

Boltzmann Medal to Prof. Deepak Dhar

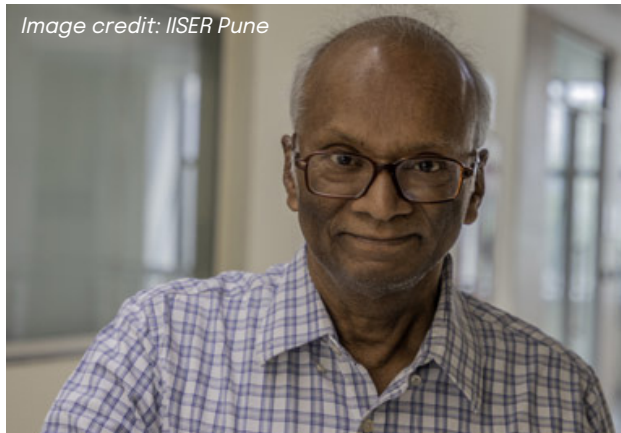
PROF. Deepak Dhar from the Indian Institute of Science and Education Research, Pune and Prof. John J. Hopfield of Princeton University, USA, have been selected for the Boltzmann Medal by the Commission on Statistical Physics (C3) of the International Union of Pure and Applied Physics (IUPAP) this year.

The Boltzmann Medal is considered the highest honour in the field of statistical physics. Prof. Deepak Dhar is the first Indian scientist to receive this honour.

This year, the Commission on Statistical Physics at the International Union of Pure and Applied Physics decided to recognise the contributions of the duo — the medals will be presented at the upcoming StatPhys28 Conference to be held in Tokyo in August 2023.

IUPAP started this award in 1975 and for the first time, it was awarded to K.G. Wilson who became a Nobel Laureate later in 1982. The Boltzmann Medal is given once every three years to researchers who have obtained new results concerning statistical mechanics. The award is in memory of the great pioneer of statistical mechanics Ludwig Boltzmann (1844-1906).

Image credit: IISER Pune



Prof. Deepak Dhar has been awarded the Boltzmann Medal for his seminal contributions to several areas of statistical physics, including exact solutions of self-organised criticality models, interfacial growth, universal long-time relaxation in disordered magnetic systems, exact solutions in percolation and cluster counting problems and definition of the spectral dimension of fractals.

Prof. Dhar did his PhD from California Institute of Technology in 1978 and came back to India to join the Tata Institute of Fundamental Research, Mumbai. He is currently a distinguished visiting professor at the Indian Institute of Science and Education Research, Pune, since 2016. He was also conferred the Shanti Swarup Bhatnagar Prize. He is the fellow of all three major science academies of India and also a TWAS fellow.

Study finds eating carbs earlier in the day linked to better heart health

THE time of day that people with diabetes eat certain foods may be just as important to their well-being as portion size and calories, according to a new study published in the Endocrine Society's *Journal of Clinical Endocrinology and Metabolism*.

Mealtimes should be in line with the biological clock – a natural, internal process that regulates the sleep-wake cycle and repeats every 24 hours. Health outcomes for people with diabetes may be improved if certain foods are eaten at different times of the day.

"We observed that eating potatoes in the morning, whole grains in the afternoon, greens and milk in the evening and less processed meat in the evening was associated with better long-term survival in people with diabetes," said Qingrao Song, M.D., of Harbin Medical University in Harbin, China. "Nutritional guidelines and intervention strategies for diabetes should integrate the optimal consumption times for foods in the future."

The researchers analyzed data from 4,642 people with diabetes from the National Health and Nutrition Examination Survey to determine their risk of dying from heart disease. They found people with diabetes who ate potatoes or starchy vegetables in the morning, whole grains in the afternoon, and dark vegetables such as greens and broccoli and milk in the evening were less likely to die from heart disease. Those who ate a lot of processed meat in the evening were more likely to die from heart disease.

The Endocrine Society, Press Release

Air pollution causing heart diseases

AIR pollution poses as much health hazard as tobacco smoking, according to a paper published in *Cancer Biology & Medicine* (Zhao, 2019). Fine particles floating in the air, known as PM2.5, present the greatest threat to human health among the air pollutants. These microscopic particles are ten times finer than the thickness of our hair. While breathing in polluted air, PM2.5 quickly reaches our lungs and blood circulation and remains there for a long time.

There can be many sources of PM2.5, such as smoke from coal-based factories, diesel-petrol vehicles, home cookstoves, garbage burning, crop residue burning, etc. PM2.5 is often made of heavy metals, inorganic, and organic constituents. When inhaled, it reaches the lungs and blood circulation, where it can cause unexpected changes in the biochemical pathways vital for sustaining life. These biochemical changes eventually lead to severe diseases of the heart and lungs.

Oxidative stress is the prime manifestation of PM2.5 morbidity, leading to life-threatening heart attacks. In winter, PM2.5 levels in Delhi and most of North India are generally more than 200 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) of air which is more than three times the daily Indian standard of 60 $\mu\text{g}/\text{m}^3$, according to data from the Central Pollution Control Board.

PM2.5 Indian standard has been set four times higher than the WHO's daily standard of 15 $\mu\text{g}/\text{m}^3$ to control air pollution mainly arising from industries and vehicles. In contrast, according to a World Bank report, the typical average PM2.5 level in the air across the USA is about 10 $\mu\text{g}/\text{m}^3$ only. According to an estimate, every citizen living in Delhi consumes about ten cigarettes daily by breathing in polluted air. Strenuous exercising in polluted air can be fatal and is a great concern for sports enthusiasts, according to the *British Journal of Sports Medicine* (Carlisle, 2001).

According to a study published in August 2021 in the journal *Environment Epidemiology*, air pollution was the cause of nearly 7,00,000 premature deaths in Delhi between 2010–2016, i.e., Delhi alone had more than one lakh air pollution-related deaths every year. According to a news report published in *Amar Ujala* newspaper, there were 5760 heart-related complaints reported in five private hospitals of Ghaziabad (adjacent to Delhi) 20 days during November–December 2021.

About 1000 suffered heart attacks, including those who recovered from COVID-19.

Heart diseases, also known as cardiovascular diseases, are the leading cause of death globally. Although death from heart disease is more common in 60 years of age or older people, there are reports that young people have also died from severe heart diseases such as heart strokes in the last two decades.

High blood pressure and diabetes, which were once called the disease of the elites, have reached villages today. Contaminated food and water are often thought to cause surges. Refined edible oils in daily meals are often implicated in heart diseases. Rising deadly diseases like cancers due to smoking and drinking are well researched and medically proven. However, recent epidemiological researches have revealed many startling facts.

According to WHO and Institute for Health Metrics and Evaluation (IHME) assessments, air pollution is one of the five leading causes of death worldwide. An eminent cardiologist associated with the Harvard Medical School presents terrifying statistics on worldwide deaths linked to air pollution. Air pollution-linked illness was found to be seven crores globally, and 70 lakh people lost their lives, according to the WHO. Out of these deaths, about 24 lakh deaths were associated with Ischemic Heart Disease (IHD), and 13 lakh deaths were due to heart strokes, that is, a total of 37 lakh deaths from heart ailments.

One out of every five air pollution-related deaths was linked to cardiovascular manifestations globally. This number is even more alarming for India – one in three deaths linked to air pollution-induced heart diseases. For the USA, it is roughly one in 20 deaths.

At the same time, 15 lakh deaths were linked to respiratory illness, 13 lakh deaths to Chronic Obstructive Pulmonary Disease (COPD), and 5 lakh deaths were found associated with lung cancer.

Air pollution is a severe challenge. Without the combined efforts of governments and citizens, we can not win the war against air pollution.

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New tech to aid screening and monitoring of lung diseases

INDIA has a high burden of Tuberculosis, recording close to 2.64 million cases and 75,000 plus deaths in 2019. A considerable percentage of these cases come from underdeveloped, remote areas without proper access to healthcare services. It is a huge challenge to triage, screen, and monitor it promptly, and at scale, with minimal resources.

A project enabled by the Bengaluru-based Centre for Cellular and Molecular Platforms (C-CAMP), and supported by the UK's Foreign, Commonwealth & Development Office (FCDO), has led to the development of a technology that promises to offer a rapid, affordable, easy-to-use, and point-of-care solution.



British Deputy High Commissioner to Andhra Pradesh and Telangana, Dr Andrew Fleming, checking out the new technology

It is an AI-based mobile app. A person just has to cough into a mobile phone and receive an assessment of whether he or she is suffering from any lung disease, through the power of Artificial Intelligence (AI). A doctor could then go through the report and determine the next course of action.

Salcit Technologies, a start-up supported by C-CAMP, had first developed the platform named Swaasa for general lung assessment. Subsequently, under a consortium project supported by the FCDO, C-CAMP brought together technical, clinical & health systems expertise through Andhra Medical College (AMC), and PATH, an international, non-profit health

organization based in Seattle, to extend and develop this platform to triage for COVID-19, besides TB. While TB has been a perpetual problem, there seems to be no early end to COVID-19, also a lung disease.

According to a release from C-CAMP, the development, validation & pilot deployment of this technology has been extremely promising, with triaging results showing more than 95% sensitivity under laboratory conditions for COVID-19. There will be further testing at the field level. C-CAMP will continue to actively catalyse the commercialisation efforts through its national and international ecosystem which includes diverse stakeholders from industry, government, clinical, and the investor community, it added.

The technology was showcased to the British Deputy High Commissioner to Andhra Pradesh and Telangana, Dr Andrew Fleming, at the Govt. Chest & TB Hospital, Andhra Medical College, Vishakhapatnam in the presence of Dr Niranjana Joshi, Associate Programme Lead, C-CAMP, Dr P.V. Sudhakar, Former Principal, Andhra Medical College, Dr K.V.V. Vijaya Kumar, Superintendent, Chest & TB Hospital, and Mr Manmohan Jain, CSO, Salcit Technologies.

Dr Andrew Fleming said, "After the success of the UK-India Astra-Zeneca vaccine collaboration, our bilateral health tech partnership goes from strength to strength with this AI solution. Through this, there can be huge savings in terms of cost and time to the health system." He also checked the functionality of the technology by taking the test on the spot, through the Swaasa app, well within a minute.

Dr Vijaya Kumar said, "I thank C-CAMP for bringing all of us on a common platform. Tools such as this are very helpful for us. This will reduce the immense burden on the hospital. We hope that this technology can be extended even further for other lung ailments like Asthma, Bronchitis, and COPD."

Dr Taslimarif Saiyed, C-CAMP CEO & Director, said, "For more than 10 years, C-CAMP has played a major role in India in enabling deep-tech innovations from a very early stage with entrepreneurship as a vehicle. We have so far supported more than 300 innovations. This AI platform is one such example of C-CAMP's efforts. Once developed & proven, these innovations will not only create impact for the society in India but also be scaled in other low & middle-income geographies across the world."

India Science Wire

A math model to predict COVID-19 vaccine efficacy

CCOVID-19 vaccines have been a game-changer in the current pandemic. Several vaccine candidates have conferred a high degree of protection, with some reducing the number of symptomatic infections by over 95% in clinical trials. But what determines this extent of protection? The answer to this question would help optimise the use of available vaccines and speed up the development of new ones.

Researchers at the Indian Institute of Science (IISc) and Queensland Brain Institute (QBI) in Australia have now addressed this question by developing a mathematical model that predicts how antibodies generated by COVID-19 vaccines confer protection against symptomatic infections. The study was published in *Nature Computational Science*.

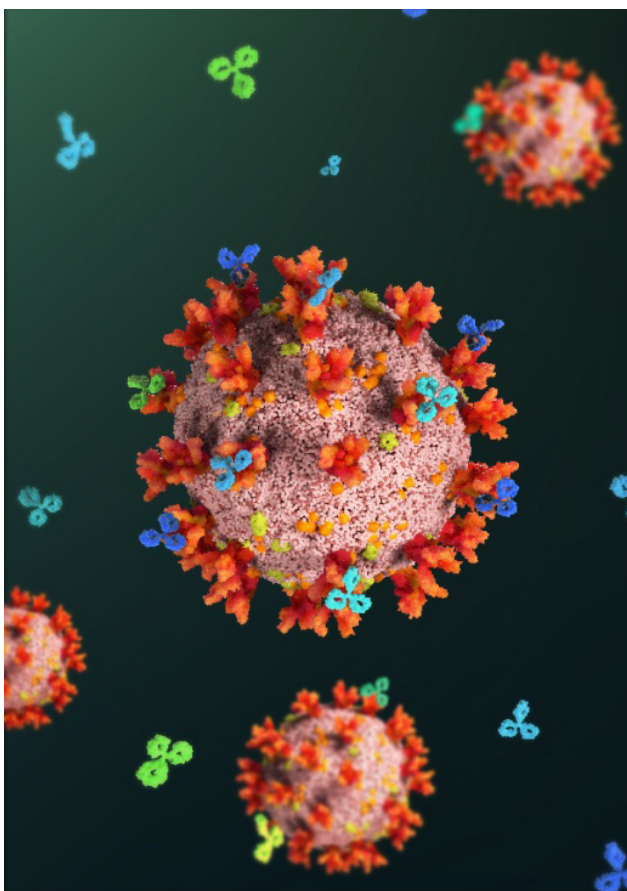
The researchers first analysed over 80 different neutralising antibodies reported to be generated after vaccination against the surface spike protein of SARS-CoV-2, the virus that causes COVID-19. These antibodies are typically present in the blood for months and prevent virus entry by blocking the spike protein. The researchers hypothesised that these 80 antibodies constitute a 'landscape' or 'shape space', and each individual produces a unique 'profile' of antibodies which is a small, random subset of this landscape.

The team then developed a mathematical model to simulate infections in a virtual patient population of about 3,500 people with different antibody profiles and to predict how many of them would be protected from symptomatic infection following vaccination.

"The reason predicting vaccine efficacies has been hard is that the processes involved are complex and operate at many interconnected levels," says Narendra Dixit, Professor at the Department of Chemical Engineering, IISc, and the senior author of the study. "Vaccines trigger several different antibodies, each affecting virus growth in the body differently. This in turn affects the dynamics of the infection and the severity of the associated symptoms. Further, different individuals generate different collections of antibodies and in different amounts."

"This diversity of antibody responses was a challenge to comprehend and quantify," adds Pranesh Padmanabhan, Research Fellow at QBI, the first author of the study.

The model developed by the team was able to predict the level of protection that would be conferred after vaccination based on the antibody 'profile' of the individual, and the predictions were found to closely match efficacies reported in clinical trials for all the major approved vaccines.



An artist's rendition of SARS-CoV-2 viral particles with their spike proteins (orange) blocked by different antibodies (smaller floating objects of different colours) generated in an individual following vaccination.

Image credit: <https://www.lensmedical.com/>

The researchers also observed that vaccine efficacy was linked to a readily measurable metric called antibody neutralization titre. This opens up the possibility of using such models to test future vaccines for their efficacies before elaborate clinical trials are launched, the authors suggest.

Dixit, however, cautions that the study is based on current vaccines which have been designed to work on the original SARS-CoV-2 strain. "Our formalism is yet to be applied to the new variants, including Omicron, where other arms of the immune system and not just antibodies appear to be contributing to vaccine efficacies. Studies are ongoing to address this."

Reference:

Padmanabhan P, Desikan R & Dixit NM. Modeling how antibody responses may determine the efficacy of COVID-19 vaccines. *Nature Computational Science* (2022) <https://www.nature.com/articles/s43588-022-00198-0>

IISc, Press Release