VIGYAN PRASAR

# DREAM 2047

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UNITED NATIONS SUSTAINABLE DEVELOPMENT

FOLIC ACID MUST FOR HEALTHY AND SAFE PREGNANCY

THE MENACE OF SOUND POLLUTION

Padma Shri Govind Swarup

## DOYEN OF INDIAN RADIO ASTRONOMY

**Editor-in-Chief:**
Nakul Parashar

**Editor:**
Nimish Kapoor

**Production:**
Pradeep Kumar
Bipro Kumar Sen
Amitesh Banerjee

**Expert member:**
Biman Basu
Sumita Mukherjee

**Address for correspondence:**
Vigyan Prasar, A-50,
Institutional Area, Sector-62,
Noida-201 309, U.P., India

**Tel:** +91-120-2404430, 35

**Fax:** +91-120-2404437

**e-mail:**
dream@vigyanprasar.gov.in

**website:**
http://www.vigyanprasar.gov.in



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Dr Nakul Parashar on behalf
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469, Patparganj Industrial
Estate, Delhi 110 092
Telefax: 22424396, 22526936.

**Cover Design By:** BIPRO KUMAR SEN



NAKUL PARASHAR

# Widening the SCoPE

SCoPE (Science Communication, Popularisation, and Extension) is a fast-upcoming interdisciplinary domain of science and technology. It has a special mention in the new STIP (Science & Technology Innovation Policy) under the topic 'Science Communication and Public Engagement'. Special emphasis is provided on capacity building and research. SCoPE is also in line with the national policy on Scientific Social Responsibility (SSR 2020), where scientists and researchers will be motivated and incentivised to engage in science communication and public engagement activities. Institutes and organisations will be encouraged to earmark a percentage of the allocated budget (SSR fund) for science communication and public engagement activities.

Under the new STIP, special impetus has been laid on mainstreaming science communication. Every public-funded institution and the department will have a dedicated wing set up for science communication and public engagement in STI-related activities. Science Media Centres will be established at national and regional levels as an interface between media persons, scientists, and science communicators that can enable mainstream media to increase its coverage of scientific topics.

SCoPE is the mandate for Vigyan Prasar. Born on 12 October 1989, Vigyan Prasar has been actively engaged in nation's service in the domain of SCoPE since its inception. From print to electronic to digital to social media, Vigyan Prasar has been fully active through every possible media in ensuring that the agenda of SCoPE is fully met.

On the print side, in its journey of past 31 years and counting, Vigyan Prasar has produced some of the finest books written by famous subject matter experts. With a growing list of more than 300 titles, Vigyan Prasar dominates the SCoPE scenario with its list of popular science titles, predominantly in Hindi and English. Dream 2047, its flagship monthly published in Hindi and English regularly since 1998, reaches out to more than thirty-six thousand subscribers in the country. However, these numbers have grown bigger since June 2020, whence Dream 2047 has been circulated electronically. Inspired by the success of wide acceptance of a popular science monthly, Vigyan Prasar decided to delve deeper into other Indian languages about two years ago. Its first monthly in Urdu came up in May 2019 with the title *Tajassus,* and since then twenty-two issues have successfully been published. Similarly, *Bigyan Katha,* in Bangla recently published its eighth issue. In the south, *Ariviyal Palagai,* in Tamil produced its ninth issue recently. *Kutuhali* in Kannada and Vigyan Ratnakar in Maithili are expected to reach their readers shortly. Inspired by the success of these monthlies, Vigyan Prasar has embarked upon various projects to widen the SCoPE in Marathi, Gujarati, Oriya, and Assamese in near future. On the non-periodicals front, the print publication division of Vigyan Prasar is dedicated to serving the nation with some of the best science communicators as authors of its books in Hindi and English.

The journey of widening the scope of SCoPE through Vigyan Prasar's initiatives continues, and I assure you to introduce the remaining ones in the coming issues. Happy Holi!

**Email:** nakul.parashar@vigyanprasar.gov.in

BIMAN BASU

# RECENT DEVELOPMENTS IN SCIENCE AND TECHNOLOGY

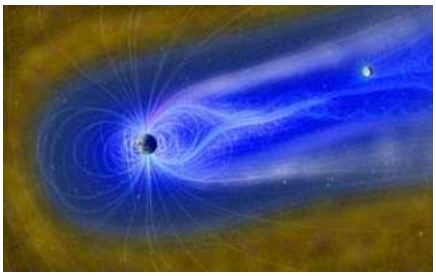
## EARTH'S MAGNETOSPHERE AS SOURCE OF LUNAR WATER

Before the *Apollo* era, Moon was thought to be dry as a desert due to the extreme temperatures and harshness of the space environment till India's Moon Impact Probe from Chandrayaan-1 mission crashed on to the lunar surface to reveal presence of water vapour in lunar soil in 2008. Many studies have since discovered lunar water -ice in shadowed polar craters, water bound in volcanic rocks, and unexpected rusty iron deposits in the lunar soil. However, despite these findings, there is still no true confirmation of the extent or origin of lunar surface water.

Understanding the sources of lunar water is crucial for studying the history of lunar evolution and also the solar wind interaction with Moon and other airless bodies. There have been several theories about the origin of water on Moon. The prevailing theory is that positively charged hydrogen ions ($H^+$) propelled by the solar wind bombard the lunar surface and spontaneously react to make water as hydroxyl ($OH^-$) ions and molecular water ($H_2O$). However, a recent study published in *Astrophysical Journal Letters* (https://iopscience.iop.org/article/ 10.3847/2041-8213/abd559) suggests that solar wind may not be the only source of water-forming ions. The researchers show that particles from Earth can also seed Moon with water.

It now appears that water is far more prevalent in space than astronomers had believed earlier-from the surface of Mars and Jupiter's moons to Saturn's rings, comets, asteroids and Pluto. Water has been detected even in clouds far beyond our solar system. The new discoveries have also ruled out the assumption that water was incorporated into these objects during the formation of the solar system, because there is growing evidence that water in space is far more dynamic. Surprisingly, the latest analysis of surface hydroxyl/water surface maps by the *Chandrayaan-1* satellite's Moon Mineralogy Mapper ($M^3$) showed that lunar surface water does not disappear during this magnetosphere shielding period.

By comparing a time series of water surface maps before, during and after the transit through the magnetosphere, the researchers argue that lunar water could be replenished by flows of magnetospheric ions, also known as "Earth wind". The presence of these Earth-derived ions near the Moon was confirmed by the Japanese Kaguya satellite, while observations by NASA's *THEMIS-ARTEMIS* satellite were used to profile the distinctive features of ions in the solar wind versus those within the magnetosphere Earth wind.



Artist's depiction of the Moon in the magnetosphere, with "Earth wind" made up of flowing oxygen ions (grey) and hydrogen ions (bright blue), which can react with the lunar surface to create water. The Moon spends more than 75% of its orbit in the solar wind (yellow), which is blocked by the magnetosphere the rest of the time. (Credit: E. Masongsong, UCLA EPSS, NASA GSFC SVS.)

## STORING DATA IN DNA

The present digital age is driven by data and the amount of digital data produced has long been outpacing the capacity of existing storage media. It is estimated that more data was created in the past two years than in all of preceding history. Most of the world's data today is stored on magnetic and optical media. Despite improvements in optical discs, storing a 'zettabyte' of data ($10^{21}$) would still take many millions of units and use significant physical space. Scientists have been looking for alternative ways of storing data to reduce storage space and have come up with the ubiquitous DNA as a solution. DNA has been the predominant information storage medium for biology and holds great promise as a next-generation high-density data medium in the digital era. Currently, the vast majority of DNA-based data storage approaches rely on in *vitro* DNA synthesis as very few methods are available for encoding digital data into the chromosomes of living cells in a single step. But now researchers have developed a technique for direct storage of digital data in living cells. Using an engineered redox-responsive CRISPR adaptation system, they encoded binary data in 3-bit units into CRISPR arrays of bacterial cells by electrical stimulation. A team of researchers at Columbia

Continued to page 18 →

## High level committee constituted for distribution and administration of COVID-19 Vaccines

A National Expert Group on Vaccine Administration for COVID-19 (NEGVAC) has been established, which provides guidance on all aspects of COVID-19 vaccination including prioritization of population groups, procurement and inventory management, vaccine selection, vaccine delivery and tracking mechanism, etc.

NEGVAC is chaired by Member (Health), NITI Aayog and co-chaired by Secretary (H&FW). It has representation of Secretaries from Ministry of External Affairs, Department of Expenditure, Department of Biotechnology, Department of Health Research, Department of Pharmaceuticals, Ministry of Electro- nics and Information Technology, representative from five State Governments, and technical experts.

NEGVAC has prioritized healthcare workers and frontline workers during the initial phase of COVID-19 vaccination followed by prioritized population groups of persons aged 50 years and above, and those aged less than 50 years with comorbidities. The vaccination of healthcare workers is going on.

During the first phase of COVID-19 vaccination, the vaccine is being provided by the Central Government, free of cost to States and UTs for vaccination of healthcare workers and frontline workers.

## DBT-NCCS scientist helps dispel doubts on COVID-19 vaccination

The largest vaccination campaign against COVID-19 launched by India recently has caught the attention of the world. However, there are several questions and misconceptions about the efficacy, safety and logistics of vaccination against the coronavirus.

To help address some of these questions and spread awareness among the general public, a Pune-based NGO, Bhavatal, organised in association with


the Association of the Microbiologists of India a discussion on the topic with Dr Yogesh Shouche, Scientist Emeritus at DBT-National Centre for Cell Science (DBT-NCCS), in Pune. This discussion was held in Marathi to reach out to a wider regional audience.

## Study shows significant reduction of heavy metal pollution during COVID-19 pandemic

Efforts to minimize industrial wastewater can substantially reduce heavy metal pollution in the Ganga water in a short time span of a few months, a study carried out during the COVID-19 pandemic has shown.

The COVID-19 pandemic lockdown provided a team of scientists from Indian Institute of Technology Kanpur a rare opportunity to quantify the impact of


restricted anthropogenic activities on the water chemistry resilience of large rivers. It also showed the high resilience of dissolved heavy metals.

They analysed the daily geochemical record of the Ganga River and showed that reduced industrial discharge during 51 days of mandated nationwide lockdown decreased the dissolved heavy metal concentrations by a minimum of 50%. In contrast, inputs from agricultural runoff and domestic sewage like nitrate and phosphate remained almost the same as these sources were not impacted by the nationwide confinement.

The research is supported by the Indo-U.S. Science and Technology Forum (IUSSTF), a bilateral organization under the DST, Government of India and U.S. Department of States and recently published by 'Environmental Science and Technology Letters'.

## SOP for reopening of swimming pool released

Ministry of Youth Affairs & Sports has permitted the use of swimming pools by all in fresh COVID-19 reopening guidelines. According to these new guidelines, swimmers must follow 6 feet distance, use face mask, except when in pool, self-monitor health and avoid use of pool if suffering from COVID-19 and others practices must be followed. The swimmers have also been asked to furnish "Obligatory self-declaration" and trainees will have to submit a mandatory COVID-19 negative report before being allowed inside the premises.

All personal training equipment belonging to an athlete shall be disinfected while the athlete is inducted into the training centre. Athletes and staff shall be screened before being allowed access to common field-of-play/training facilities. RT-PCR test shall be conducted for new/ returning athletes. It also bars residential athletes from sharing soaps, towels and any other utility in common shower areas. Besides, spitting and clearing of nasal/respiratory secretions on the pool especially during swimming or at any place within the facility other than toilets shall be prohibited. The swimmers will also need to perform hand-hygiene before and after use of all training equipment. The usage of Aarogya Setu app has also been made mandatory.

COVID-19 Newsletter Team of VP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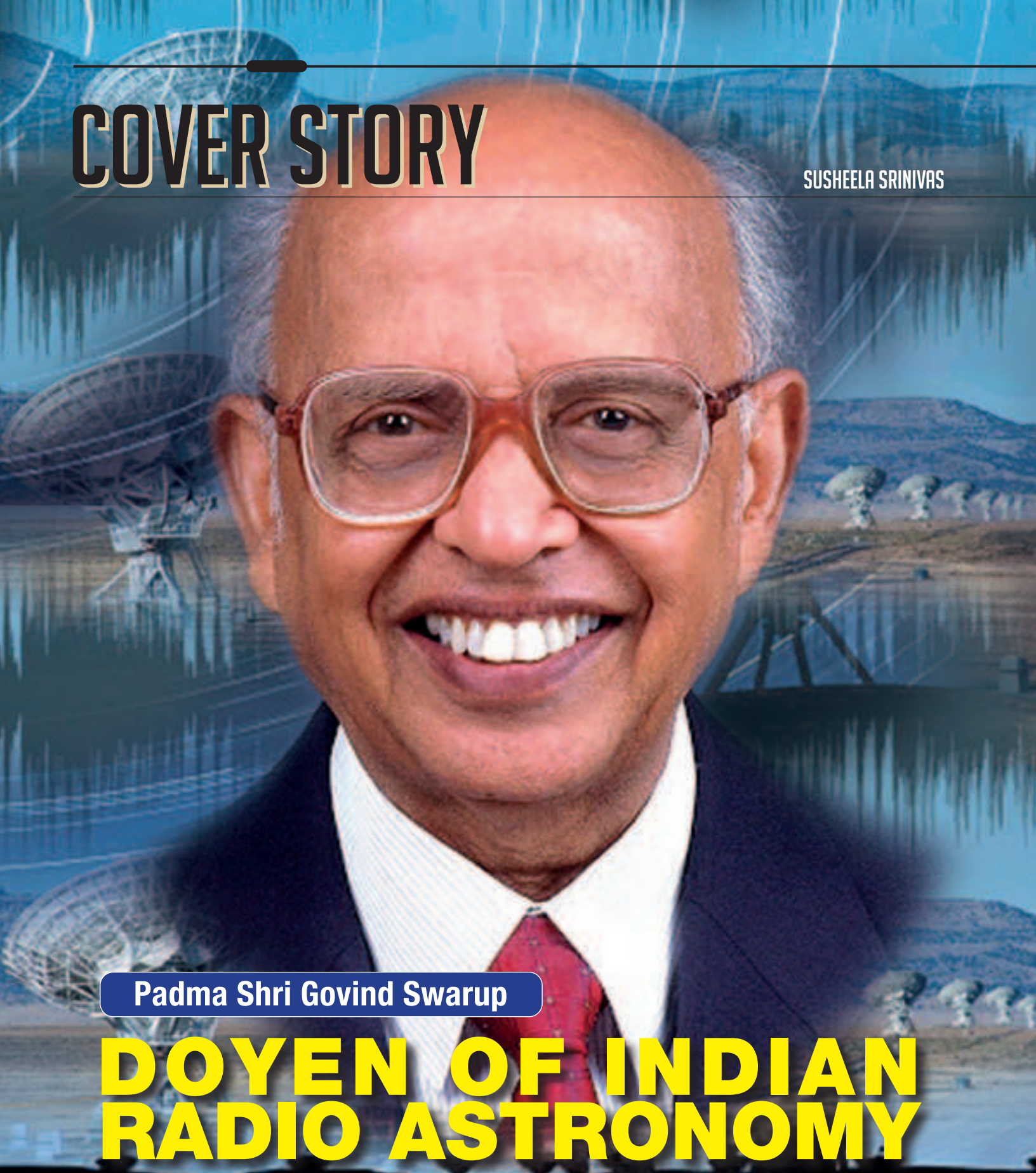


## Padma Shri Govind Swarup

# DOYEN OF INDIAN RADIO ASTRONOMY

**Professor Govind Swarup's six decades of stellar scientific contributions remain inspiring to upcoming radio astronomers even to this day. He envisioned ambitious goals for a scientific India with his out-of-the-box thinking and tenacity. We explore the life and times of the stalwart scientist who was born in March 1929.**

**India enjoys the covetous** position of being among the few leading nations in radio astronomy research, all thanks to the relentless and tenacious efforts of a stalwart radio astronomer—Professor Govind Swarup. Professor Swarup was a scientific pioneer who was instrumental in establishing two large radio telescopes in India, which pivoted India to a global radio astronomy position.

Professor Swarup's long, illustrious scientific career spanned across India, Australia and the USA. He has, to his credit, the nurturing of one of the world's finest community of Indian radio astronomers. Even today, a large part of India's radio astronomy fraternity comprises his students and their students.

Swarup and Parthasarathy at the Pott's Hill Observatory, Sydney

The ever-smiling down-to-earth professor-universally called Govind -was an enthusiastic mentor, quick to notice and encourage talent. His genial disposition and curiosity for scientific conversations often drew students and scientists to him. Even after his retirement in 1994, Professor Swarup continued to take an active interest in radio astronomy. An apt example to show his passion in the field would be his co-authorship at the age of 88 of a research paper in 2017 on the radio observations of planet Venus!

## The untrodden path

Young Govind was fond of reading from an early age, influenced by his parents and grandfather. After his matriculation, he joined the Ewing Christian College, Allahabad (now Prayagraj) for Intermediate college studies. Here he became the secretary of the College Physics Club. After this course, he was asked to pursue engineering at Benares (now Varanasi), following his uncle's footsteps. However, Govind had other plans and instead enrolled for a BSc in Physics at Allahabad University. He graduated in 1948 and immediately registered for an MSc at the same University.

Govind was exposed to the eminent physicist and co-discoverer of Raman scattering, Professor K S Krishnan's lectures at the University. Professor Krishnan would, later in 1950, employ the young, dynamic Govind at the National Physical Laboratory in New Delhi.

Swarup with Ron Bracewell

Govind Swarup, a young man of 21 years, joined the newly formed National Physical Laboratory (NPL) to work under Professor K.S. Krishnan in paramagnetic resonance. Realising Swarup's immense potential, professor Krishnan recommended his name for a two-year fellowship to an Australian Radiophysics facility at Pott's Hill, Sydney. Professor Joseph Pawsey, Australia's pioneer radio astronomer, mentored Swarup. Govind Swarup quickly grasped the nuances and helped speed up the technological aspects of the facility in Australia. At the Pott's Hill telescope facility, Govind and his colleague Parthasarathy conducted extensive studies on the Sun.

After this stint in Australia, Govind returned to India in 1955 to assist professor Krishnan, who was eager to build a radio astronomy group in India. Govind began work on the 500 MHz receiver in Delhi, which was to receive 32 dish arrays from Pott's Hill facility. However, the ambitious project had to be shelved owing to procedural hurdles.

## Growing leaps and bounds

By the end of 1956, Govind proceeded to the Harvard College Observatory in the USA to study the dynamic spectra of solar bursts at the Ft Davis facility. He spent a year at the facility on rigorous solar research, publishing several research papers. He achieved significant success by discovery of a new type of solar burst called the 'U-burst'. He also invented a method popularly called the Swarup-Yang technique, which is widely employed to provide phase stability for large radio arrays.

In 1957, Govind proceeded to Stanford to pursue a Ph.D. in radio astronomy under Professor Ron Bracewell. Professor Bracewell was a world-renowned radio astronomer working on designing and building the radioheliograph-a crisscross array of dish type radio telescopes. Swarup also worked with Bracewell on building large cylindrical antennae. This concept came to use a decade later in his efforts in India.

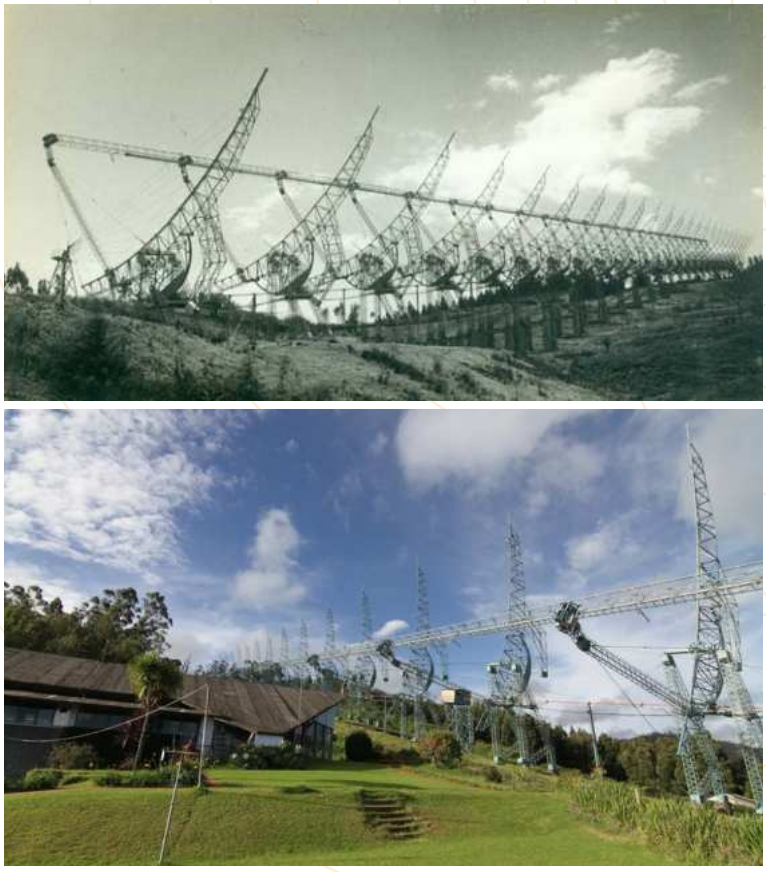
Soon after his doctorate, Govind Swarup was offered a professorship at Stanford. Although he worked in the position until 1963, he often contemplated returning to India and starting a radio astronomy group.

Soon, professor Swarup returned to India along with three of his contemporary scientists-T.K. Menon, R. Kundu, and T. Krishnan. Homi Bhabha, an eminent physicist and founding director of the Tata Institute of Fundamental Research (TIFR), offered them positions. Professor Bhabha facilitated and catalysed professor Swarup's ambitious project to establish the National Centre for Radio Astrophysics (NCRA).

In the early 60s, radio astronomy was a nascent study globally and several advanced nations began investing in related research. Professor Swarup was aware that India's proximity to the equator would be advantageous to set up a radio telescope. Whereas India was building itself after independence and funding advanced scientific research, projects such as radio astronomy at that stage were hard to come by. However, young and dynamic Professor Swarup envisioned ambitious goals for a scientific India. With his out-of-the-box thinking, he doggedly pursued the goal. He set up a large radio telescope on a shoestring budget despite the odds and scarcity of funds.

Professor Swarup was instrumental in conceptualising and setting up two large radio telescopes. The first, the Ooty Radio Telescope (ORT), was functional in 1970. The second, the Giant Metrewave Radio Telescope (GMRT), started in the 90s and became operational in 2002.

The upgraded version of GMRT called uGMRT was inaugurated on his 90th birthday in 2019. To this day, the GMRT holds the position as the most sensitive Metrewave radio interferometer in its category in the world.



The Ooty Radio Telescope (ORT)

## The Ooty Radio Telescope

After returning to India in 1963, Professor Swarup designed a small solar array at Kalyan, near Mumbai, which began functioning in a few months. The telescope array comprised 32 dishes that now came through from the Pott's Hill Observatory, Australia. However, the radio telescopes of the era had limited resolution. To accurately position a point in the sky from where the radio source was coming was challenging.

Professor Swarup devised a better solution to overcome this hurdle by employing the Lunar Occultation Technique. An occultation is an astronomical event where an object comes between a source and the observer. In lunar occultation, Moon comes in the foreground, blocking the distant star as it traverses its path around Earth. Relevant calculations reveal that a star occulted by Moon will appear or disappear on Moon's edge every 0.1second. The occultation method was advantageous because it avoided glare and made for a better observation of the radio source. By this technique, several distant stars could be observed unhindered.

Professor Swarup nursed a bigger ambition with this success: to design and establish a highly sensitive radio telescope to track the position and angular size of radio sources. He envisioned thwat observations with such a telescope could help understand the prevailing Steady State and Big Bang theories.

He devised an innovative design for the sensitive instrument by using a cylindrical telescope, aligned along the north-south slope of a hill and rotating parallel to Earth's rotation axis. Such a telescope would require only a single rotation axis to track the star sources.

The novel design was brought to fruition in the late 1960s with the 530-m long, 30-m wide Ooty Radio Telescope (ORT). The telescope was set up at an elevation of 2,240 metres on the hill slopes of Ootacamund (Ooty) in Tamil Nadu.

The ORT became a world-class telescope and one of the largest in the world during that time. It played a significant role in contributing to several important astronomy research like determining the evolution of the size of radio sources, determining space weather, and studies on galactic ionised interstellar sources. The ORT also served as a training ground for several upcoming radio astronomers. Five decades later, the ORT is still the largest steerable telescope in the world.

## The Giant Metrewave Radio Telescope

Next, Professor Govind Swarup undertook the challenging task of establish a giant, highly sensitive telescope that could investigate radio astrophysical problems ranging from the nearby solar systems to the edge of the observable universe. For this magnificent project, Professor Swarup once again came up with

## A MAJESTIC RIDE TO SCHOOL

Born on 23 March 1929, Govind received his schooling in Moradabad.

His father, Ram Raghuvir Saran was a landlord and owned farms in Moradabad (UP). He also owned an elephant on which he visited the farms during the wet seasons.

12-year-old Govind went to the Coronation Hindu High School in Moradabad. There, he would often hitch a ride to school on the elephant whenever it had off days.

(Source: Sudhir Phakatkar, TIFR, Journal of Astronomical History and Heritage, 2019)

## AWARDS GALORE

Professor Govind Swarup is fondly called the 'Father of Indian Radio Astronomy'. In his long scientific career, he has earned a string of awards and accolades. A few noteworthy ones being the following:

- 1972 – S.S. Bhatnagar award (CSIR)
- 1973 – Padma Shri (one of India's highest civilian awards)
- 1987 – Tskolovosky Medal (Federation of Cosmonautics, USSR); Meghnad Saha Medal (National Academy of Sciences, India)
- 1990 – John Howard Dellinger Gold Medal (International Union of Radio Sciences)
- 1993 The C.V. Raman Medal (Indian National Science Academy)
- 2007 Grote Reber Medal
- 2009 Homi Bhabha Award for Lifetime Achievement

He was elected as a fellow of several prestigious science academies-the Royal Society, Indian National Science Academy, Third World Academy of Sciences, International Astronomical Union, to name a few.

He was the second president of the Astronomical Society of India

He was also on the editorial boards of *Indian Journal of Radio & Space Physics* (1990-2000), National Academy of Sciences, India (1997-2000).

The GMRT

a brilliant idea. Instead of designing one large cylindrical telescope, he proposed an array of smaller parabolic dishes that would work in unison to give the required result. Professor Swarup and his team invented the SMART (Stretched Mesh Attached to Rope Trusses) technique. With this technique, large 45-m dishes could be assembled quickly and affordably.

The array led to establishing the Giant Metrewave Radio Telescope near Pune under the aegis of NCRA. The project was a first of its kind in India. The radio signals would be integrated using optical fibres and sent to the central electronics station for analysis.

The GMRT is a versatile and highly sensitive instrument comprising 30 parabolic dishes of 45 m diameter each. The novel SMART design allowed the reflecting surface to be made from thin stainless-steel wires, making the dish light and reducing wind effects. The gargantuan project launched in 1987 was fraught with several challenges and engineering hurdles, taking a decade to complete.

In 2002, the GMRT was designated as an international open-access facility, making it one of the most important telescopes in the world today. Researchers across 40 nations make use of the GMRT to study galaxy clusters, quasars, radio galaxies, pulsars, supernova remnants, star-forming regions, and even signals from probes set up on Mars. In the past decade and a half, astronomers have collected valuable inputs about our universe by combining GMRT and other global telescopic data.

## The legacy lives on

Professor Swarup's six decades of stellar scientific contributions remain inspiring to upcoming radio astronomers even to this day. Many of his protégés recall the encouragement and mentoring they received from the gentle giant. Although he retired from formal work in 1994, Professor Swarup pursued his scientific endeavours-this time round, by becoming an enabler of quality science education in India. His vision manifested as the Indian Institutes of Science Education and Research (IISER), which soon grew into seven centres.

Professor Swarup breathed his last on 7 September 2020 at the age of 91, plunging the scientific fraternity and all those who interacted with him in gloom.

The torchbearer may have passed, but his legacy lives on.

The author is a science communicator.
**Email:** sushsri@gmail.com

RAVINDRA KUMAR SINHA

# UN Sustainable Development

**Technology and social organization can be both managed and improved to make way for a new era of economic growth. Economy is not just about the production of wealth, and ecology is not just about the protection of nature; they are both equally relevant for improving the lot of humankind.**

Sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs. The concept can be traced to the United Nations World Commission on Environment and Development (WCED)-commonly known as the Brundtland Commission, named for its Chair, Gro Harlem Brundtland, former Prime Minister of Norway, and its report published in the form of a book entitled Our Common Future. The Report recognised that human resource development in the form of poverty reduction, gender equity, and wealth redistribution was crucial to formulating strategies for environmental conservation, and it also recognised that environmental limits to economic growth in industrialised and industrialising societies existed.

The central idea of the Brundtland Commission's definition of "sustainable" is that of intergenerational equity and the Commission presented the environment as something beyond physicality, to include social and political atmospheres and circumstances. It also insists that development is not just about how poor countries can ameliorate their situation, but what the entire world, including developed countries, can do to ameliorate our common situation.

The concept of sustainable development does imply limits-not absolute limits but limitations imposed by the present state of technology and social organization on environmental resources and by the ability of the biosphere to absorb the effects of human activities. But technology and social organization can be both managed and improved to make way for a new era of economic growth. Sustainable development requires meeting the basic needs of all and extending to all the opportunity to fulfil their aspirations for a better life. A world in which poverty is endemic will always be prone to ecological and other catastrophes. Humanity has the ability to make development sustainable to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs.

Sustainable development requires that those who are more affluent adopt lifestyles within the planet's ecological means, for example, in their use of energy. Further, rapidly growing populations can increase the pressure on resources and slow down any rise in living standards; thus, sustainable development can only be pursued if population size and growth are in harmony with the changing productive potential of the ecosystem.

Sustainable development is not a fixed state of harmony, but rather a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are made consistent with present as well as future needs. It is not to pretend that the process is easy or straightforward. Painful choices have to be made. Thus, in the final analysis, sustainable development must rest on political will.

**First, environmental stresses are linked one to another. For example, deforestation, by increasing run off, accelerates soil erosion and siltation of rivers and lakes. Air pollution and acidification play their part in killing forests and lakes. Such links mean that several different problems must be tackled simultaneously.**

The United Nations Con- ference on Environment and Development (UNCED), held in Rio de Janeiro, Brazil in June 1992, changed the international environmental agenda. For the first time, the United Nations system examined both environmental protection and economic development on an equal footing at the same conference. Based on the concept of "sustainable development" the general recognition that development is a priority for Third World countries, but that the environmental consequences of development must be taken into account-has shaped the international environmental agenda.

Environment and development are not separate challenges; they are inexorably linked. Development cannot subsist upon a deteriorating environmental resource base; the environment cannot be protected when growth leaves out the costs of environmental destruction. These problems cannot be treated separately by fragmented institutions and policies but are linked in a complex system of cause and effect.

First, environmental stresses are linked one to another. For example, deforestation, by increasing run off, accelerates soil erosion and siltation of rivers and lakes. Air pollution and acidification play their part in killing forests and lakes. Such links mean that several different problems must be tackled simultaneously. And success in one area, such as forest protection, can improve chances of success in another area, such as soil conservation.

Second, environmental stresses and patterns of economic development are also interlinked. Thus agricultural policies may lie at the root of land, water, and forest degradation. Energy policies are associated with the global greenhouse effect, with acidification, and with deforestation for fuel wood in many developing nations. These stresses

all threaten economic development. Thus, economics and ecology must be completely integrated in decision making and law-making processes not just to protect the environment, but also to protect and promote development. Economy is not just about the production of wealth, and ecology is not just about the protection of nature; they are both equally relevant for improving the lot of humankind.

Four primary dimensions of sustainable development have been derived from the Brundtland Report: Safeguarding long-term ecological sustainability, satisfying basic human needs, and promoting inter-and intra-generational equity. These dimensions are fundamental objective values, not subjective individual preferences. Thus, they are not negotiable.


### Safeguarding long-term ecological sustainability

The Brundtland Report gives two reasons for setting minimum requirements for ecological sustainability. First, if basic human needs are to be met on a sustainable basis, Earth's natural base must be conserved. Human development tends to damage ecosystems, which reduces the number of species. The loss of plant and animal species can greatly limit the options of future generations. Therefore, the Brundtland Report argued that "sustainable development requires the conservation of plant and animal species". Second, the report argued that "the case for the conservation of nature should not rest only with the development goals. It is part of our moral obligation to other living beings and future generations".

### Satisfying basic human needs

Satisfying basic human needs is defined as a primary dimension and is at the core of the development part of sustainable development. The Brundtland Report mentions employment, food, energy, housing, water supply, sanitation, and healthcare as basic human needs. The Report does not, however, refer only to basic needs. People are, according to the report, entitled to aspire for more than just covering their basic needs: "Sustainable development requires meeting the basic needs of all and extending to all the opportunity to satisfy their aspirations for a better life".

The Report argues that living standards that provide for more than basic needs can be sustainable, but only if such living standards assure long-term ecological sustainability. Thus, not every aspiration for a better life is compatible with the goal of sustainable development.

### Promoting inter-and intra-generational equity

Even the narrowest definition of physical sustainability-as the minimum requirement for a sustainable development-must take into account social equity, which implies that the present generation must meet its needs without compromising the ability of future generations to meet theirs. The Brundtand Report puts it this way: "We act as we do because we can get away with it; future generations do not vote; they have no political or financial power; they cannot challenge our decisions".

Furthermore, the Brundtland Report claims that social equity between generations "must logically be extended to equity within each generation". Thus, social equity as an integral part of sustainable development has two dimensions-time and space. From this perspective, sustainable development has consequences for equity within and between generations both globally and nationally.

In addition to the primary dimensions, there are a number of secondary dimensions, like the aspiration for a better life, preserving nature's intrinsic values, promoting protection of the environment, promoting public participation, and satisfying aspirations for an improved quality of life. These secondary dimensions are subordinate to the primary dimensions. Thus, preserving nature's intrinsic values (a secondary dimension) must give way whenever basic human needs (a primary dimension) are threatened. Correspondingly, satisfying aspirations for quality life (a secondary dimension) should be subordinate to safeguarding long-term ecological sustainability (a primary dimension).

Sustainable development was clearly illustrated at the United Nations Conference on Sustainable Development (Rio+20), held in Rio de Janeiro on 20-22 June 2012. One of the conference's main outcomes was the agreement by member states to set up sustainable development goals, which could be useful tools in achieving sustainable development.

In September 2015, the General Assembly of the United Nations adopted the 2030 Agenda for Sustainable Development as a universal call to end poverty, protect the planet and ensure that all people enjoy peace and prosperity by 2030. The agenda includes 17 Sustainable Development Goals (SDGs) to transform our world (see image).

India is committed to achieve the 17 SDGs and the 169 associated targets, which comprehensively cover social, economic and environmental dimensions of development and focus on ending poverty in all its forms and dimensions. At the Central Government level, NITI Aayog has been assigned the role of overseeing the implementation of SDGs in the country.

Image Courtesy: UN SDG

The author is Vice Chancellor,
Shri Mata Vaishno Devi University, Katra.
**Email:** rksinha.pu@gmail.com

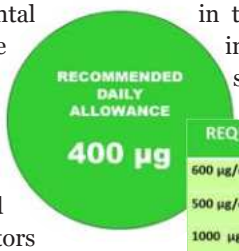
ARUSHI JAIN AND SABYASACHI SENAPATI


# Folic acid must for healthy and safe pregnancy

**Women are strong pillars of any vibrant society. Sustained development of the country will be only possible if we take holistic care of the women and children. The survival and well-being of mothers is also important to solve broader economic, social and developmental challenges.**

Pregnancy is an important phase in a woman's life and requires utmost care and precautions in terms of balanced nutrition, overall wellbeing and timely medical care. Globally, many pregnant women do not get necessary healthcare and essential nutrients that results into pregnancy-related complications and significantly higher rate of maternal or foetal/ neonatal deaths. According to WHO, maternal death is the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from accidental or incidental causes. There is high incidence of maternal death in African and South-East Asian countries. India witnesses maternal mortality rate of around 145 per 100 thousand live births. Many factors contribute to maternal death including hypertension, abortions, poor health facilities, sexually transmitted diseases (STDs), infections, child marriages, nutrient deficiency, etc. Over the years, attempts have been made to combat nutrient deficiency in order to safeguard maternal lives and prevent birth defects in new born.

One of the major nutrients required for healthy pregnancy and normal foetal development is folic acid. Folate or folacin (Vitamin B9) is a water-soluble vitamin and is an essential nutrient in diet because it is not synthesised by human body. It naturally occurs in many foods as folate and can be synthetically made as folic acid which is converted to its metabolically active form, folate in the body. Folic acid acts as an important cofactor without which some metabolic reactions in the body cannot occur. Folic acid along with iron and vitamin B12 has a major role in red blood cell (RBC) formation by bone marrow. It is required for the nucleic acid synthesis (DNA and RNA) that codes for the information to produce new RBCs by bone marrow. If the body does not receive sufficient amount of folic acid, then it leads to decrease in production of red blood cells resulting in anaemia (a condition in which haemoglobin in the blood falls below the normal range). Folic acid is also very important in formation of new cells, mainly those of nervous system including brain and spinal cord and so, folic acid deficiency might lead to defects in nervous system development in infants at birth. During pregnancy and child birth, major complications can occur due to deficiency of folic acid in pregnant women. Folic acid reserves in mother's body are exhaustively used by the developing foetus, so when required concentration is not maintained due to lack of




| REQUIREMENT OF FOLIC ACID | CONDITION |
|---|---|
| 600 µg/day | PREGNANT WOMAN |
| 500 µg/day | BREAST FEEDING WOMAN |
| 1000 µg/day | PREGNANT WOMAN (TWINS) |
| 4000 µg/day – 5000 µg/day | PREGNANT WOMAN WITH A NEURAL TUBE DEFECTED CHILD PREVIOUSLY |

intake of folic acid-rich diet, it leads to folic acid deficiency in mother. This deficiency results in anaemia which increases the risk of restriction of foetal growth, pre-term deliveries, still-births, low birth weight, and infant and maternal mortality. According to WHO's World Health Statistics data, 40.1% of pregnant women worldwide were anaemic in 2016. This situation is highly prevalent in South-East Asian countries including India.

### Effects on foetal growth

Deficiency of folic acid can lead to devastating consequences in the foetus. The deficiency of folic acid is found to lead to neural tube defects (NTDs) in foetus. Spina bifida and anencephaly are two most common types of NTDs. Spina bifida arises when spine fails to close completely around the spinal cord during foetal development and 70% of the spina bifida cases occur due to folic acid deficiency. In anencephaly, normal development of brain is hindered with missing bones of skull and large parts of brain like cerebrum and cerebellum. These brain parts are responsible for normal vision, hearing, coordination, and emotions.

### Recommended foods and supplements

To prevent all such complications, a pregnant woman should consume high amount of folic acid before, during and after pregnancy. The recommended daily allowance (RDA) for folic acid is 400 micrograms (µg), and for pregnant women it is up to 600 µg. In case of a woman with diabetes, blood disorders, coeliac disease and who already had a child with neural tube defect, $4_{2}000$-$5_{2}000$ µg of folic acid per day is recommended. In case of a woman carrying twins, around $1_{2}000$ µg of folic acid intake per day is necessary.

Folic acid can be obtained by body through diet rich in folic acid. Folic acid is naturally found in legumes (beans, peas, lentils), asparagus, green leafy vegetables (spinach, kale, arugula, cabbage, broccoli), citrus fruits (oranges, lemons, grapes), brussels sprouts, nuts and seeds (walnuts, flax seeds), wheat germ (embryo of wheat kernel), eggs, beef liver, mushrooms, and fruits like banana and papaya. These are the good sources of folic acid but sometimes do not meet the daily requirement due to less availability or high demands of folic acid by the body, such as in case of pregnancy.

### Food fortification with folate

Nowadays, to combat folic acid deficiency in women, especially in reproductive age group (15-49 years), fortified foods are recommended. Food fortification is the addition of micronutrients like vitamins and minerals such as iron, zinc, iodine, folic acid, etc., to staple food like wheat, rice, oil, salt, and milk. This can be done due to commercial reasons but it also majorly contributes to public health policies which aim to prevent nutritional deficiencies in citizens. It is a cost-effective method and does not disturb the normal eating pattern of individuals because nutrients are added to staple foods which are widely consumed. According to National Family Health Survey-4 (NFHS-4), 53.1% women in reproductive age group in India are anaemic. In order to reduce the risk of deficiency many fortified foods have been introduced by Food Fortification Resource Centre, FSSAI for public use and intake. To maintain a sufficient amount of folic acid required during pregnancy, wheat flour, which is commonly used in Northern India for chapatis and rice, which is a staple food for more than 65 per cent Indians, have been fortified with folic acid and introduced in the market under many manufacturers and brand names. Along with these, many baked products like bread, muffins, cookies, etc., and energy drinks, breakfast cereals, energy bars and pasta have also been fortified with folic acid.

Illustrations: Arushi Jain

An Indian government initiative called Weekly Iron and Folic Acid Supplementation Program (WIFS) was established by the Ministry of Health and Family Welfare in response to growing prevalence of anaemia in adolescent girls and boys. It aimed at "fixed day-Monday" approach for weekly administration of IFA tablets having 100 mg iron and 500 µg folic acid for 52 weeks in a year.

As the fatal effects of folic acid deficiency in pregnant women and infants are becoming evident, much effort is being put over these approaches including fortification of food, use of folic acid supplements and various government initiatives to reduce folic acid deficiency in pregnant women. If these methods are applied effectively then India will soon be able to see a fall in maternal mortality and infant mortality rate, giving rise to new and healthy lives.

Arushi Jain and Dr Sabyasachi Senapati are with the Immuunogenomics Laboratory, Department of Human Genetics & Molecular Medicine, School of Health Sciences, Central University of Punjab, Bathinda.
**Email:** s.senapati@cup.edu.in

P. K. MUKHERJEE

# The Menace of Sound Pollution

**Undesirable or unwanted sound produces a kind of pollution called noise pollution Elderly people, women and children may be the worst sufferers of noise pollution.**

Every day, we encounter a variety of sounds. Stop for a moment and think of your favourite sound. Now, imagine permanently losing the ability to hear your favourite sound..... slowly. That would be tragic, to say the least. But this can happen when an individual is exposed to sounds that are too loud, at work or at home. Such sounds are unwanted and can be disruptive and dangerous. They are better described as noise. In other words, loud, non-harmonious sound or vibration that is unpleasant and irritating to the ear may be termed as noise. The term has been derived from the Latin word "nausea".

It is often said that noise pollution differs from other forms of pollution in that unlike air, water and soil pollutants, once abated it leaves no residual remnant in the environment or in the human body. However, this is not true as noise does leave its effects, which can deteriorate after continued exposure to harmful sounds.

### What causes noise pollution?

Commercial and industrial activities, construction work using heavy, noisy equipment, road, air and railroad traffic, and the rapid increase in the use of machines and other technologies are all associated with noise pollution. Agricultural machinery, such as tractors, threshers, harvesters, tube wells, powered tillers, etc., all have made agriculture highly mechanical but at the same time heavily noisy too. In India, noise is also at its peak in most of the social events. Public address systems also contribute in a big way to noise pollution. The noise pollution created in this way makes the condition of people living nearby really difficult indeed.

Household gadgets like TV, mobiles, mixer-grinders, pressure cookers, vacuum cleaners, washing machines, dryers, coolers, air conditioners also contribute significantly to noise. Also, lawn-mowers and gardening equipment add to the cacophony.

### Effects of noise pollution

Noise affects not only human beings, but it impacts vegetation, animals, and property as well. Hazardous effects of noise depend on its intensity (loudness measured in decibels), duration, and frequency or pitch (high or low). Human ears have sensory (hair) cells and auditory nerves (also referred to as cochlear nerves or acoustic nerves) for hearing. The hair cells are found inside the inner ear called cochlea. There are about 3,500 inner hair cells and 12,000 outer hair cells in each cochlea. The hair cells transform the sound vibrations to electrical impulses that are sent to the brain through the auditory nerve. The brain tells you that you are hearing a sound. However, if the cochlear hair cells are subjected to repeated sounds of high intensity, they may not get the opportunity to recover fully. Thus, they can be permanently damaged leading to noise-induced hearing loss (NIHL).

Besides the sensory cells, the delicate tympanic membrane or the eardrum can also be permanently damaged by a sudden loud sound, such as an explosion. Another condition, often part of NIHL, resulting from noise pollution is tinnitus. This is a condition described as the perception of sound (e.g., buzzing, ringing or hissing) in the absence of any external stimulus; that is, in absence of any sound that others can hear). This essentially takes away the opportunity from the sufferer to experience quiet, which can be quite distressing. Tinnitus not only affects sleep and concentration of the sufferer but also disrupts their thought process and emotions. This produces an interruptive effect on speech and social interaction as well.

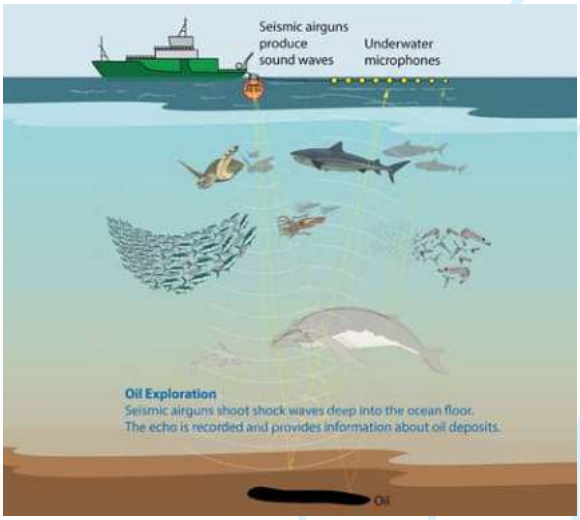
Besides affecting hearing, noise can

have non-auditory effects as well. It can disrupt sleep and concentration and can produce heart-related, respiratory, neurological and other physiological effects in an individual. Several psychological and physiological problems such as stress, hypertension, anger and frustration, lower resistance to disease and infection, circulatory problems, ulcers, asthma, colitis, headaches, and gastrointestinal disorders, have been linked directly to noise.

Elderly people, women and children may be the worst sufferers of noise pollution. Studies reveal that hearing loss due to ageing comes much earlier now. Previously, elderly people used to complain about hearing loss after crossing the age of 60. However, now hearing loss begins about 10-15 years earlier and people in the age group of 45-50 years complain about hearing deficit.

Women, especially pregnant women, may suffer from noise-related stress which may affect their foetus. A foetus exposed to noise may experience a change in heart rate, or it may suffer the impact of its mother's noise-related stress. Continued exposure to loud noise may produce so much stress and irritation in pregnant women that, in exceptional cases, it may also lead to abortion.

Children may be the worst hit due to noise pollution. An article published few year back in the journal *Indian Paediatrics* stated that exposure to noise during pregnancy may result in high-frequency hearing loss in new-borns, growth retardation, cochlear damage, premature birth and birth defects. Noise pollution has also been linked to slower language development and learning, resulting in learning disabilities as well as attention difficulties in older children. Children in noisier neighbourhood have been shown to suffer from increased stress and diminished motivation.




## Effect on animals

Noise pollution has harmful effect on animals, vegetation and property as well. Both livestock and pets are harmed by noise, as are animals in the wild. Noise can also disturb wildlife feeding and breeding. Pets react more aggressively in households where there is constant noise.

Animal species that depend on mating calls for reproduction are often unable to hear these calls on account of the excessive man-made noise due to chain-saw operations by the timber companies and other such activities in the forest. As a result, they are unable to reproduce, which leads to a declining population.

Some animals use sound waves to echo-locate and find their way when migrating. Disturbing their sound signals means they get lost easily while migrating. To cope with the increasing sound around them, some animals are becoming louder, which may further add to the level of sound pollution.

Even marine animals are not spared. They are subjected to the noise made by submarines and big ships under water. Industrial underwater extractions, marine construction and military activities also cause lot of underwater noise pollution (UNP). Many marine species, especially whales depend on sound to communicate. Therefore, any interference by noise pollution can negatively impact their ability to find food and mates, navigate, avoid predators and take care of their young.

## Effect on property/buildings

Loud sound is very dangerous to buildings, bridges and monuments. It creates vibrations which by striking the walls of the buildings weakens their structure. Collapse of many of the bridges are known to be caused by an acoustic phenomenon called resonance. Buildings, particularly in high-sound zones, such as those near airports and high-traffic zones are quite vulnerable. Supersonic booms from jet planes are another source of problem. Besides having a deafening impact on the ears, they have, in some cases, been known to shatter window panes and destroy old dilapidated buildings.

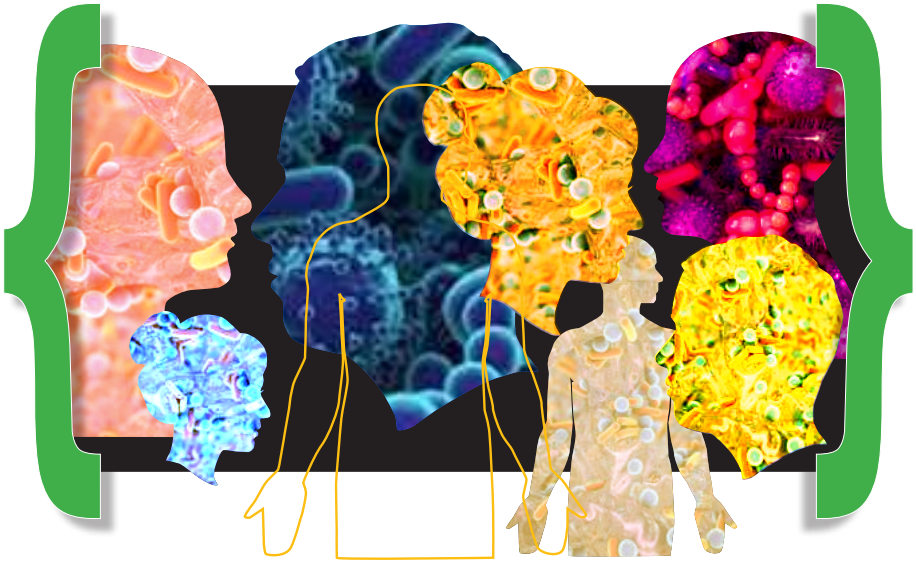
## Combatting the menace

Effective control of noise pollution can only come through greater awareness. In the first place, there should be restrictions on the use of loudspeakers/public address systems. Also, unnecessary honking and use of pressure horn in automobiles and transport vehicles should be banned. High level of noise should be prohibited in work places, educational institutions, residential areas, near hospitals, etc. Bursting of high sound generating fire crackers and fireworks should be avoided during festivals, parties, marriage functions, etc.

Extensive plantation of trees on the roadsides can help absorb the noise pollution caused by vehicular traffic thus reducing the effect of noise pollution substantially. Insulation of houses with sound-proof windows should be ensured which can be done with proper planning. Subjects related to noise pollution should be added to school textbooks to create awareness about noise pollution from a young age.

Dr P. K. Mukherjee is a Science Writer and Communicator.
**Email:** mukherjeepradeep21@gmail.com

JINU MEDHI AND MOJIBUR R. KHAN



# Role of the human microbiome in infection and protection against COVID-19

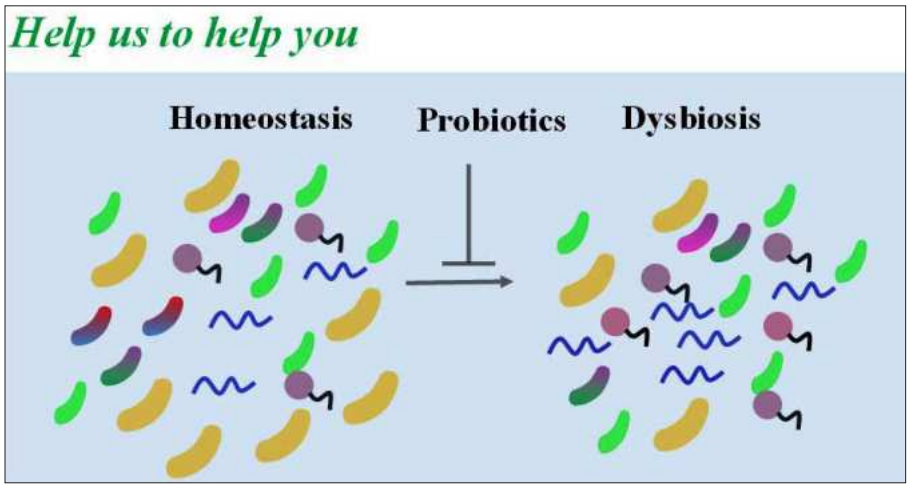
**Researches have shown that if gut microbes are destroyed by antibiotics then the lungs become more susceptible to infection by influenza virus. Also, improving the microbiome in the gut by use of prebiotics and probiotics can significantly improve immune response to many infections including to those of the lung.**

The human gut microbiome is made up of trillions of bacteria, fungi and other microbes. The gut microbiome plays a very important role in our health by helping control digestion and benefiting our immune system and many other aspects of health. These microbes are acquired at the time of one's birth and train our immune system how to react to pathogens. The profile of microbes in the microbiome changes with the mode of birth (normal or caesarean), age, diet, medication, ethnicity, etc. Apart from efforts to develop drugs and vaccines, scientists are also trying to understand links of COVID-19 with human gut microbiome. The microbiome can have significant role on how our body would react to the threat of COVID-19.

It has been established that when the balance of the gut microbiome composition and function is disturbed in particular ways, it leads to disease, a phenomenon described as 'microbiome dysbiosis'. Animal and human studies have been generating continuous proofs that gut microbiome dysbiosis has a definitive role, which is causal in nature towards abnormality or impairment in the regulation of a metabolic or physiological process visible as and in diabetes and obesity-the risk factors of severe COVID-19 disease.

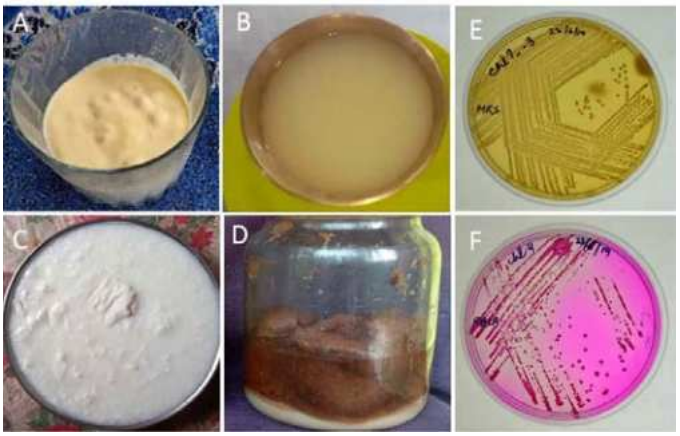
Metagenomics is a technique of studying microbes recovered directly from environmental samples without culturing them. Using this technique, a significant reduction of bacterial diversity in the COVID-19 patients has been observed. The persistence of dysbiosis is detected in patients even after 30 days of clearance of the virus. Compared to healthy controls, these patients display lower relative abundance of beneficial symbionts and higher relative abundance of opportunistic pathogens including Streptococcus, Rothia, Veillonella and Actinomyces. Further, a positive correlation of COVID-19 severity with the abundance of Coprobacillus, Clostridium ramosum and Clostridium hathewayi bacteria has been found. Another observation in some COVID-19 patients was a reduction in Lactobacillus and Bifidobacterium.

The gut microbiome is able to positively modulate our defences in response to infections that include respiratory tract ones caused by the influenza virus and *Streptococcus pneumoniae* bacteria. This occurs through the activation of antiviral immune response and




Probiotics may prevent the transition of the microbiome from 'homeostasis' to 'dysbiosis'.

phagocytosis (the process by which a cell uses its plasma membrane to engulf a large particle), and prevention of excessive inflammation. However, it is not that simple and depends a lot on the quality of the microbiome. Different species of the gut microbiome can tilt the balance either towards pro- or anti-inflammatory responses, with the latter being more protective. Thus, different sets of gut microbes play different roles in regulating the immune system.




Common fermented foods and potential probiotic isolates on selective media A and C-Curd; B-Rice beer (Xaj Pani); D-Pickle; E and F-Potential probiotic isolates on selective media.

With regards to COVID-19, recent studies have shown that specific members of the gut microbiome are always associated with severe disease. They have also been shown to be associated with immune markers known to be present in higher levels during severe disease. The association between gut microbiota and immune markers was found to be greater than that of the other known risk factors of COVID-19 severity, such as age and obesity.

However, we must stop wondering about what role the microbiome has in protecting against a virus that targets the lungs. Research with mice models have shown that if gut microbes are destroyed by antibiotics then the lungs become more susceptible to infection by influenza virus. There are many other studies which have shown that improving the microbiome in the gut by use of prebiotics and probiotics can significantly improve immune response to many infections including to those of the lung.

This is because prebiotics can induce significant shifts in immune and metabolic markers. It has been shown that a diet containing non-digestible carbohydrates such as those found in whole grains caused a decline in the levels of pro-inflammatory cytokine IL-6 and insulin resistance. In a related study, the dietary inclusion of butyrylated high-amylose maize starch improved plasma level of anti-inflammatory cytokine IL-10. These beneficial effects came from the prebiotic inclusion in diet and is due to production of short-chain fatty acids and improved immune modulation in the gut-associated lymphoid tissue.

Probiotics are live microbes which when administered in adequate amounts confer health benefits on the host. The common probiotics are the bacterial genera *Lactobacillus* and *Bifidobacterium*. Fermented milk products and yogurt are rich in probiotics. Probiotic-rich yogurt has been shown to be effective in reducing the counts of the enteric pathogens such as *E. coli* and *Helicobacter pylori*. Interestingly, Bifidobacteria along with Lactobacilli have been successful as a prophylactic against traveller's diarrhoea.

Metagenomics is a technique of studying microbes recovered directly from environmental samples without culturing them. Using this technique, a significant reduction of bacterial diversity in the COVID-19 patients has been observed.

Probiotics have also shown good response in improving inflammatory conditions and in regulation of innate immunity using receptors and their corresponding signalling pathways. In mice model-based research it has been shown that T regulatory cells, responsible for reducing the allergic response, are activated on administration of probiotic bacteria such as *Lactobacillus rhamnosus, Bifidobacterium lactis*, and *Bifidobacterium breve*. Probiotics can modulate the balance between pro-inflammatory and anti-inflammatory cytokines and thereby enhance virus clearance by host immune system. The acute respiratory distress syndrome is a major complication associated with COVID-19. Studies suggest the role of *Lactobacillus plantarum* in enhancement of anti-inflammatory cytokines and suppression of pro-inflammatory cytokines in young adults. Prebiotics in diet such as wheat bran, beans, and certain root vegetables can increase butyrate levels that leads to reduction in inflammation and improvement in asthma and cystic fibrosis.

Thus, there is sufficient amount of scientific evidence to link the human microbiome with the risk of infection and protection against COVID-19. Further work will likely confirm that pro-inflammatory microbes can contribute to immune responses that make severe cases of COVID-19 more likely. At the same time, this could also mean that beneficial microbial species, the type that promote anti-inflammatory response, can be used to prevent or supplement the treatment in favour of immune alterations that can prevent manifestation of severe COVID-19.

Dr Mojibur R. Khan is Associate Professor II, Life Science Division, IASST Guwahati and Jinu Medhi is UGC SRF, IASST Guwahati.
**Email:** jinumedhi@gmail.com

← Continued from page 3

Artist's impression of data stored in a DNA molecule. (Credit: Shutterstock ymgerman)

University in USA led by Sung Sun Yim has developed a way to allow DNA strands to store more data. The group applied a small amount of electricity to DNA strands to allow for encoding more information than was possible with other methods (*Nature Chemical Biology*, 11 January 2021 | DOI: 10.1038/s41589-020-00711-4).

Life's genetic information is stored in DNA, usually encoded using the four DNA bases-adenine (A), cytosine (C), thymine (T), and guanine (G). The corresponding DNA sequence can be chemically synthesised in a laboratory and even stored within everyday objects.

Harris Wang at Columbia University in New York and his team have gone one step further; they have used a form of CRISPR gene editing to insert specific DNA sequences that encode binary data into bacterial cells. By assigning different arrangements of these DNA sequences to different letters of the English alphabet, the researchers were able to encode the 12-byte text message "Hello world!" into DNA inside *E. coli* cells and were subsequently able to decode the message by extracting and sequencing the bacterial DNA.

Experts say, we are still a long way from having a working system that replaces the current digital devices, "but it's a small step along the way to something that might do that."

## NEW ANTIBIOTICS TO FIGHT RESISTANT BACTERIA

Antimicrobials-including antibiotics, antivirals, antifungals and antiparasitics-are medicines used to prevent and treat infections. Antimicrobial resistance (AMR) occurs when bacteria, viruses, fungi and parasites change over time and stop responding to medicines, making infections harder to treat. As a result of drug resistance, antibiotics and other antimicrobial medicines become ineffective and infections become increasingly difficult or impossible to treat.

The World Health Organization (WHO) has declared AMR as one of the top 10 global public health threats against humanity. It is estimated that by 2050, antibiotic-resistant infections could claim 10 million lives each year. The list of bacteria that are becoming resistant to treatment with all available antibiotic options is growing and few new drugs are in the pipeline, creating a pressing need for new classes of antibiotics to prevent public health crises.

The emergence and spread of drug-resistant pathogens that have acquired new resistance mechanisms, leading

Bacteria of many types (Credit: The Wister Institute)

to antimicrobial resistance, continues to threaten our ability to treat common infections. Especially alarming is the rapid global spread of multi-and pan-resistant bacteria (also known as "superbugs") that cause infections that are not treatable with existing antimicrobial medicines.

New antibacterials are urgently needed-for example, to treat carbapenem-resistant gram-negative bacterial infections as identified in the WHO priority pathogen list. However, if people do not change the way antibiotics are used now, these new antibiotics will suffer the same fate as the current ones and become ineffective.

But there is hope. Recently, researchers of Wister Institute, Philadelphia, USA have come up with a new generation of antimicrobials, which they call 'dual-acting immuno-antibiotics' (DAIAs) that uniquely combine direct antibiotic killing of drug-resistant bacterial pathogens with a simultaneous rapid immune response for combating AMR (Nature, 23 December 2020; | DOI: 10.1038/s41586-020-03074-x).

The researchers focussed on a metabolic pathway that is essential for most bacteria but absent in humans, making it an ideal target for antibiotic development. This pathway, called methyl-D-erythritol phosphate (MEP) or non-mevalonate pathway, is responsible for biosynthesis of isoprenoids-molecules required for cell survival in most pathogenic bacteria. The lab targeted the IspH enzyme, an essential enzyme in isoprenoid biosynthesis, as a way to block this pathway and kill the microbes. Given the broad presence of IspH in the bacterial world, this approach may target a wide range of bacteria.

Biman Basu is a former editor of the Science Reporter, published by CSIR.
**Email:** bimanbasu@gmail.com

**Form IV (see rule 8)**

Details of the ownership and other facts relating to monthly newsletter 'DREAM 2047'.

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I, Nakul Parashar do hereby declare that to the best of my knowledge and belief, facts mentioned above are true.

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