of one or more isolation pods with negative or positive pressure containment areas for individuals, processes and protocols for maintaining hygiene and avoiding cross infections, while permitting testing and safe interaction with local team. Its one round proto has been done. Cost of development is Rs 10 lakhs
- **Development of Behaviour forming antiviral hand gloves:** The institute is working on creation of a wearable hand gloves that regularly reminds the user to sanitize his hands and also enables this. Cost of development is Rs 10 lakhs.
- **Electrochemical ELISA test:** Path Shodh, a startup incubated at IISc, has developed a semi-quantitative electrochemical ELISA test for COVID-19 IgM and IgG antibodies, which repurposes a lab-on-palm platform developed by the company. The product has been fully validated and CDSCO license has been obtained for manufacture and sale.
- **Nasal cannula:** A team is working on designing a high-efficiency nasal cannula which can regulate the flow of oxygen using nozzles and reduce wastage. The design will facilitate the reuse of tubing and disposing of only the nasal cannula part, which can reduce cost by about 50%.
- **X-ray Setu:** ARTPARK, IISc and Niramai Health Analytix have developed an AI-based tool to interpret chest X-ray images sent over WhatsApp by doctors and generate automated reports. The tool works even with low-resolution images and is suitable for different lung abnormalities.

IIT Bombay

- Portable / wheeled UVC based sterilization unit and germicidal cabinet
- Phytoformulations for walk-through, hand rub and surface sanitizers for human safety
- CPAP helmet for mildly distressed patients (Figure-2)
- Wash resistant antibacterial and antiviral coatings for masks and textiles (DURAPROT) (Figure-3)
- Surface spray for decontamination and anti-viral action
- Biodegradable antiviral plastic like films for face shields

Figure 2: CPAP Helmet masks

Figure 3: DURAPROT coated face masks

- Mechanized ambu-bag for patients with moderate respiratory difficulties
- Advanced ventilator for severely critical patients
- ICU ventilators (Vi-SWAAS)
- Anti-viral nutraceuticals and phytopharmaceuticals
- Aerosols for pneumonitis and ARDS complications of COVID-19; safe biohazard transporter
- Robotic disinfection unit
- Products for immediate societal use like low-cost PPE solutions including masks, face shields, aerosol box for hospitals, washable coverall suits, urination attachment for coverall suit, temperature controller for coverall suit, etc.
- IT solutions such as CORONTINE app for quarantine adherence and tracking/tracing asymptotic carriers; User-friendly, customized information access with humans-in-the-loop (World Wide Help)
- An algorithmic protocol for pooled RT-PCR testing of samples for COVID-19 (tapestry pooling)
- Lokacart, an e-commerce software platform, for quick connect of sellers and consumers directly.
- Cost-effective instant care oxygen delivery system
- Electrolysis based portable oxygen generator system
- Development of zeolite-based oxygen concentrator and
- Sustainable and economical O2 production through electrolysis

- Technology for conversion of nitrogen generator to oxygen generator in collaboration with industry. This is under deployment through interfacing between government and industry partner.

  Many technologies developed for COVID-19 pandemic mitigation have been licensed to Industries.

IIT Delhi

The Research & Development Unit initiated the fast-track COVID research and internally funded five Faculty Interdisciplinary Research Projects (FIRP) within the institute and two Multi-institutional Faculty Interdisciplinary Research Projects (MFIRP) with the National Institute of Immunology (NII). Some of the significant outcomes of these efforts are:

- **Corona testing kit Corosure:** An RT PCR-based kit for Covid detection developed at IITD, approved by ICMR, has been transferred to Newtech Medical Devices Pvt. Ltd. New Delhi.

  Currently, Corosure based Corona testing facility is fully operational on the campus. About 100-300 samples are collected per day by JITM skills Pvt. Ltd. & Rs. 800/- is charged per sample. This facility is available for both the IITD community as well as outsiders.
- **KAWACH Mask:** IIT Delhi startup ETEX launched an affordable and effective face mask, KAWACH, to protect COVID-19.
- **NSafe mask:** An IIT Delhi startup, "Nanosafe Solutions," has launched antimicrobial and washable face mask "NSafe".
- **Three Layered Mask:** Nanoclean Global Pvt. Ltd., a startup of IITD developed three-layered good quality surgical masks for hospitals & health workers
- **Antimicrobial fabrics:** Fabiosys Innovations startup of IIT Delhi.
- **Coverall:** IIT Delhi researchers along with Scientist of DRDO developed an affordable PPE coverall that reaches adequate levels of breath ability
- **Ayurvedic herb Ashwagandha can be an effective therapeutic and preventive drug against the COVID-19 infection:** collaborative research by IIT Delhi and AIST Japan
- **The Tea (Camellia sinensis) and Haritaki (Terminalia chebula) extracts may act as potential therapeutic options against COVID-19:** IIT Delhi study.
- **Sanitization:** Automated Touchless Dispenser for hand Sanitization is installed at the Entrance of MS Bldg
- **Covid-19 dashboard PRACRITI:** IITD Researchers developed a Web-based Dashboard for the Prediction of Corona Transmission in India.
- **PRACRITI –** A Web-based Dashboard for Prediction of Corona Transmission in India.

IIT Madras

- AirOk Technologies Private Limited, incubated at IITM aims to scale N95 face masks
- Collaboration with NexGen3d Technologies to design and manufacture face shields.
- Yaathum a startup incubated at IITM Incubation Cell, is developing a real-time RT-PCR test for COVID-19 to detect the SARS-Co-V-2 in 2 hours.
- IIT Madras has proposed to set up a Covid-19 testing facility.
- Passive Microwave Radiometry successful in screening breast tumours and inflammatory disease such as arthritis, sprain is being proposed for measure core body temperature and lung infections for covid-19.
- Design and deploy a scalable touchless sanitizer dispenser in partnership with M/s. Shima Engineering Projects, Chennai. Working model has been developed and verified. Efforts will be focused on mass production with help from CWS, IIT Madras.
- Padmaseetha Technologies Pvt Ltd - An ISO 13485 certified med-tech startup incubated at IITMIC, is developing Smartphone based portable battery-operated ventilator with humidifier.
- ConzumeX Industries Private Limited - ConzumeX (a smart wearable company incubated at IITM Incubation Cell) is building Low-cost Ventilators.
- Hands free thermal scanner
- **A Novel First Aid Technique for Treating COVID-19:** Ubiqare enables doctor-driven specialty care to patients at home, reducing hospital visits and stay.

IIT kanpur

- **National super model initiative in development of mathematical model for pandemics called SUTRA:** IIT Kanpur played an integral role in development of the model named SUTRA (Susceptible, Undetected, Tested (positive), and Removed Approach) being used to forecast the trajectory of COVID-19 pandemic in India
- **Oxygen Consumption Monitoring Portal:** It is imperative to have data on the volume or quantity of oxygen, available to multiple stakeholders to understand the ongoing situation, analyze various alternatives and

recommend the most feasible and rational action plan. In this regard, IIT Kanpur team has developed a web-based portal for monitoring state-wise oxygen consumption. The system is available at the following URL: https://gssl.iitk.ac.in/o2info/

- **Mission Bharat O2 (MBO2):** IIT Kanpur has launched "Mission Bharat O2" (MBO2) Open Manufacturing Challenge. MBO2 is a community learning-based model aimed at readying twenty different high-quality manufacturers from different parts of the country to simultaneously scale-up the production of oxygen concentrators and large-scale oxygen plants.
- **Technical Help in Oxygen Plant Installation to the Empowered Group of Government of India:** IIT Kanpur is providing technical help in installation of 162 oxygen plants across country.

IIT Kharagpur

- **COVIRAP:** Itis a point-of-care device for rapid diagnostics of pathogenic infection via nucleic acid-based detection, which can not only be used for detecting COVID-19 on a community level. Version 1 has been validated by ICMR-NICED. The technology has been transferred to companies for commercialization and in-house facilities have been established for kit development, device prototype development and training.
- Preparation of low-cost Hand Sanitizer, according to WHO recommended formulation
- **Preparation of CDC-recommended triple-layer fabric Face Masks:** 40 women community health workers have been trained in their manufacturing.
- **COVICUBE:** A device which can simultaneously measure respiration rate, Oxygen saturation, breathing rate, Temperature which can be very effective for early screening of COVID-19 patients and constant monitoring of the patient at the hospital as well. Currently, a commercializable prototype is being developed.

IIT Guwahati

- **Mathematical and Statistical Modeling of COVID-19 Outbreak in India:** we Extent of effectiveness of the three successive nationwide lockdowns has been examined in this research. It suggests the impactful success in the control of spread of COVID-19, resulting from the implementation of the lockdown in a timely manner.
- **COVID-19 in India:** State-wise Analysis and Prediction: Data science models to analyze and predict the total number of COVID-19 infected people for different states in India in the next 30 days. **Shiny-App** has also been developed which can be used to see the state-wise predictions. The results can be useful for the different states governments for planning purpose.

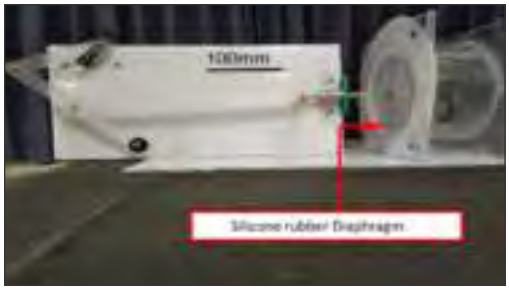
- 

Figure 4: Preliminary prototype of ventilator system by IIT Guwahati

A Systematic Review of the Efficacy and Safety of Favipiravir (Avigan) for the Treatment of Novel COVID-19 Infections: It has been found that Aviganas well as its derivates synthesized molecules has immense potentiality to become a possible inhibitory drug candidate to mitigate COVID-19.

- Manufacturable Ventilator (Figure-4) for Respiratory Emergencies of COVID-19 Disease: An advanced version of the ventilator is under testing which will provide four controllable features of the breathing cycle such as breathing rate, inhale-exhale time (I:E) ratio, tidal volume and the inhale-exhale pause, each controlled by the mechanical knobs present on the front and side panels of the device.
- Methodof preparing disposable water repellent mask and a product thereof: Considering the recent scenario of worldwide COVID-19 pandemic, here we are in the process of extending the lotus-leaf inspired extreme water repellence to develop an economic, environmentally friendly and anti-viral face mask,
- Viral Transport Medium kit (VTM), Viral RNA isolation kit, and Covid-19 detection (RT-PCR kit) were developed and supplied to Assam government
- Antiviral/Antimicrobial spray to contain COVID-19 pandemic
- Prototypes were developed from Water Energy Nexus lab include, UVC LED system to disinfect areas; and Smart self-check kiosk with disinfectant tunnel to provide a community solution to fight against COVID-19 by ensuring surveillance of an individual's health and disinfection of the items belonging to the individual.
- Design Intervention for Low-Cost Respiratory Venturi Mask Valve for COVID-19 Patient. Design ready for 3d printing of the valve
- **Various other research projects include:** RT-PCR kits and devices, RNA isolation Kit, Viral Transport Media (VTM) kit, 3-layer fabric masks, compostable plastic masks, low-cost face shields, Local Home Delivery Networks, Regular Health Monitor, Travel Tracker, etc.

IIT Roorkee

- **Prana-Vayu** (low-cost portable ventilator): being developed in collaboration with AIIMS, Rishikesh. The prototype has been tested successfully for normal and patient-specific breathing conditions. The material cost per ventilator is estimated to be INR 45000/-.
- Face Shields for the first line defence of healthcare professionals. The frame of face shield is 3D printed. The manufacturing cost per shield is approximately INR 45. These face shields were distributed freely to front line workers in the cantonment area, municipal workers in Roorkee and Haridwar region, in addition to the staff at IIT Roorkee.

- **VyaanHepa Reusable Respirator,** developed by three recent graduates of IIT Roorkee aims to provide highest level of protection from all kinds of airborne pollutants.
- Department of Physics has designed and developed portable Covid-19 screening booth in association with Nagar Nigam Roorkee
- The researchers at the department of Chemical Engineering have **developed a UV based continuously operating sterilization system** for disinfecting common use accessories and electronic devices. The prototype has been handed over to Haridwar Municipal Corporation.

- The Department of Biotechnology have developed nano-coated masks that contain a layer of silver nano particles and plant based antimicrobial agents on the surface and thereby provides better protection to the user. It is useful in preventing the entry of several pathogens including corona virus.
- "Discovery of structure - based antivirals against SARS-Cov2 targeting key viral genome replication enzymes". It is a computer based, in-silico approach in identifying novel antiviral agents for coronavirus.
- A research group at IIT Roorkee has predicted ten potential drugs for the treatment of COVID-19. Out of these, the antiretroviral drug Saquinavir comes out to be very effective for repurposing. It is usually sold under the brand names Invirase and Fortovase, and is used together with other medications to treat or prevent HIV/AIDS. The research findings have been published in the journal Plos One.

IIT (BHU) Varanasi

- Participating in UP government initiatives of oxygen audit during second wave of COVID. These activities are still ongoing.
- A non-contact sensors-based disable an elderly activity recognition system during home isolation.
- Development of Covid19 resistant mask and PPE using functional silver nano particles spray.
- Artificial Intelligence Assisted Screening of Lead Antiviral Molecules and development of carbon quantum dots against SARS-CoV-2 (COVID) infection.

- Development of Lateral Flow Electrochemical Bimodal Sensor for the Diagnosis of COVID-19.
- Bottom-up approach by making sanitizer and giving training to police personnel and city administration regarding sanitization.

- Development of non-touch sanitizer dispenser
- Re-purposing of clinically approved drugs for possible treatment for COVID-19 by targeting SARS-CoV-2 main protease. Their drug repurposing work has identified the following compounds (Figure-5), details of which are already published in international Journals.

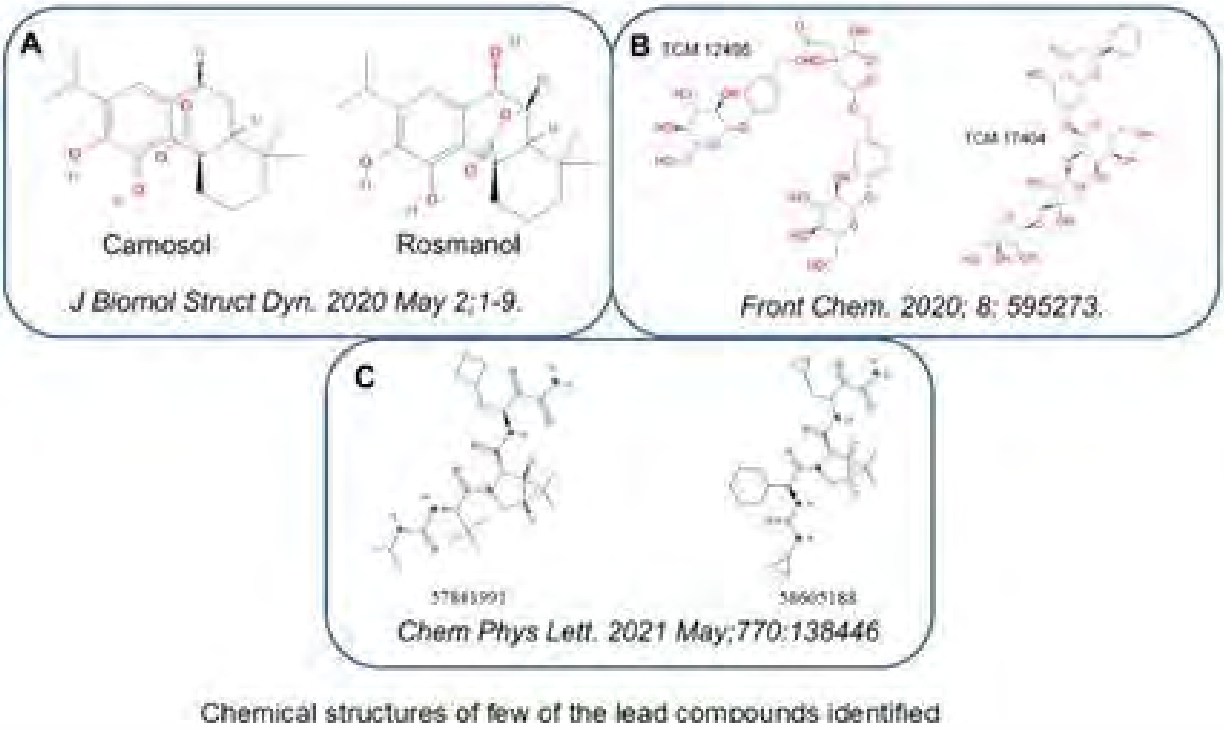


Figure 5: Chemical structure of compounds identified for possible treatment of Covid-19

IIT (ISM) Dhanbad

- A spatially descriptive, and dynamic model to the COVID-19 data has been developed for application
- Development of Deep Learning based Model for the Automatic Identification of COVID-19 disease using CT image history.
- Development of new process chemistry towards synthesis of repurposed drugs for potential treatment of Covid-19.
- Design and Development of MWCNT based low-cost mask.
- Silver nanoparticles based super hydrophobic anti-viral coating on cloth.
- Development of new process chemistry towards synthesis of repurposed drugs for potential treatment of Covid-19.
- Development of silver nanoparticles based super hydrophobic anti-viral coating on cloth.

IIT Gandhinagar

- RT-PCR Testing facility: Using the available laboratory facilities and participation of enthusiastic volunteer students, the Institute developed an RTPCR testing facility and is helping the local government for sample testing.
- IITGN researchers developed an interactive COVID-19 Dashboard called **"MIR AHD Covid-19 Dashboard"** to provide real-time information at various levels. It could assess the local risk factors to give a city scale projection of COVID-19 incidence while accounting for various social distancing scenarios.
- IITGN researchers developed an Artificial Intelligence-based deep learning tool for detection of COVID-19 from Chest X-ray images. It could be used for preliminary diagnosis before the medical test.
- A study conducted by a team of researchers at IIT Gandhinagar has been exploring to detect presence of SARSCoV-2 genes in the wastewater. This research is coordinated by Gujarat Pollution Control Board (GPCB) and Gujarat Biotechnology Research Center (GBRC).
- Development of industry friendly technology for fabricating highly reactive, nontoxic, and transparent antiviral surface coating.
- DNA programmed microfluidic devices as cost effective, high throughput point of care diagnostic platforms for Covid 19 detection.
- Development of a reusable plasmonic platform for specific detection of Covid-19 RNA at ultralow concentrations.
- Impact of air pollution on COVID-related secondary exacerbations
- The Effects of Reverse Migration on Indigenous Communities Following India's Covid-19 Induced Lockdown

IIT Bhubaneshwar

- Development of a Patient Responsive Active Assist coNtrol (PRAAN) Ventilator.

Figure 6: UVC Disinfection Cabinet

Figure 7: low-cost portable ventilator

- Development of a UVC Disinfection Cabinet (Figure 6).
- Development of a low-cost portable Ventilator (Figure 7).
- Development of a face shield with antimicrobial properties.
- Development of a Pocket Sanitizer.
- Development of effective disinfectants and washing materials. Hand Sanitizer prepared by researchers as per WHO parameters.
- Development of a Disinfectant Tunnel and station.
- Neutralizing Peptide Antibody Designed for Human Complement Fragment 5a (hC5a).

- Rational Design of broad-spectrum antiviral peptides targeting the spike protein and the lipid bilayer of the SARS-CoV-2.
- Antibody like neutralizing peptides designed for human complement fragment 5a (hC5a) for alleviating "hypercytokinaemia" associated with severe COVID19. Evaluation of natural polyphenols and nucleoside analogues compounds as novel corona virus (SARS CoV-2) main protease (Mpro/ 3CLpro) inhibitors – An in-silico docking and molecular dynamics simulation study.
- Mass production of metal oxide nanomaterials with antimicrobial characteristics, and nanofibers, which can be used to develop air filters and biomedical applications
- Experimental studies on droplets transport during sneezing and breathing.
- Evaluation of efficacy of various standard and non-standard face masks and face shield. Double Masking Protection vs Comfort – Qualitative Assessment.
- Computational studies on ventilation rate influence on droplet transport inside various indoor environments like offices, meeting rooms, isolation wards etc.
- Systematic network and meta-analysis on the antiviral mechanisms of probiotics: a preventive and treatment strategy to mitigate SARS-CoV-2 infection.

IIT Hyderabad

- Supermodel for the prediction of Covid-19 progress in India.
- In a research, funded by DST-Nanomission, a team of researchers at IIT Hyderabad has proved that the drug Amphoterecin B (Am B) can be formulated in the form of oral tablets using nanofibrous FDA approved polymer (gelatin) matrix. This is a first-ever attempt to fabricate nanofibrous oral tablets of Amphotericin B. It is published in two peer-reviewed international journal papers: https://doi.org/10.1016/j.nanoso.2019.100367 and https://doi.org/10.1016/j.mtcomm.2020.100953. This work has a potential for further advancement for necessary clinical trials before commercialization with the help of interested pharma partners.
- Fast acting and long-lasting sanitizer and antiviral coating has been developed and commercialized by a startup, EaffoCare Innovation, e-launched by honorable MoE.

- Developed sanitizer and distributed about 200 liters daily to the District Collectorate and government hospitals in Hyderabad during the first phase of Covid.
- Developed an app that is being used by Telangana Govt. for vaccination throughout the state.
- Pure EV, a company incubated out of IITH Pure EV have manufactured about 5500 3-ply masks and distributed to local needy people and have distributed around 10,000 face shields to Police, Administrative, Health Care, and Hospitals in Sangareddy district and GHMC.

- Developed and deployed an App for tracking the distribution of rice and money to more than 3,00,000 migrant workers.
- Nemocare and Heamac, two startups of Centre for Healthcare Entrepreneurship (CfHE) of IITH, have developed Nemocare Raksha, a wireless wearable, for Covid-19 patient monitoring in isolation wards.
- USafe, a start-up under CfHE has developed a N95 equivalent Mask US9TMthat is reusable and less expensive.
- Aerobiosys, a startup of CfHE at IITH, has developed a low-cost portable ventilator, **Jeevan Lite.**
- Developed an app that helps to monitor quarantining, on the request of Telangana state government.
- Dept. of Design has developed a UV air sterilizer **"Swatchh Air"** supported by IITH via a BUILD (Bold Unique Ideas Leading to Development) project.
- UV based Sterilizer **"Sudhikaran"** has been installed in the campus.

IIT Jodhpur

- Low-Cost Reusable Marble Dust Appended Composite Ceramic Porous Mask for Air Purification and Water Issues During & After COVID-19 Pandemic
- A UV-light Sterilization System/ Hybrid UV-H2O2 Sterilization System to disinfect artefacts and N95 masks for reuse.
- SMART HEALTH solutions for Rapid Mass Diagnosis for COVID – 19 which includes AI driven diagnostics using X-ray and CT-images of lungs
    - Deployed at IIT Jodhpur PHC. (https://telemedicine.iitj.ac.in/)
    - 40+ doctors are registered on the portal that includes experts with various specialties

- CoViDoc - A platform to connect patients with hospitals/doctors in contactless mode and Smart Health Solutions for Rapid Mass Diagnosis for COVID-19.
- Curcumin-CNT based Polymer Composites for Low-Cost and Reusable Antiviral Textile.
- Design and Development of Face Shield for COVID-19 Health workers.
- Development of Anti-microbial Superhydrophobic Coating on Personal Protective Equipment (PPE) to combat COVID-19
- Development of light activatable quantum dot impregnated antiviral paint.
- Food Products Sterilization using UV Light to fight COVID-19.
- Cold Plasma Detergent in the environment to fight COVID-19
- AI Driven Estimation of COVID-19 Prognosis using Multimodal Data
- Non-Invasive Estimation of Care-Body Temperature, Heart-Rate, SPO2 for Classification of subject AS Healthy or Non-Healthy(Symptoms of concern: fever despite ambient temperatures; silent hypoxia-COVID-19)
- Establishment of AI-Based Platform to Monitor and Identify Smell, Taste and Key COVID 19 Therapeutic Hotspots
- An advanced photo catalytic oxidation sterilization system based on uv-light and metal oxide nanoparticles catalyst to treat N95 filtering face-mask respirators for reuse. The technology has been transferred to industries.
- **Campus RAKSHAK Project:** IIT Jodhpur is coordinating in tandem with IISc Bangalore, IIT Kharagpur, IIIT Hyderabad, IIT Bombay to ensure population safety in campuses through "Campus RAKSHAK" initiatives. The Campus Rakshak solution framework- a contact-tracing, bio-surveillance, scenario exploration, and decision-support platform- can provide vital information to campus administrators to help with their decisions, generate connectivity, mobility, hotspot insights, save testing costs and explore scenarios for safe operation.
    - **The GoCoronaGo (GCG)**, aprivacy-respecting digital contact tracing App) has been rolled out at IIT Jodhpur campus in collaboration with IISc Bangalore in December 2020 and, so far, installed by 500+ campus residents (https://gocoronago.app/)
    - Tapestry Pooling: Compressed sensing algorithms for Group Testing of Pooled Samples
    - **Campus Modeller:** An agent-based simulation framework for assessment of intervention strategy against Covid-19 spreading in Campuses
    - **HealthBadge:** The HealthBadge system will provide the interface for the campus administrator to explore various options. It will also help summarize infection levels in the campus. It is currently under process of clearance.
- A prototype wristband (Figure-8) is developed which will create a sound alarm if two such bands come close to each other.
- **Non-invasive estimation of vital physiological parameters at screening/monitoring points:** The objective of the project is to find non-invasive estimation of vital physiological parameters such as core body temperature (despite ambient temperature), heart-rate, respiration-rate, blood-oxygen saturation levels (SpO2) - from thermal and RGB videos, towards classification of individuals as 'healthy' or otherwise. Research ongoing.

Figure 8: Prototype wristband for social distancing

IIT Patna

- **Sanitization Devices:** The Kingshahi Pvt. Ltd, incubated at IIT Patna, found a WHO guideline complied, lower cost, highly effective full body sanitization solution for limiting contamination in sterile areas. The product is under testing at AIIMS Patna and results are very promising. Awaiting certification for deployment
- **BigOHealth App,** incubated at IIT Patna, started a social initiative where any covid symptomatic patient can consult the doctor 24/7 through their platform.
- Telemedicine Platform, **Bikedoc,** an Online consultation company incubated at IIT Patna, has built a telemedicine platform in two versions- one Kiosk model and one Bike model- which can be used for monitoring of patients and remote consultation.
- Anti-viral, anti-bacterial fabrics for hospital bed sheets and textiles.
- Indigenous bipolar mask with two lines of protection against bacteria and virus with advance protection of copper.
- Food and Drug Delivery Robot
- Reusable face shield
- IIT Patna has implemented Contact less Electronic (QR Code based) Entry / Exit System.
- **Development of Knowledge Graph and Structure prediction of Proteins of COVID-19:** Developed a knowledge graph containing bio-medical entities related to COVID-19, SARS-CoV-2, and to construct a query system on the top of it to help researchers quickly and efficiently find their way through COVID-19 data set.
- Drug-Target Affinity for Drug repurposing for Covid19 Drug discovery using Graph Neural Network (under Microsoft AI for Health COVID-19 Grant)
- Ongoing theoretical research areas include analysing the pattern and trends in infections/recovery from the available data and influence of various factors (geographic, lockdown, vaccination, population density, etc), finding ways to predict future infection rates and ways to curb its spread and development/search of novel materials to tackle the challenges of bio safety.
- An ICSSR sponsored project on the theme of designing disaster preparedness training module based on contextualized knowledge.

IIT Indore

- **Candidate Vaccine against SARS-CoV2:** Developed a candidatein partnership with NCCS Pune and using a pseudovirus vector-based platform. Animal studies have shown promising results.Presently, efforts are focused to improve antigenicity and broadness of the candidate to accommodate the spreading of the double mutant (B.1.617) strain of SARS-CoV2.

- **Development of Virucidal Cationic Polymeric Nanoparticles for Face Masks and PPEs:** Fabrication of highly charged nanoparticles comprising of a cationic polymer to inactivate the Corona virus sticking on the surface of the PPE. To further enhance the virucidal efficiency of these nanoparticles, they will be loaded with the known virucidal photosensitizers.

Figure 9: 3D printed reusable mask

- Development on **Shape Memory Alloy based optical temperature sensor** for sensing the body temperature. This device can be fitted into the fabric of the patient and the body temperature can be continuously monitored without physical contact or thermometer or thermal scanner.
- **Development of UV disinfection Box and Arms:** Development of sterilization chamber using 254 nm ultra-violet (UV) rays to sterilize personal objects i.e. mobile phone, wallet, etc. of duty-bound police, doctors, and associated personnel. Such boxes have been donated to local Police Station and Primary Health Center and to different offices within the Institute.
- Development of customized 3D printed reusable masks having a provision to have reusable filters and straps. (Figure-9).
- **Development of Disinfection Tunnel** using ICMR approved bio compatible water-soluble surfactants through mist-spray technology for surface sterilization of inanimate objects used in hospitals, airport, vehicles, materials transport, etc.
- **Development of Self-illuminating Fluorescent Bricks** to convert the existing concrete buildings into **closed UV chambers** by completely packing the openings (i.e. doors, windows, and ventilators) to avoid exposure to UV light.
- Development of UV-C LEDs and UV-C photodetectors for disinfection of surfaces/ PPEs against COVID-19 and other pathogens.
- Identification of a Potential Peptide Inhibitor of SARS-CoV-2 Targeting its Entry into the Host Cells
- Identifying Possible Potent Inhibitors against COVID-19 via Computational Drug Repurposing Study.
- **Dual Targeting of 3CLpro and PLpro of SARS-CoV-2:** A Novel Structure-Based Design Approach to treat COVID19 infection
- Detection of Coronavirus using advanced machine learning techniques

IIT Ropar

- **Sampark-o-Meter:**A mobile-based app called "Sampark-o-Meter" which can indicate areas on maps with maximum corona virus infection possibility.
- **Low-Cost Ventilator (Figure-10):** IIT Ropar team comes up with low cost ambubag-based ventilator for shorter duration like during ambulance transport.
- **Anti-Microbial Coating for PPE kits:** Developed two noble synthetic materials (hydrophilic and

hydrophobic) for anti-microbial coating on PPE kits and disinfectant sprays for tunnels and for fogging.

- **Containment Box:** Containment Box for protecting frontline healthcare workers can allow it to be converted into a negative pressure chamber by connecting the vacuum from the wall-gas supplies, readily available in most hospitals.
- **Negative Pressure Room (NPR):** NPR has been designed to prevent transmission of COVID-19 through air at isolation wards and testing labs, thus protecting the medical staff from infection.
- **Intelligent Infrared Vision System for Covid-19 suspect identification:** This is portable, economical, and safe with remote screening capabilities along with self-decision making ability to detect suspects without human intervention at crowded places
- Medi-Sarathi: Autonomous vehicles called Medi–Sarathi has been developed for delivery of samples and medicines for COVID patients. It consists of two prototypes:
  - Drone System to curtail COVID-19 Infection in 'Touch Me Not' Environment.
  - RC Trolley System to curtail COVID-19 Infection in 'Touch Me Not' Environment.

Figure 10: Low-cost ventilator by IIT Ropar

- **Tech-traditional eco-friendly mobile cremation system:** Indian Institute of Technology, Ropar has developed a prototype of a moveable electric cremation system which claims to be using first of its kind technology that involves smokeless cremation despite using wood. It uses half of the wood otherwise required for the cremation and still is eco-friendly because of the technology that uses combustion air system.

IIT Mandi

- **Reusable MoS2 - Modified Antibacterial Fabrics with Photothermal Disinfection Properties for Repurposing of Personal Protective Masks:** The repurposed surgical masks could filter out around 97% of 200 nm particles and 96% of 100 nm particles, thus making them potentially useful for preventing the spread of corona viruses (120 nm) by trapping them along with antibacterial protection against other airborne pathogens.

- Nanofiber membrane decorated face mask with an efficacy of 94-99% at a pressure drop much lower than N95 has been developed.
- Low cost auto tuned mechanical ventilator.

- A low-cost ultraviolet light triggered viral disinfection panel, which has the direct application on courier box, PPE gear, travel bags, currency, wallet etc,
- An automatic thermal sensor, which will reduce the human intervention.

IIT Palakkad

- Low-cost ventilator is being designed.
- **Pulse Plethysmograph for ICUs:** In this project, low-cost pulse plethysmograph will be developed that has the capability to transmit vital parameters of patients to the nurse-station especially when alarming conditions occur.
- **Automated Lung Ultrasound for COVID-19:** IIT Palakkad intends to develop an automated analysis of ultrasound lung scans using machine learning techniques and conduct clinical trials.

- **Low-cost Test Kit for Fast Screening of COVID-19 Patients:** a paper strip-based visual testing method that can be used at point-to-care analysis in a community setting. This testing method is very specific and one full test can be run within ~10-15 minutes
- **Real-time Crowd Sensing using Mobile Phone:** Aim to create a software tool that uses data received at the base stations from mobile phone users to predict user locations and count the number of users in a given area.
- **Design and Manufacture of Respirator Masks:** A massive effort to develop novel masks/respirators to contain the spread of COVID-19 is underway. These masks and respirators need to be tested for breathability which is an indicator of the ease with which a person wearing the mask can breathe.
- **Pulse Oximeter Design and Development:** IIT Palakkad has signed a Project Agreement with ITI Limited, Palakkad to design and provide support for the fast-track manufacturing of Pulse Oximeters (50 Nos.). The Pulse Oximeters will be manufactured and supplied to Government of Kerala free of cost.

IIT Tirupati

- **Design and Manufacturing of a Reusable Antimicrobial N 95 Equivalent Respirator:** Developed an indigenously made N95 equivalent compatible reusable face mask. It has been planned to start mass production soon at a commercial scale and for this an MoU is already signed with the Amara Raja Group.
- **Development of Portable Sterilization Unit for PPEs:** A portable sterilization unit (Figure-11) has been developed for sterilization of PPEs such as masks, gloves etc. The developed equipment has enhanced sterilization efficiency. IIT Tirupati is collaborating with a local start-up for mass manufacturing of the unit.
- **Thermal Sterilizer for Hospitals:** IIT Tirupati designed and developed a Thermal Sterilizer called BLAAST (Blower Aided Air Sterilization by Temperature). The gadget can be used to sterilize airborne

respiratory drops carrying coronavirus through thermal treatment and can be very useful in COVID wards in hospitals and other situations. Prototype is already developed and manufacturing feasibility at large scale is being contemplated. Provisional Indian Patent is filed for the design and prototype.

- **Development of Apps and Games for creating awareness about Covid 19 and tracking mobility:** Research in Intelligent Software & Human Analytics (RISHA) Lab IIT Tirupati has developed educational games for increasing awareness of health measures for COVID-19 pandemic
- **Chest X-Ray based detection of Covid 19:** Developed a deep learning-based approach for diagnosing Covid 19 using chest X ray.
- **Designing and Manufacturing of Face Shields for Frontline Workers:** A face Shield was designed and fabricated with 500 mm micron thick PP sheet. 1000 face shields were fabricated and distributed to frontline workers like doctors, police, etc. The technology was transferred to Amararaja Industries and their workers were trained.

Figure11: Portable Sterilization unit

IIT Jammu

- Bulk sanitizers were provisioned for Army units, CRPF, BSF and CISF (AAI).
- Face shields fabricated in Central Workshop at large scale for use in campus as well as front line workers.
- With an industry partner, IIT Jammu is developing 5LPM/10LPM/20LPM oxygen concentrators. This technology shall be further investigated for low energy portable format and energy efficient format.
- Touchless hand sanitizer equipment was created for their own medical unit.
- Touchless remote temperature reader has been developed with an industry partner and is in use at their entrance areas.

IIT Bhilai

- **Identifying optimal immunization strategies in Indian Context against COVID -19:** Aims to do a comparative analysis of various strategies for immunization using computational model and provide immunization strategies.

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- **Multi-cluster models for epidemic spread and evaluation based on data-driven parameterization –** The project is aimed at characterization of clusters and development of multi-cluster model for the spread of the epidemic based on data-driven parameterization. The deliverable will be in the form of a user-friendly software for the use by GoI.
- Touchless soap and water dispenser for hand sanitization were developed.
- Touchless remote temperature sensor for human beings was designed, fabricated and user for entry control at IIT.

IIT Goa

- **IIT Goa has designed a Mechanical Ventilator (Figure-12)** based on automatic compression of ambubag. Design of various parts for mechanical ventilator was carried out at IIT Goa. Design of Slider, Crank, Punch and Casing Block of mechanical ventilator was carried out using Computer Aided Design facility of IIT Goa.

- IIT Goa, in collaboration with Georgia State Univ., Atlanta and Univ. of Washington, Spokane, USA, has been engaged in **development of novel** drug molecules for treating COVID-19
- It has developed a minimum viable product (MVP) for contactless attendance in educational institutions and workplaces using computer vision and sensor integration techniques.
- IIT Goa collaborated with the India Supermodel team **to predict the spread of the epidemic in various states in India.**
- A team of faculty members has been involved in **investigation to predict the virus spread from coughing.** In this study, it was found that; without the surrounding wind speed, the smaller droplets coming out due to coughing will travel a larger distance ranging from 1.5 to 2 m.

Figure 12: Mechanical Ventilator by IIT Goa

IIT Dharwad

- **Development of Oxygen Concentrators that can deliver medical grade oxygen:** Each unit (Figure-13)is being developed to cater to 15-20 patients in a typical hospital environment. Unlike the existing solutions, this system is expected to effectively reduce the use of adsorbent material quantity required significantly for the same oxygen output.
- Development of software application for providing reliable, accurate and timely information related to **Covid-19 Healthcare Resources** in Karnataka, including information on the availability of hospital beds, oxygen supply and vaccines, with an alerting mechanism.
- **A demonstration of an AI-enabled crowd sensing application** which exploits 5G connectivity for physical distance computation in order to enable practice of Social Distancing guidelines.
- **Development of an Epidemic Model:** A team from IIT Dharwad has constructed a more realistic SAQR model (abbreviated for susceptible, asymptomatic, quarantined and recovered), with several advantages over the traditional SIR or SEIR models.
- **Design, prototyping and production of ultra-low-cost Face Shields and Intubation / Aerosol boxes:** IIT Dharwad has produced more than 20,000 face shields (Figure-14) in collaboration with NGOs, SMEs and volunteers and distributed them across different hospitals. An Intubation / Aerosol box (Figure-15) is an inexpensive, reusable personnel protection device. The design has been shared with various companies to scale-up the production.

Figure 13: Oxygen Concentrator by IIT Dharwad

Figure 14: Face Shield

Figure 15: Intubabtion/Aerosol Box

Indian Institutes of Science Education and Research (IISERs)

IISER Kolkata

IISER Pune

IISER Mohali

IISER Bhopal

IISER Thituvananthapuram

IISER Tirupati

IISER Berhampur

IISER Pune

- **Development of Ventilation aiding systems for COVID-19 Patients:** Laboratory Prototype of an ICU ventilator has been achieved. Engaged with industry for making industrial prototype and taking to TRL level 8/9.
- **Chemical Oxygen Generators: Portable and transportable devices for instantaneous oxygen gene:** Prototype is available. Design of a reactor for continuous and controlled production is being worked out. The institute is working with partners to take it to TRL 7/8.
- **Real-Time Infectious Diseases Hazard Map for India Based on Transportation Networks:** Objective of the project is to create and deliver a stand-alone, real-time, web-based, hazard map for infectious diseases spreading based on transportation networks in India. This map gives hazard values for about 450 cities and towns in India with a population of more than 1 lakh. In the next few weeks, an online resource for this hazard map will be made available. Prototype web resource will be ready to be launched very soon.
- **Using olfactory fitness to detect asymptomatic COVID-19 patients:** To quantitatively assess the olfactory functions of asymptomatic COVID-19 patients, the institute designed an olfactory-action meter that determines a detectability index at different odour concentrations and an olfactory matching accuracy score. The test can be performed in less than 20 minutes and identifies 82% of asymptomatic SARS-CoV-2 carriers, despite the fact that subjectively, only a few of the patients noticed a compromised ability to smell. The experimental workflow prescribes a sensitive, low-cost and high-throughput screening process that can be administered to large populations, thereby helping to prevent the rampant spread of COVID-19. Prototype is ready and working, used for quantifying the olfactory fitness of COVID-19 patients.
- **High-Tech Low-Cost Paper-Based Viral Nucleic Acid Detection:** The institute aims to develop a paper-based viral nucleic detection approach as a tool for a point of care (PoC) support and monitoring system for public health. The institute has designed the gene circuit using the thermodynamics of RNA and stability predictions. The institute is in the stage of synthesis of the circuit to test VER1.0.
- **Developing animal models for COVID-19 Pathogenesis Research:** This project is aimed at eliminating one of the major bottlenecks in the availability of transgenic animal models to study viral outbreaks in India. IISER Pune (NFGFHD) has established a state-of-the-art facility for gene-editing technology and generation of animal models. Currently animals are in active breeding and available for the use of researchers across the country.
- **Epidemiological and Serological Surveillance of COVID-19 in Pune City:** The institute conducted a study to gain insights into the prevalence and transmission features of SARS-CoV-2 infections in Pune and to evaluate the immunological responses in the asymptomatically infected population. Five high-incidence prabhags (sub-wards) of Pune city were studied. The study implicates the influence of local factors and living conditions in viral transmission, identifies a complex immune response that is age-associated and highlights that a subset in the infected population remains susceptible. These findings will allow for development of better management policies, appropriate for conditions in low and low-middle income countries.

- **Data Curation, Analytics and Monitoring of COVID-19 in Pune City:** The objectives of the project are Curation, collation and organisation of patient, testing and contact tracing data collected by PMC. The team is involved in developing a scalable database and analytics system which will allow user-friendly exploration and analysis of COVID-19 data. The design of this system was based on all the learning that occurred over the past 6-8 months both in terms of the challenges in data curation and in terms of presentation of information to the PMC administration
- **Indigenisation of Diagnostics (InDx):** Centre for Cellular and Molecular Platforms (CCAMP) a Not-for-Profit Company at Bengaluru has launched a project called Indigenisation of Diagnostics (InDx). Center of Excellence (CoE) for Chemistry at IISER Pune will perform end-to-end chemical and functional testing and validation of amidites oligonucleotide probes, and dNTPs required for the COVID-19 testing.
- **Finding new and repurpose existing drugs to inhibit spike protein/ACE2 interaction:** The project aims to find new and repurpose existing drugs to inhibit spike protein/ACE2 interaction. The computational study has been done. Now the institute needs to perform experimental validation.
- **Genome sequencing and surveillance in Pune:** The aim of this project is to assess the emergence of SARS-CoV-2 variants and their contribution to viral transmission, virulence, clinical outcomes, re-infections and breakthrough infections. This project has just started and the team is optimising the sequencing strategies.
- **Vaccine development for COVID-19:** The research group of the institute is engaged in the development of self-assembling protein nanoparticle vaccine against SARS-CoV-2 virus utilizing a micelle-assisted protein labeling (MAPLab) technology: They have invented a new method called "micelle-assisted protein labeling (MAPLab) technology for custom design of VPLs based on a chemical strategy. The top candidates for cellular screening will be tested in animal models for their safety, tolerability, and efficacy.
- **Targeting the SARS-CoV-2 Replication-transcription machinery for therapeutics against COVID-19:** The institute laboratory is working towards identifying inhibitors and repurposing drug molecules using biochemical and structural techniques.

IISER Mohali

- **Generation of neutralizing monoclonal antibodies for SARS-COV2:** Aresearch team has been working on the generation of neutralizing monoclonal antibodies for SARS-CoV2.Their results suggest that targeting polybasic cleavage site (CS) in addition to the the receptor binding domain (RBD) of S protein by sdAbs could reduce infectivity of SARS-CoV2.
- **Development of urea derivative compounds as potential drugs against SARS-CoV-2:** Aresearch team developed a few urea-based potential drugs for SARS-CoV-2, in collaboration with scientists at IIT Ropar and CSIR-IMTECH Chandigarh.

Animal testing of such lead compounds to investigate their suitability for the development of novel anti-SARS-CoV-2 therapy is also being carried out.

- **Synthetic reconstruction of an attenuated SARS-CoV-2 virus for vaccine development and high content inhibitor screen:** A research team is currently working on the synthetic reconstruction of an attenuated SARS-CoV-2 virus for the vaccine development. They have currently completed the design strategy for the synthetic SARS-Cov-2 and using these synthesized blocks process of recombining the fragments in yeast. They have initiated work to establish the immunogenicity of such epitopes in laboratory animal model. Now the approach is being extended for other proteins of the virus.
- **SHIVA (Figure-16):** Sterile Hydration of Indoor Virus by Air-pump for use in COVID Isolation Wards and ICUs with Very Poor Ventilation: The research team developed an in-house air pump "SHIVA" for use in COVID isolation wards and ICUs with very poor ventilation. The cost of the system developed with the use of an air-pump usually used in home aquariums, a CPU fan, two BPA-free PET bottles and sodium dichloroisocyanurate is approximately Rs. 2000. 'SHIVA' will also prove to be beneficial for use at homes when residents are in self-quarantine or domestic help is required for elderly people living alone.

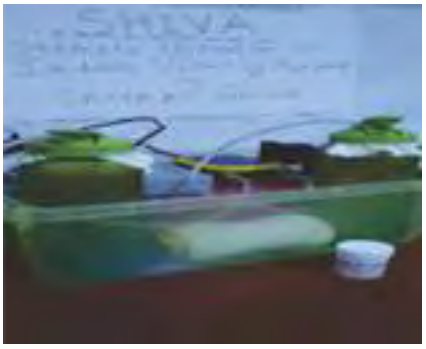


Figure 16: 'SHIVA'- In-house air pump

IISER Bhopal

- **Development of low-cost oxygen concentrator "Oxycon" (Figure-17):** The objective of this project was to design and develop a low-cost oxygen concentrator for large scale production and easy market accessibility. The cost of such oxygen concentrator is affordable. The prototype is under commercialization through a "Technology Transfer Agreement" with 4 companies.
- **Design and development of an alerting system "Co-Alert" (Figure 18) to maintain**

Figure17: low-cost oxygen concentrator 'Oxycon'

Figure 18: "Co-Alert"-Alerting System for Social Distancing

social distance in large scale meeting places and in campus The objective of this project was to design and develop an alerting system to maintain social distance in large scale meeting places and in campus. Its cost is around Rs. 11,000/- (eleven thousand). Its prototype has been developed. Currently the institute is looking for companies for commercialization.

- Intelligent Flexible Electronics Using Oxide TFTs for Storage Temperature Monitoring of Critical Medicine (COVID 19 Vaccine)
- The aim of this research is to design Flexible Electronics Using Oxides for safe storage and transportation of vaccines. The work is still in early stages. The required circuit building blocks required to implement the prototype have been figured out and many novel oxide TFT based circuits have been tested from simulations and are under fabrication.
- **Development of lentiviral spike particles with reporters for studying SARS CoV2 entry and screening of inhibitors** The results obtained from the project hold important implications for the design and interpretation of similar LV pseudotyping-based studies.
- **Modeling the spread of the Covid-19 viral infection at the cellular level** A new model using the Green's function and the Wilemski-Fixman approximation is proposed to provide insight into effects of noise on viral dynamics.
- **Drug repurposing for the COVID-19 treatment:** Drug repurposing of Rapamycin is being used to identify potential drug for the treatment of Covid-19 in collaboration with University of Nebraska Medical Centre, USA.

IISER Thituvananthapuram

- **DST SERB "Development and Evaluation of diagnostics and Candidate Vaccines for emerging SARS-Coronavirus-2 (DEC-VAC SARS):** IISER TVM aims at establishing a state-of-the-art virus characterization platform. This will help to define relevant molecular targets of viral surface glycoproteins and immunogens for the rapid development and evaluation of diagnostics.
- **Development of therapeutics against COVID:** Research is focused on the assessment of therapeutic value of Epigallocatechin-3-gallate (EGCG), a potential molecule against emerging SARS-1, MERS and SARS-2 coronaviruses.
- **Development of novel vaccination approaches against COVID:** One research team at IISER TVM is evaluating nanoparticle-based vaccine for SARS-CoV-2.
- **Establishment of a pseudotype viral system:** For research on pathogenic viruses such as SARS-CoV-1, MERS-CoV-1, and SARS-CoV-2, a very expensive BSL3 facility is required. To minimize the costs involved in COVID research, IISER TVM is establishing a pseudotype viral system. This can be used for neutralization assay for coronaviruses.

- **Screening for compounds that inhibit entry of viruses:** Research at IISER TVM has found that green tea extract inhibits the entry of SARS-CoV-1, MERS-CoV and SARS-CoV-2 by blocking receptor-spike interaction
- **Modelling, Analysis and Prediction for SARS-CoV-2 Infections:** The major aim of this project is to develop a mathematical model for the spread of covid infections and carry out detailed analysis concerning the stability of the model that points to disease-free equilibrium state. IISER TVM is working on a stochastic SIR model with or without distributed time delay.

IISER Berhampur

- **Development of fluorescent human transmembrane serine protease 2 (TMPRSS2) activity sensor for rapid screening of inhibitors in vitro and in living cells to combat human COVID-19 and other respiratory infections:** This research is aimed to develop a genetically encoded FRET based sensor for detecting hTMPRSS2 activity in vitro and in living cells, which can potentially be useful in drug discovery process.
- **Binding Insight of Clinically Oriented Drug Famotidine with the Identified Potential Target of SARS-CoV-2:** The research aims to study the mechanism behind the working of Famotidine, which has been proven to be efficient against treatment of Covid-19

IISER Kolkata

Leveraging reverse genetics strategies to study structure –function interplay of virus host attachment spike protein to design for COVID-19: The project is related to use of Neem bark extract, to ameliorate COVID infection in mouse and human cell line. Topical application of the solution obtained from neem bark may be ingested through the nostril or vapor may offer protection from contagious COVID spread. Ingestion of the Neem extract water can also boost the immune resistance of the body.

IISER Tirupati

Development of Portable optical sterilization unit (POCSU): This is a hybrid device having a UV-C system and a cold plasma reactor in the same unit, and to the best of our knowledge is the world's first hybrid sterilization device. The final objective of the present proposal is to develop a portable, scalable and efficient hybrid disinfection reactor for sterilization. It has been developed at IIT, Tirupati and is being tested at IISER, Titrupati. Prototype is ready at IISER Tirupati for testing.

National Institutes of Technology (NITs)

NIT Agartala

Motilal Nehru NIT Allahabad

MANIT Bhopal

NIT Calicut

NIT Durgapur

NIT Hamirpur

Malaviya NIT Jaipur

NIT Jalandhar

NIT Jamshedpur

Visvesvaraya NIT Nagpur

NIT Raipur

NIT Rourkela

NIT Silchar

NIT Srinagar

Sardar Vallabhbhai NIT Surat

NIT Surathkal

NIT Tiruchirappalli

NIT Warangal

NIT Arunachal Pradesh

NIT Delhi

NIT Goa

NIT Manipur

NIT Meghalaya

NIT Mizoram

NIT Nagaland

NIT Puducherry

NIT Andhra Pradesh

NIT Calicut

- **Reusable Aerosol Boxes for treating COVID-19 Patients:** This device helps anaesthesiologists and other physicians while intubating patients by protecting them from aerosols and droplets containing virus. Delivered to many medical colleges and hospitals in Kerala.
- **Emergency Ventilator with Exhale Disinfector:** A breathing aid for the patients experiencing difficulty in breathing. Prototype delivered to Govt. Medical College Kozhikode, Kerala. In the Emergency Ventilator, the exhaled air of the corona patient is bubbled through soap solution to disinfect it, which is a unique feature of this product.
- **Nasal Air filter:** The Nasal air filter contains viscous drop of oil, glycerin gels, antiseptic/disinfectant solution so as to disinfect the air (inhale/exhale) containing the corona viruses.
- **Fabrication of UV disinfection chambers for office files:** Spreading of microorganisms through surfaces could be prevented effectively in a non-contact mode. The chamber used in the administrative offices of NITC for disinfecting the office files. There are provisions for safe insertion of files/ papers into the chamber. The lamp energy, exposure time, and lamp-file distance could be controlled remotely.
- **3D Printed Reusable PLA Face Shields and Masks:** The frame is made out from PLA (polylactic acid), one of the most popularly available raw materials for 3D printing.
- **UV based Luggage Disinfection System for scanning Luggage/Bags:** Designed and fabricated and being used in the NITC campus for scanning luggage and bags of students and visitors on their arrival in the campus.

NIT Durgapur

- **PRANAYAM:** To mitigate the oxygen scarcity due to COVID pandemic, a low-cost indigenous Oxygen Concentrator (PRANAYAM) has been developed. Encouraging results have been observed in hospital. Technology transfer has been lined up with various companies for manufacture and marketing.
- **PRANESH (Figure-19):** An affordable, plug-and-use, easily maintainable semi-automatic ambu-bag ventilation system (PRANESH) has been developed, tested in hospital and certified by MEDIVALLEY, AIC-AMTZ.

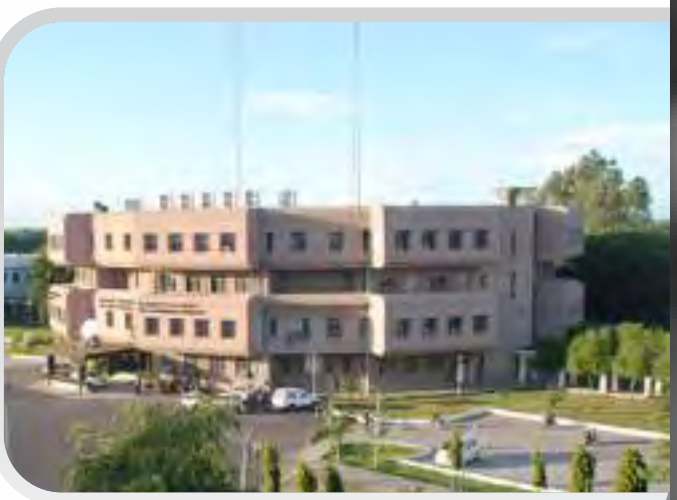
- Affordable UV-C based Document Sanitization Chamber, UV-C based Material Sanitization Chamber, Touch-less Hand Sanitizer Dispenser, Touchless Water Tap, Non-Contact IR Thermometer, UV-C Room Sanitization System and Wi-Fi enabled Contactless Remote Temperature Measurement System were also developed in the Institute and are being used.

Figure 19: PRANESH- ambu bag ventilation system

Malaviya NIT Jaipur

- Tracking Corona virus in sewage treatment plants with Dr B Lal Institute of Biotechnology, Jaipur
- A comprehensive study has been published on Application of deep learning techniques for detection of COVID-19 cases using chest X-ray images.
- The institute is working on Scenario based Recovery Pathway from COVID-19 using Fuzzy-AHP in tourism and hospitality sector.
- Modification of natural zeolites for oxygen production by pressure swing absorption. This will help to reduce the dependence on foreign manufacturers for zeolites
- The institute is working on Emergency Conversion of Indian Domestic LPG Cylinders for Storage and Use of Medical Oxygen.
- An automatic Hand Sanitizer machine is being used in the offices of Institute.
- Malaviya Innovation and Incubation Centre has worked on development of surveillance drones, UV based senitizing box, 3D printed whole face screen, sanitizing tunnels, PPE kits, Sample collection panels/covered OPD cabins for doctors.

NIT Jalandhar



- The Institute has developed a service robot to serve the Covid infected patients. This robot is capable of delivering food, medicine and other materials. The wheeled mobile robot can be Tele-operated through touch screen/joy- stick or mobile phone.
- A novel technology for chemical-free sanitization of the indoor air to combat the spread of COVID-19 through airborne transmission in enclosed spaces such as offices, lifts, shops, restaurants, classrooms, hospitals,

airplane cabins, health care facilities, ICUs, isolation and quarantine centers etc. has also been developed.

- For surface sanitization, 'an apparatus for ultraviolet sterilization of the surface' has been developed.
- Patents have been filed for the above mentioned inventions and also the developed solutions/technologies have been transferred to various companies for commercialization.
- A low-cost reusable face mask to reduce the risk of droplet infection has been developed by the Institute. The developed technology has been transferred for commercialization to two different companies.
- To counter the limitations of conventional PPEs, NITJ has designed and developed a Single Piece Full Body PPE (Marshall) for common use.
- NITJ has also developed a low-cost hand sanitizer which is herbal in nature and with more than 70% alcohol. This in-house developed hand sanitizer was distributed to para-military forces BSF, CRPF and the Punjab police.

NIT Jamshedpur

- The Institute has filed a patent on "Safety Mask".
- The Institute is working on a collaborative international project titled "A modeling-based study on infectious deadly diseases models by using fractional derivatives".
- Developed an App named **"Suraksha-Covid-19"** to trace and track the quarantine patients, developed an automated COVID-19 Web App: [https://covidhelp.page]
- The Institute has done research on implementing Industry 4.0 tools to add flexibility in supply chain management in the Post-COVID era, psychological resilience to mitigate mental distress due to COVID-19 among the employees of SMEs, challenges of human resource management on supply chain management post-pandemic, the impact of COVID-19 on businesses and the road to economic recovery. Presently, the Institute is working on the development of a data analytics tool for future predictions and pursuing research.

Visvesvaraya NIT Nagpur

- The Institute has developed a two-way ventilator (Figure-20) splitter and restrictor prototype. The prototypes of ventilator splitter were tested successfully on artificial lung model and handed over to IGGMC Hospital. The trials were conducted at surgical intensive care unit.
- Remotely operated trolley "Sahayak" Robot developed by VNIT for transporting food and other items in the quarantine zones has been handed over to AIIMS, Nagpur.

Figure 20: Two way ventilator splitter

- **Simulation of Arterial Blood Gas (ABG) Interpretation:** This simulator shows the physiology of a working ventilator, oxygen movement from lungs to blood, oxygen transport in blood, level of oxygen necessary for body and how it is used, how the heart works with lungs to supply oxygen and functions of the heart. The simulation models mimic the functions of a pumping heart and breathing lungs, beside other concepts of physiology of the vital organs. VNIT, Nagpur has proposed to donate this simulator model to various AIIMS and GMCs of the state.

NIT Silchar

- Diagnosis of COVID-19 using machine learning techniques such as a deep convolutional neural networks-based approach, an extreme learning machine, optimized deep learning and generative adversarial network through X-ray and CT images.
- A generic machine learning based approach to accelerate the detection of COVID 19 viruses using finite element.
- Forecasting probable spread estimation of COVID-19 using exponential smoothing technique.
- Novel mathematical formulation for multi attribute decision making problem like face mask selection in COVID 19.
- Developed a hardware-based, GUI-enabled solution for monitoring health as well as location data for quarantined patients.
- Developed visible active photo catalytic materials for disinfection of bacteria and viruses.

NIT Warangal

- The Institute has developed a multi-purpose, chemical-free and eco-friendly sterilisation system named 'OzoNIT'. Using the system, which resembles a refrigerator, one can easily disinfect vegetables, fruits, packed food, milk packets, masks, clothes, wallet, currency notes, watches, cell phones, ornaments, shoes, handbags, newspaper, parcels, etc, in one go

- A study conducted by the Institute on Lung Disease Network reveals the Impact of Comorbidity on SARS-CoV-2
- The Institute has also taken up computational structure-based drug design for identifying antiviral from natural products targeting SARS-CoV-2, under Extreme Science and Engineering Discovery Environment COVID-19 project.
- The Institute is working on SARS Cov-2 receptors (ACE-2 and Spike) with screening of various approved and natural products to understand the efficacy of these compounds with receptors.

NIT Arunachal Pradesh

- **Sanitizer developed from Tea plant extract oil:** The Institute has prepared hand sanitizers based on tea tree oil. The main goal is to produce this product to ease up the shortage of hand sanitizer and "Alcohol rub sanitizer" which helps to keep away coronavirus as advised by WHO. The tentative cost of the hand sanitizer is Rs. 30/- for 100 ml which is more cost effective than commercialized sanitizers which are presently available in market.
- **Low cost automatic hand sanitizer dispenser:** The Institute has also developed a low-cost automatic hand sanitizer dispenser during the outbreak of COVID 19. This dispenser machine is based on simplified function of Infrared Sensor (IR Sensor) which detects the presence of hand at the outlet of dispenser to actuate the motor for flow of sanitizing fluid. Overall cost incurred for realization of this project was only Rs. 600 (Rupees Six Hundred Only).

NIT Puducherry

- The Institute has developed a mobile application named HOPE which is intended for finding employment opportunities for the migrant workers at their current location. Similarly, the employers can also seek skilled laborers in their vicinity, and resume the stranded activities. It is a cross-platform app that can run on both iOS and Android. Currently, the app can be used in Tamil, Hindi, English, Malayalam, and Telugu languages.

- The institute is working on the development of Electrospun Nanofibrous Membrane as Air Filter for COVID-19 safety measures. Faculty members are analyzing the Mathematical Modeling and Analysis of Transmission of Coronavirus Disease (COVID19).

NIT Rourkela

- A visible light disinfection technology for microbes which is also termed as Photodynamic Inactivation has been developed by NIT Rourkela.
- Yarev Technology Private Limited is a Start-Up at FTBI, NIT Rourkela, which is focusing on disruptive solution in the field of home-automation, water quality monitoring, Automatic Starters & Automatic dispenser (Sanitizer & Soap). The Institute is currently selling Dispensers under Brand "ASAR" for which they have already got a Trademark Certificate.

NIT Manipur

- The Institute has been working on "In silico drug design". In vitro, studies have also been initiated through external collaboration. The results obtained from "in silico" studies were published. Two vital research proposal on silico drug design for COVID-19 were submitted to SERB (core research grant and MATRICS) for funding. In addition, the department of Chemistry is active in preparing alcohol-based hand-made sanitizers.
- The Institute has also designed a full body disinfection chamber for installation in public places. A sensor based short tunnel which sprays sanitizers when people passed through the tunnel was developed.

NIT Agartala

- Created a solution that can be useful as a disinfection tunnel with an integrated control system for the atomization of any biocides and virucides.
- Developed a system to recognize a person behind the mask based on the image processing technique.

Motilal Nehru NIT Allahabad

- Developed a deep learning and lungs X-Ray image-based detection system for Covid-19.
- The Institute has been granted a Design patent for Gel Imaging Device and has registered a Copyright for AMRIT (Assessment, Monitoring, Reporting and Intelligent Tracking) App. AMRIT app is mobile based application that track patients having cough, cold, fever or breathing problem and is currently being used by the local administration to track Patient/ customer, Chemist shop owner, Medical practitioner, Asha Workers, etc.

MANIT Bhopal

- The institute has developed an arm or elbow operated water tap handles to prevent direct hand contact using 3D printing.
- **Patho Wrecker Device** for disinfecting air and surface that requires minimal manpower and electric energy to operate.
- The design and development of cost-effective ventilator which runs on solar energy and can also be operated manually.
- An automatic Hand Sanitizer machine **(Haath Prakshaalak)** with an additional facility to read the body temperature is designed.

NIT Raipur

- Camera based detection of Mask on human face - This AI solution provides key observation, prediction and smart insight about public behaviours. As a result, common people can be kept safe and maintain the physical distance from the contaminated area and affected regions of COVID-19 pandemic
- Some other completed projects are Non-touch Liquid-Soap Dispenser (Mechanical), Non-touch Sanitizer Dispenser (Electrical) and Temperature Screening & Mask Detection Pass-gate.

NIT Andhra Pradesh

- The Institute has developed low-cost UV based disinfection boxes for the grocery shops in Tadepalligudem and also has fabricated Foot operated hand sanitizer dispensers for use in the campus.
- The Institute is setting up O2 generator to aid the oxygen supply for COVID patients in and around NIT Andhra Pradesh (especially rural health centres). Also, along with Pressure Swing Adsorption, use of membranes in enhancing the purity of Oxygen is being studied. The Institute is also performing Data analytic studies on the Spread of Covid-19 in futuristic scenario.

NIT Mizoram

- The Institute has developed ResNet based deep learning framework for detection of Covid-19 from CT scan images of the chest. This proposed work can diagnose COVID-19 suspected CT scan images very fast, without the intervention of any specialized doctor.
- It is also working on identifying the possible viral receptor for causing SARS-CoV-2 or COVID-19 infection to humans. The possible impact of this study will be the discovery of effective drugs for COVID-19.

NIT Srinagar

The Institute has designed and developed Frugal ventilator namely **Valley-Vent Inspiron Ventilator**. The unit is in the concept and prototyping stage and is to be tested by simulation models initially, followed by the animal testing and finally human testing before delivering it to the hospital for patient use.

NIT Delhi

The Institute is working for Development of Dynamic Mathematical Modeling for COVID-19 Spread and Containment. In order to predict the spread and its containment, this project proposes to develop a dynamic mathematical model taking various real time parameters into account.

NIT Surathkal

The Institute has designed and fabricated 10000 face shields for use by health care workers of Dakshina Kannada and Udupi districts by using 3-D printing technology. The institute has produced 3D printed components for Circuit splitter and flow regulator to double the capacity of Ventilators for Multiple patient lung ventilation.

NIT Meghalaya

The Institute has developed and filed a patent fora low-cost and hand gloves (Figure-21) which can reduce the spread of the corona virus. The Institute is also developing a face mask that can protect the user with an assurance of above 99% in a heavy viral load atmosphere

Figure 21: Hand Made Gloves

Sardar Vallabhbhai NIT Surat

- The AI based Chest X-Ray scanning system
- Automated Trolley for Covid-19 patient

NIT Goa

Institute is working on the Design of portable virus (COVID-19) disinfection machine.

NIT Nagaland

The institute is working on Biosensors application for detection of SARS-CoV-2 (Covid 19) using CT-Scans featuring NEMS and AI-Technology. Institute is also working on SARS-CoV-2 Detection from human body X-ray Image by enhancing features of Deep Learning and neural networks.

NIT Tiruchirappalli

The Institute is working on design and development of a low-cost multi-functional smart portable ventilator.

NIT Hamirpur

"Automatic & Touch-free Hand Sanitizer Dispenser machine with a real-time high body temperature detector"

Indian Institutes of Information Technology (IIITs)

IIITDM Jabalpur

IIITD & M Kancheepuram

IIIT Bhagalpur

IIIT Kottayam

IIIT Nagpur

IIIT Ranchi

IIIT Sri City Chittoor

IIIT Guwahati

IIIT Allahabad

IIITDM Jabalpur

The Institute has designed and developed a Double Air Suction Resuscitation Device (Mechanical Ventilator) in collaboration with the doctors of Netaji Subhash Chandra Bose Medical College, Jabalpur.

- Besides, the Institute faculty members have submitted research project proposals to various funding agencies to start R&D work on Covid Project proposal titled "Design and Development of Virucidal Fabric using Electrospinning Technology: A Novel Approach for Protective Mask against COVID 19" submitted in the BIRAC scheme.
- Project proposal titled "Lightweight and breathable fiber fabrics addressing antiviral and virucidal properties" submitted under IRHPA Scheme to SERB Govt of India.
- Project proposal titled "Identification of Potent Anti-viral Agents to Prevent and Cure Corona Viral Infections" submitted under the BIRAC Scheme.
- Project proposal titled "Deep Neural Network based Forecasting and Inferences from Pandemic Data" submitted under SERB Scheme.
- Project proposal titled "Repurposing of Drugs and Design of Drug-derivatives for the Treatment of COVID-19" submitted to DST Govt of India.
- Project proposal titled "Markov Chain as applied to SIS model of Epidemiology for better understanding of the Infective Compartment for COVID-19 case study in India".
- Project Proposal titled "Modeling challenges of COVID-19 virus host dynamics on lungs and respiratory system during infection and treatment" under the call by IUSSTF, scheme "Virtual Network for COVID-19".
- Project Proposal titled "Development of Texture Improvement Framework for Chest X-Ray Radiographs for Automatic COVID-19 Detection from a Safe Distance.
- Early identification and accurate CT score calculation of pneumonia during covid-19 using computer vision.
- Chest computed tomography images and clinical features of patients with COVID-19 pneumonia (Identification of non-informative CT (NiCT) images, positive CT (pCT) images, negative CT (nCT) images).

IIIT Allahabad

The following research works were carried out at IIIT Allahabad during the past one year pertaining to Covid:

- The Institute has been working on a DBT-funded project for "Development of kit for simultaneous isolation of viral RNA by magnetic nanoprobe and rapid detection of novel coronavirus by highly luminescent gold nanoclusters",.
- Carried out research exploring Digital service responses of Life insurers in India in the wake of COVID-19 pandemic.
- Some of the research carried out by the Department of Management includes assessing financial stress during the COVID-19 pandemic and Student Sentiments on Job V/S Entrepreneurship during the COVID-19 pandemic.
- Automated diagnosis of COVID-19 with limited posteroanterior chest X-ray images using fine-tuned deep neural networks.
- Monitoring COVID-19 social distancing with person detection and tracking via fine-tuned YOLO v3 and Deepsort techniques.
- COVID-19 epidemic analysis using machine learning and deep learning algorithms.
- Study of Covid 19 epidemic in India with SEIRD model

IIIT Bhagalpur

- The institute has filed patents on technologies related to COVID 19 detection namely "Bacterial and Viral Infection Localization and Classification Using X-rays and CT Images" and "A Handheld Device for Bacterial and Viral Infection Detection Using X-rays and CT Images"
- **Field trial & implementation of COVID detection software:** IIIT Bhagalpur has developed a software which can be used for COVID-19 detection. The software works based on X-Ray/CT Scan digital input and capable of detecting COVID-19 within a second. The developed software has proved to be 95-98% authentic in detecting COVID-19. This software has been developed as per the guidelines of WHO using AI based image processing technique of chest x-ray. It can be used for screening purpose of COVID 19 /pneumonia/tuberculosis/normal infection. At present it is in process of validation at AIIMS Patna as per the guidelines of ICMR.
- IIIT Bhagalpur is also working for the development of cost-effective Smart Ventilator.

IIITD&M Kancheepuram

- The institute has designed a UV sanitizer for grocery shops and supermarkets. Product is in the market and is being commercialized by VLOG Innovations LLP, Chennai. The design offers the most economic mode of commuting the items from its entry to exit through the sanitization chamber. It also avoids the use of highly complex and expensive conventional mode of conveyor belt.
- The efficient form for food sanitization for hotels and food delivery entitiesis developed by BiRD Lab @ IIITDM Kancheepuram. The prototyping and testing is done where the light exposure is increased by 80% which proves the efficiency of its sanitization.

IIIT Sri City Chittoor

- **Indoor Air Quality Monitor & Purifier:** It is a low cost yet a quantitative and qualitative integrated gas sensor module for monitoring temperature, humidity, CO2, TVOC, O2 purity and O2 concentration. This air purifier filter can trap up to 0.1 microns at efficiency rate of estimated 99.97%.
- **"Smart Intravenous Dripper- SID":** It is an IV-line automation device which is integrated into the healthcare system and could potentially disrupt the healthcare automation space.
- **Negative Pressure Wound Therapy with Remote Monitoring:** The incidence of patients with non-healing and complex wounds is very high, especially among diabetic patients. It is a low-cost innovative device to help patients in rural and peripheral areas who do not have access to this care due to travel restrictions.

IIIT Kottayam

- Developed a machine learning approach to proactively fabricate and produce COVID-19 products such as gloves, face masks, etc, in a collaborative manner using the "cloud manufacturing" concept.
- Collaborated with a few other Institutes to develop a time-variant fuzzy time-series analysis to forecast the COVID-19 cases.
- A blockchain-enabled privacy preservation of COVID-19 medical records was implemented.

IIIT Guwahati

- **Ongoing Projects:** Effects of Non-pharmaceutical Measures on COVID-19 Pandemic in India and Network-based Forecast Beyond Relaxation of Lockdown.
- Control-Theoretic Distributed Optimal Resource Allocation Approaches to Hinder Epidemic Spreading over Networks and Its Forecasting for Indian Cities

IIIT Nagpur

- MOU with AIIMS, Nagpur for facilitating Research Collaboration and for undertaking need-based Projects. Under this MOU, a device has been developed for effectively tracking & monitoring of the COVID-19 patients.
- Mobile apps "COWAR" and "COVID CARE – 2020" have been developed.

IIIT Ranchi

- Group of researchers of IIIT Ranchi is working on detection of corona virus electronically/optically.
- Mathematical modelling based on nonlinear techniques and algorithms based on Machine Learning & Data analytics to predict the trend of spread of corona pandemic.

Protect yourself.

Protect your community.

Get vaccinated.