

VIGYAN PRASAR

# DREAM

2021

JULY 2020 / Vol. 22 / No. 10 / ₹ 20



## SIR PATRICK GEDDES: A SCIENCE GENERALIST PAR EXCELLENCE

THE MYTH OF  
IMMUNE-BOOSTERS

PERILS OF  
OVER-SANITATION

PROSPECTS OF  
PLASMA THERAPY  
FOR COVID-19  
PATIENTS

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Published and Printed by  
Dr Nakul Parashar on behalf  
of Vigyan Prasar, A-50,  
Institutional Area, Sector-62,  
Noida-201 309, U.P., India  
and Printed at Chandu Press,  
469, Patparganj Industrial  
Estate, Delhi 110 092  
Telefax: 22424396, 22526936.

Cover Design By: BIPRO KUMAR SEN

# MY WORD

NAKUL PARASHAR

## Grappling with the infodemic

# LIKE

anyone else, I am also curious to be duly updated on the global developments to find a solution to the COVID-19 pandemic. I Google, visit several websites, and land up on a new site every time I begin my search. On my most accessible bridge to the world, my handheld device, my phone, I find a lot of advisories, a lot of videos and a lot of words — words of science and technology that I might not have heard so far. All of a sudden, don't you think we have a lot of information around? How relevant, how redundant, how useful, how correct, how complete, how reliable, are they? That's how the information burst of the new normal seems to be evolving. To sift the relevant facts through the haystack of information appears to be the beginning of the new normal in science communication. Without having to be present in person, information scientists infer that this is one of the better times for the science communicators. This is a time when the quantum of society's attention towards science is at an all-time high. It has never been so high, so far. So is the availability of information, an infodemic of irrelevant inferences, and fake news. Amongst many papers being written and published, Pakinam Amer, ex-Editor-in-Chief Nature Middle East, and currently a research fellow at MIT, in her podcast series released by Nature, has spoken to a number of stakeholders during her research. She says that a lot still needs to be done in order to explain the uncertainties to the public.

By the way, this year is a centenary year for a lot of things too. The book titled, An Indian Pioneer of Science: The Life and Work of Sir Jagadis C Bose was written in 1920,

is one of them. Interestingly, Acharya Bose passed away 17 years after this biography was published. This leads to a query: Who was the author, and why was he in a hurry to have written this biography so early?

Writing about a legend like Acharya Bose and that too in his time, obviously, would require a person with a similar bent of mind — a person who could realise the relevance of bringing Acharya Bose's accomplishment to the fore. Someone who could demonstrate on ground the term 'scientific social responsibility', a term that we talk about more often nowadays. It was Sir Patrick Geddes, a British biologist, sociologist, geographer, philanthropist, and town planner, who wrote Bose's first biography. In the opening lines of his preface to the book, Sir Patrick says — "I am asked whether the title of this book means especially a pioneer in science, who happens to be an Indian, or a pioneer of science in and for India. The answer is—Both. For on one hand, Bose is the first Indian of modern times who has done distinguished work in science, and his life-story is thus at once of interest to his scientific contemporaries in other countries and of encouragement and impulse to his countrymen." This quote from Geddes is music to my ears. It reminds me of the lyrics of Bob Dylan's famous number — The answer, my friend, is blowin' in the wind.

This book is indeed worth a read, unravelling a lot about the relation between two greats — Bose and Geddes. Well, we bring more on Geddes in this issue.

Enjoy and stay safe!

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## RECENT DEVELOPMENTS IN SCIENCE AND TECHNOLOGY

## AN EXOPLANET WHERE IT RAINS MOLTEN IRON

Exoplanets are not new. All planets in our solar system orbit around the Sun but exoplanets orbit around other stars. Being hidden by the bright glare of the stars they are difficult to see directly with telescopes. Till now, more than 4,000 exoplanets have been discovered. But the strangest of exoplanets has just been discovered where scientists have found evidence of molten iron droplets raining on the planet's night side. The discovery was made with a new instrument called ESPRESSO (Echelle Spectrograph

for Rocky Exoplanets and Stable Spectroscopic Observations) on ESO's Very Large Telescope (VLT) in Atacama Desert, Chile. The giant exoplanet named WASP-76b orbits around the star WASP-76, about 640 light years from Earth in the constellation of Pisces.

According to the scientists, WASP-76b orbits so close to its host star that its dayside is extremely hot. It orbits its star at about 3% of the distance between the Earth and the Sun, resulting in scorching surface temperatures and the weird phenomenon of molten iron falling from the sky.

The astronomers also detected a strong signature of iron vapour at the evening border that separates the planet's day side from its night side



Exoplanet raining iron-nickel

(Nature, 11 March 2020). According to the scientists, "A fraction of this iron is injected into the night side owing to the planet's rotation and atmospheric high-speed winds. There, the iron vapours encounter much cooler environments, condense and rain down as droplets".

## SOLVING BENZENE STRUCTURE IN 126 DIMENSIONS

Benzene ( $C_6H_6$ ) is the smallest of the organic aromatic compounds and the parent compound of numerous important aromatic compounds. It is a colourless liquid with a characteristic odour and is primarily used in the production of various polymers. Understanding how its electrons work has implications for electronics too.

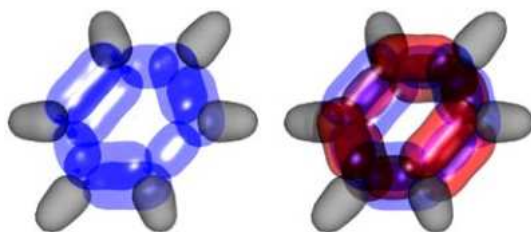
The atomic structure of benzene is pretty well understood. It is a ring consisting of six carbon atoms, and six hydrogen atoms – one attached to each of the carbon atoms. The structure with three double bonds was proposed by German organic chemist August Kekulé as an attempt to explain how a molecule whose molecular formula was  $C_6H_6$  could be built out of carbons which make four bonds. The

ring and the three double bonds fit the molecular formula, but the structure does not explain the chemical behaviour of benzene well. According to scientists, where it gets extremely tricky is when we consider the molecule's 42 electrons.

Ever since the 1930s, a debate has raged inside chemistry circles concerning the fundamental electronic structure of benzene. It is a debate that in recent years has taken on added urgency because benzene is the fundamental building-block of many opto-electronic materials, which are revolutionising renewable energy and telecommunications technology. According to scientists, the controversy around the structure of the

molecule arises because although it has few atomic components, the electrons exist in a state comprising not just four dimensions but 126 dimensions, which are of course purely mathematical.

Now, nearly 200 years after the molecule was discovered by Michael Faraday, researchers have finally revealed the complex electronic structure of benzene. A team of scientists led by Timothy Schmidt from the ARC Centre of Excellence in Exciton Science and UNSW Sydney, Australia used computing power and clever modelling to solve the 200-year-old chemistry and math puzzle and ultimately succeeded in unravelling the mystery (Nature Communications, 5 March 2020). The key to unravelling the complexity was a new mathematical algorithm called Dynamic Voronoi Metropolis Sampling (DVMS), developed by co-author Phil Kilby from CSIRO, Australia.



DVMS structures of benzene

Biman Basu is a former editor of the Science Reporter, published by CSIR.

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## THSTI's Bioassay lab completes testing for 10000 COVID-19 samples

The Translational Health Science and Technology Institute (THSTI), Faridabad's Bioassay Laboratory touched the 10,000 mark for COVID-19 testing on 2nd June 2020 having tested 10,271 samples. The Department of Biotechnology's institute THSTI receives samples from four districts of Haryana including Palwal (Civil Hospital), Gurugram (Civil Hospital and SGT Hospital), Nuh (Mandikhera Civil Hospital) and Faridabad (ESIC Hospital and Al-Falah Hospital).

Following ICMR's approval, THSTI's Bioassay Laboratory was designated a COVID-19 testing laboratory in April. The Faridabad-based institute is the only DBT-funded lab designated for COVID-19 testing in the state. The team at THSTI is led by Dr Guruprasad Medigeshi and has currently got about ten young researchers and scientists working.

**Website link:** <https://thsti.in/covid/index.php/Home/testing>

## AI-based Contactless Attendance System

Research Centre Imarat (RCI) Hyderabad, a national DRDO Laboratory, has developed an AI-based Attendance Application (AINA) that allows non-contact-based personnel verification using facial features of the person. The need is felt due to COVID-19 pandemic which made it unsafe to use contact-based biometric verification.

Existing CCTV cameras can be utilized for capturing facial images. Facial features of several thousands of employees can be stored in the computer as facial features of each employee are encoded in a small (less than 25 KB) file.

The system is scalable since the time for identification and verification for each person remains constant, even as the number of registered personnel increases. It is secure because it works as a standalone system and does not require internet, since only the facial

features are saved in encoded form and the actual face images need not be saved, thereby ensuring privacy and security. Moreover, the server for storing the facial feature database is placed within the organisation's premises.

AINA can be deployed with minimal upgradation to the legacy attendance infrastructure with RFID (Radio Frequency Identification) readers. It has a lightweight installation process and can be installed on a normal desktop computer with a GPU-based display adapter. It comes with a very intuitive and user-friendly GUI.

## DST releases information brochure on health & risk communication programme focusing on COVID-19

The National Council for Science & Technology Communication (NCSTC), Department of Science & Technology (DST) has released an information brochure for a recently launched programme on health and risk communication 'Year of Awareness on Science & Health (YASH) with focus on COVID-19'. The brochure carries information on the genesis and need of such a mega programme in the country to address the issues of risks, crises,

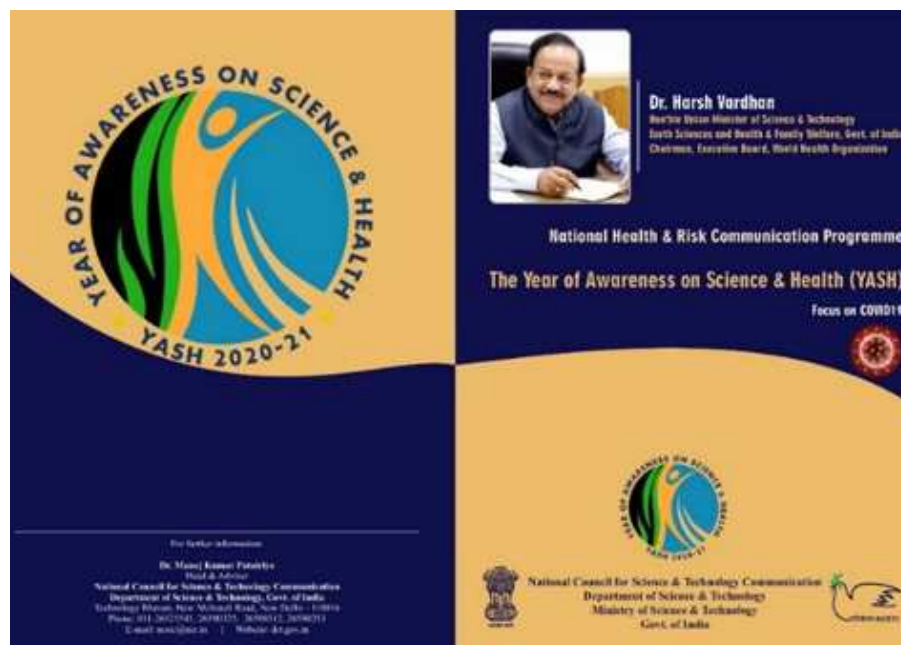
disasters, and uncertainties especially posed by the COVID-19 pandemic. The programme focuses on enhancing public understanding and awareness on science and health for better preparedness to cope with the present and future challenges.

Prof. Ashutosh Sharma, Secretary, DST said that a wide array of programmes and activities built around awareness and outreach have been envisaged involving print, electronic, digital, folk and interactive media to reach out to large cross-sections of the society under the campaign. He added that the logo of the YASH programme has been designed to create a wave of peace and bliss and depicts a sense of overcoming the situation at large and would act as a harbinger of taking forward the messages of science, health, risk and awareness.

**Website link:** <https://dst.gov.in/dst-releases-information-brochure-health-risk-communication-programme-focusing-covid-19>

## CSIR-CMERI develops new indigenous ventilator

Researchers at Durgapur-based Central Mechanical Engineering Research Institute (CMERI) have indigenously developed a ventilator amid rising cases of COVID-19. The new ventilator was unveiled in the presence of Prof. (Dr) Harish Hirani, Director, CSIR-CMERI,



and Dr Arunangshu Ganguly, Chairman and Managing Director, Health World Hospitals Pvt Ltd, Durgapur.

“The bellow design, controllers and embedded electronics of this ventilator have all been customised to ensure price efficacy as well as meeting the requirements of the relevant industries. The ventilator has undergone multiple technical and design changes after adopting critical feedbacks from healthcare professionals of the Health World Hospital and Vivekananda Hospital, Durgapur. This ventilator costs around Rs. 80,000-90,000. The ventilator will be further upgraded to meet the requirements of various other patient’s parameters,” said Prof. Hirani.

“The efficacy of a ventilator for a patient is also correlated to the effective response of the attending healthcare personnel. Steadily, the approach of this Institute will be to harness artificial intelligence capabilities to automate the functioning of mechanical ventilators, so that the ventilators automatically respond to the fluctuating variables of a patient,” added Prof. Hirani.

## WHO resumes hydroxychloroquine and chloroquine trials

World Health Organisation (WHO) has decided to resume hydroxychloroquine and chloroquine (HCQ/CQ) trails after Indian scientists have questioned its earlier decision to halt it temporarily. WHO had stopped the trails based on a study published in the journal Lancet.

This news has received overwhelming response from all spheres. “We're happy that the WHO resumed trials of hydroxychloroquine. I firmly believe that the WHO's decision was taken in haste. It was a kind of knee-jerk reaction. They should have analysed the data on their own before temporarily suspending trials,” said Shekhar C Mande, Director General, Council of Scientific and Industrial Research (CSIR).

“I think that HCQ/CQ trails are of global importance and I am glad to see them resumed,” said Dr Anurag

Agarwal, Director, Institute of Genomics and Integrative Biology (IGIB), while speaking with India Science Wire.

Dr Mande, Dr Agarwal (IGIB), and Dr Rajeeva Karandikar from the Chennai Mathematical Institute (CMI) have written a joint letter to the WHO's chief scientist Dr Soumya Swaminathan, where they have pointed out several limitations in the study as the authors have themselves acknowledged it in the article. “This study is highly flawed and should not be used to judge CQ/HCQ effectiveness or toxicity. A high quality RCT is needed,” tweeted Dr Agarwal.

## ICMR-approved probe-free RT-PCRs for diagnosis of COVID-19 developed at IIT Delhi

The researchers at Kusuma School of Biological Sciences, IIT Delhi, have developed a probe-free technology for COVID-19 detection, and it is one of the firsts to be approved by ICMR. This will be more affordable and easily scalable as compared to the existing methods. Microsoft has offered the support for this project.

The sensitivity of this in-house assay is comparable to that of commercially available kits. This assay can be used both as a qualitative (yes or no) assay without the need for extensive instrumentation and it can also be used for quantitatively to assess virus loads. The team proposes the use of this assay for specific and affordable high throughput screening of COVID-19. Time for assay is less than 2 hours. This is a probe-free assay (i.e., low cost) and is ideal for high-throughput, large-scale screening. This assay can be used as a regular PCR, i.e., it can be used in setting without a real-time PCR machine but with a regular PCR machine and agarose gel electrophoresis system. IIT Delhi KSBS Team working on this project consists of Prof. Vivekanandan Perumal, Dr Akhilesh Mishra, Dr Parul Gupta, Dr Sonam Dhamija, Prof. Manoj B. Menon, Prof. Bishwajit Kundu and Prof. James Gomes.

## Living with COVID-19: Storytelling through comic characters depicting the new normal

Nowadays, everywhere the only thing people are talking about is COVID-19 and numerous dos and don'ts that have brought life to a standstill, not just in the country but at a global level. In the wake of the COVID-19 outbreak, our lives have changed in ways we had never imagined before. The Union Ministry of Health in India has indicated that Indians would have to learn to live with coronavirus, and there might be no early tapering off of the disease. This would require an adjustment to a new normal of several aspects of day-to-day life. Activities related to induce behavioural change regarding usage of masks at all public places will not only mean intensification of awareness drives but also access to key resources. To overcome the challenge, Postgraduate Institute of Medical Education and Research (PGIMER), Chandigarh and Panjab University (PU) have come up with an e-Book on the same topic. The book elaborates on various aspects of activities being touted as new normal, that is, living with COVID-19.

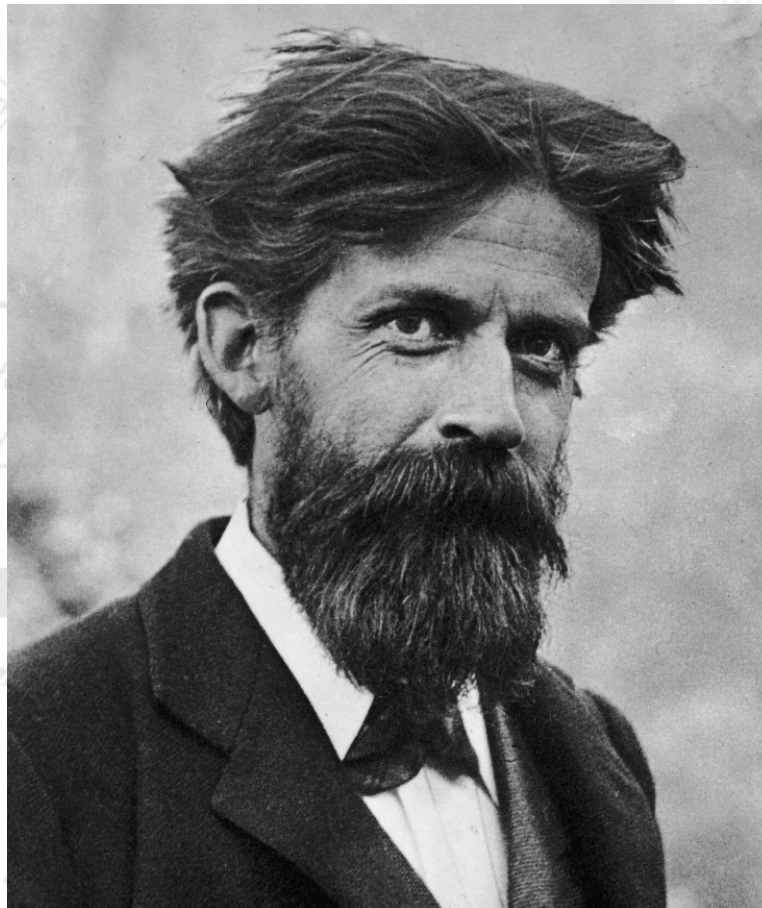
## NIRRH issues guidance for management of pregnant women during the COVID-19 pandemic

ICMR - National Institute for Research in Reproductive Health (NIRRH) issued guidance for management of pregnant women during the COVID-19 pandemic outbreak. The risk of infection in pregnant woman is the same as that in general population but as pregnancy is a state of immunosuppression and along with other physiological, respiratory and immune changes, pregnant women might show severe symptoms of COVID-19 infection as the vertical transmission risk remains uncertain.

Vigyan Samachar Team

# COVER STORY

JAYANT SAHASRABUDHE



**SIR PATRICK GEDDES:**

## A Science Generalist Par Excellence

**Sir Patrick Geddes was not just interested in science and humanities, he made serious contributions to both.**

Background image: Geddes complex maps of a participatory holistic view of life (Source: [journals.sagepub.com](https://journals.sagepub.com))

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veryone aspires to become at least a 'Specialist' in the modern era. A step further, a versatile person may be 'master of one and jack of all'. However, there are some who turn the saying on its head and come to be known as 'master of many', that is, a truly successful 'Generalist'. Polymath Sir Patrick Geddes is one such Generalist.



Sir Patrick Geddes was not just interested in science and humanities, he made serious contributions to both. On the one hand, he did path-breaking work in two streams and on the other, by synthesizing both he projected a new vision, which was more fundamental and closer to reality. He was not merely a theorist, but a man of creative and innovative action. Therefore, he could achieve a rare kind of feat of translating vision into action. The impact of both is visible even today. His ideas garnered appreciation and acceptance in his time, however, people were unable to fathom the depth of the concepts. With the growing concerns about environment, ecology and sustainability, his ideas have started gaining attention. Here is a peek into his inspiring life and work, and especially his profound bonding with India.

### Formative years

Patrick Geddes was born on October 2, 1854 in Scotland. He grew up in serene and beautiful Scottish countryside full of fields, gardens, woods and hills, which had a lasting impact on his personality and greatly influenced his career. His father veritably was his first 'natural' teacher who taught him how to take care of plants, springs and the surroundings. Patrick would often say that love for nature and a tendency to nurture it were excellent gifts he received from his father. In 1875, he joined higher studies and inevitably opted for biology. He was trained by a reputed biologist and evolutionist, Thomas Huxley. As a student he excelled in the subject of evolution theory. His research work in biology even impressed Charles Darwin. Darwin delightfully wrote to him once, "I have read several of your biological papers with great interest, and I have formed... a high opinion of your abilities" (Letter dated March 22, 1882). Gradually, but quite soon, Patrick developed a different opinion as opposed to Darwinian ideas about the process of evolution. After critical observation of the process of evolution in nature he arrived at a different conclusion, which led him in a different direction. At the same time, he came in close contact with influential thoughts of an eminent evolutionist Peter Kropotkin. He was a Russian naturalist, biologist and anarchist philosopher who contributed a lot to evolution theory. He proposed mutual aid to be the cause for evolution over survival of the fittest. Patrick found that his views resonated well with Kropotkin's. Soon, Patrick formed a firm opinion that biological evolution further occurs as a result of mutual cooperation and not by the 'survival of the fittest'. Young Patrick was influenced by another prominent figure of the era, Herbert Spencer, a British philosopher and sociologist. Spencer was best known for applying evolution theory to the study of society considering 'society' as a living organism. Both these ideas impressed Patrick and in short span of time that became his conviction, scientifically borne out of experience. He had remarkable inherent ability to synthesize all these seemingly divergent currents of thought in an apt scientific manner.



Patrick Geddes Steps, Edinburgh (source: bliphoto/stevekydd)

### Geddes's emergence as biologist, social scientist and town planner

Though Patrick never completed his studies he became a teacher in 1880 and started teaching zoology at the University of Edinburgh. Concurrently, he advanced as an evolutionary biologist and co-authored a scholarly book 'Evolution of Sex', considered as a milestone, along with naturalist J.A. Thomson in 1889. That time the city of Edinburgh had deteriorated due to industrial growth and was reeling under its effects like migrant workers, crowded unhygienic tenements, economic divide, air pollution, dirt, waste generation. Prof. Geddes, while continuing his teaching, set out to restore it to its former glory. He started living with slum dwellers, while he was striving for development from within with an inclusive approach. He was convinced that mutual cooperation could be translated into action in a living organism called 'society'. For slum development he initiated few cooperative projects. He rolled out an innovative experiment--creation of 'Outlook Tower'. 'Tower' was an instrument to educate common people, develop their understanding about betterment of city from varied dimensions and generate collective will among them for common good of the city. He used modern technology, applied scientific methodology in this 'social' experiment and thus created first 'sociological



Part of Geddes and Mears Plan for Edinburgh Zoo (1925) (Source: geddesexhib04web)

At the Paris Exposition, Geddes was introduced to Jagadish Chandra Bose. Bose had submitted his research paper to International Congress of Physicists, titled 'On the Similarity of Response in Inorganic and Living Matter'. Bose, through this paper, posited the theory that life exists in inorganic matter as well. Geddes was impressed by this discovery as it was almost an echo of his own ideas. They became friends forever.

laboratory' of the world. Regeneration of Edinburgh was achieved through this successful experiment. This earned Biologist Prof. Geddes a reputation as a social scientist and a town planner.

### Geddesian approach

In his experiment with urban development the scientific methodology he applied became popular as 'Geddesian methodology'. Geddes was fascinated deeply by Frederic Le Play's social philosophy based on triad of 'Lieu, Travail, Famille'. Geddes adopted this triad as 'Place, Work, Folk' or 'Environment, Function, Organism'. Le Play's logic enabled Geddes to place 'Work' at the centre as it affects both man and his surroundings. 'Man' changes 'Environment' through his 'Work' as per his needs. This triad forms a basis of Geddesian approach to town planning. Furthermore, Geddes developed a view that 'Man' should not attempt to conquer nature but should live in harmony with it. This fundamental view was a paradigm shift set in by Geddes as he believed that 'by leaves we live'. Geddes wrote extensively about his unique views and his far-reaching methodology. He authored the most acclaimed and remembered book — 'Cities in Evolution'. Thus, equipped he marched ahead.

### Getting established as a town planner

Geddes developed 'Cities and Town Planning Exhibition' to showcase his novel scientific ideas and promoting his methodology for urban planning. He toured important cities in England with the exhibition. Along with the exhibition, he started propagating ideas about urban development by conducting lectures. He was credited with reopening neglected study of 'City' in regional and social contexts. His reputation as a town planner drew him to India. Lord Pentland, the Governor of Madras, was instrumental in bringing Prof. Geddes to India.

### Geddes in India – As a town planner

Apart from England, the country where Geddes spent major part of his life was India, where he stayed for almost ten years from 1914 to 1924. Lord Pentland invited him to India along with his 'Cities Exhibition' and asked for his guidance in newly developing urban areas. Pentland introduced Geddes to his colleagues Lord Willingdon and Lord Carmichael, governors of Bombay (now Mumbai) and Calcutta (now Kolkata), respectively. During his first visit to Mumbai he was invited to deliver four public lectures on his study of Mumbai city at the university. He embarked on a nationwide tour, visiting various cities and towns, giving advice on town planning and suggesting affordable ways to implement it. He worked for around forty towns or cities and prepared their plans. He covered almost all regions of India. This was a significant achievement considering Geddes was sixty years old when he arrived in India.

This sojourn gave Geddes an opportunity to observe India and its cultural-civilizational manifestations at close quarters. The observations gave rise to appreciation towards cultural and civilizational symbols of the country. His eyes caught the presence of 'Tulsi', a revered plant, in every household. He perceived faith of common people in respecting rivers as 'Lokmata'. Such beliefs touched his inner core as they resonated well with his conviction— 'love for nature'. Deciphering logic behind design of traditional Indian towns and habitats was another remarkable work he did. He coined a term 'Temple City' while he observed Madurai and many other similar towns in Madras province and described the rationale behind planning of these towns in his articles. Many other aspects like curved and narrow lanes instead of wide straight roads in Indian towns, big banyan trees near squares or junctions of the roads or water sources like lakes and wells—used as shelter for people captured his attention and he commented that this pattern looked more sensible in Indian climatic conditions. He argued with British authorities about imposing English standards and styles without considering sociocultural and regional contexts of the locality. More painful to him was the sheer removal of cultural and historical signatures of a place to introduce alien ideals. For him, understanding people and their cultural, historical settings along with geographical location of the place and their interrelations was fundamental to planning.

The most interesting and impressive work Geddes did in India was urban reconstruction of Indore, Madhya Pradesh. Maharaja of Indore invited him to improve civic conditions of the newly emerging industrial city severely hit by worst outbreak of plague. He prepared a scientific plan for improvements



Part of the Procession through Indore (Source: geddesexhib04web)



based on his triad – ‘Place, Work, Folk’. It was presented to Maharaja in 1918. This plan is still widely read and studied in the domain of town planning. The most memorable part was the novel method Geddes adopted to implement it. The execution was carried out by getting people involved voluntarily in the city’s renewal campaign. In between the occasion of Diwali, a popular festival, and the ritual of cleaning houses and its surroundings to welcome Goddess of Prosperity, Laxmi, was utilized to its fullest. A magnificent procession on the Diwali day was organized with enchanting floats and decorated carts carrying images of Goddess Laxmi. It passed through almost every part of city showering petals, distributing seedlings, plants and laddus for children. The procession was planned and arranged to project evils of the day like dirt, plague and unhygienic conditions of the city followed by hope and confidence of victory over these challenges. The procession culminated at a public park where huge effigies of Ravana and rat of plague were burnt indicating end of evil. As a consequence the city gained a new look and shine. Plague waned gradually as everyone started benefitting from the healthy surroundings and order was restored. This entire process of developing plan and its implementation was an example of successful social experiment, which integrated science and aesthetics for civic renewal.

### **Geddes in India – Presence in other walks of life**

Prof. Geddes’s connection to India was not restricted only to the domain of ‘Town Planning’. He could connect with many eminent personalities from varied walks of life. Swami Vivekananda, Sister Nivedita, Acharya J. C. Bose, Rabindranath Tagore, Mahatma Gandhi were a few notable figures. Through his close acquaintance with these influential people, he made remarkable contribution to academic, social and scientific fields in India that hitherto has remained either hidden or obscure.



Besides others, Geddes is seen here with Acharya JC Bose and Prof PC Mahalanobis (May 1927)  
(Source: *Images d’archives de l’Institut Patric Geddes de Yamaguchi-Japan*)

### **Geddes and Sister Nivedita**

It was a chance meeting between Swami Vivekananda and his disciple Sister Nivedita and Prof. Geddes in March 1900 in America. Sister Nivedita was impressed with Prof. Geddes’ idea to read and study society in a scientific manner. In 1904, she dedicated her book ‘The Web of Indian Life’ to Patrick Geddes. Later, when she took on responsibility of establishing the Indian Institute of Science from Swami Vivekananda’s side, she wrote a letter to Prof. Geddes to provide guidance for the formation of first-ever science research university in India. Prof. Geddes responded with letters in this connection. Geddes, when he met Nivedita in America, was on a tour to raise funds to organize his favourite summer school at Exposition Universille 1900, Paris to propagate his ideas about urban planning. This fair was an opportunity for Geddes to reach out to the international community. Sister Nivedita assured him secretarial support to organize this endeavour. Prof. Geddes desired her support to collate his thoughts, which he presented in several sessions at the International School of Science.

### **Geddes and Jagadish Chandra Bose**

At the Paris Exposition, Geddes was introduced to Jagadish Chandra Bose, a biologist, physicist and botanist, by Sister Nivedita. Bose had submitted his research paper to International Congress of Physicists, which was a part of the Paris Exposition. The title of Bose’s paper was ‘On the Similarity of Response in Inorganic and Living Matter’. Bose, through this paper, posited the theory that life exists in inorganic matter as well. Geddes was impressed by this discovery as it was almost an echo of his own ideas. They became friends forever. While in India, Geddes wrote the biography of Bose which was published in 1920, exactly 100 years ago. To write a biography of a living person is something really exceptional and it was Bose, the first Indian scientist, in contemporary times, to receive this rare honour. It was Sir Patrick Geddes who presented life and work of India’s first modern scientist to the entire world. Geddes precisely and successfully narrated nationalistic vigour of Bose practicing science under oppressive British rule. This reflects high standing of Prof. Geddes not only as a prolific writer but a man with lofty ideals and great humility to even admire someone of a younger age.

### **Exchange of thoughts with Swami Vivekananda**

Swami Vivekananda was invited to participate in the Congress of History of Religions organized at



Patrick Geddes with his students in Bombay University (Source: Patrick Geddes Memorial Trust)

the Paris Exposition. In a meeting with Geddes at Paris, Swamiji discussed various topics including transitions occurring in Europe, ancient Greek civilization and its impact on shaping modern Europe. And, the most important of them was evolution of races. Swamiji's thoughts on Raja Yoga impressed Prof. Geddes and his wife Anna so much that for the French translation of Raja Yoga, Geddes wrote a preface.

### Friendship with Tagore

Owing to Sister Nivedita and Bose, Prof. Geddes' name was familiar to Nobel Laureate Rabindranath Tagore. The first meeting with Tagore, a poet and novelist who was bestowed with the Nobel Prize in 1913 for literature, happened in 1917. Two great minds, the poet and the professor, drew closer to each other and their friendship matured in course of time. Tagore was appreciative of Geddes' precise scientific vision and his unique artistic ability to present his ideas in symbols. Tagore wanted to start Visva Bharati, an international university, where he dreamed of synthesizing East and West for the welfare of humanity. The university was established in 1921. Tagore invited Prof. Geddes to provide plans for the overall development of Visva Bharati. Towards the end of his life, Prof. Geddes in Montpellier in France did try to combine West with East by establishing a college, to which Tagore and Bose were made president and vice president, respectively.

### Geddes and Gandhiji

Prof. Geddes was deeply impressed with Gandhiji's personality. Gandhiji's commitment to Indian way of life was in tune with Geddes' approach to life. They met by chance in Indore in 1917 at the 8th Annual Hindi Language Conference. Prof. Geddes was working on his report of Indore in those days. They had an intense discussion and exchanged views. Later on, Geddes sent a copy of his town planning report on Indore to Gandhiji. Having known his ideas about 'Gram Swaraj' Geddes was interested in working with Gandhiji on civic reconstruction. However, Gandhiji could not respond to this initiative because of his other commitments.

### Geddes as academician and initiation of study of social science in India

Prof. Geddes was an academician with some singular, peculiar and unconventional features. Sir Chimanlal Setalvad, Vice Chancellor of University of Mumbai in 1919, invited Geddes to start a department of Sociology and offered him professorship. He accepted the offer and insisted on including the subject of civics with sociology. At this juncture, it will be relevant to note its importance. Prof. Geddes pioneered the study of sociology along with his student Victor Branford in England. Both of them founded British Sociological Society in 1903 and impressed upon University of London to start the study of sociology. The University of Mumbai was fortunate to get sociologist of such eminence to inaugurate India's first-ever department of sociology and civics. Prof. Geddes envisioned sociology as science of man's interaction with nature. This concept gave rise to a new stream 'Environmental Sociology'. And, relevance of this phenomenon is far greater in today's context. He believed that one should learn through three 'H's' – 'Head, Heart and Hand'. According to him these three 'H's' are the best instruments as theory and practice are intimately related with each other. Prof. Geddes continued in this position till 1924.

### Last days

Due to his deteriorating health conditions he decided to leave India. He went to France to spend the rest of his life with his family. He continued to experiment with different ideas and schemes till he breathed his last on April 17, 1932.

Through the triad of 'Environment, Function, Organism' or 'Place, Work, Folk' Geddes could experience and witness turbulent interplay of these three factors. His sole effort was to resolve imbalance between 'Man, Machine and Nature'. He envisioned great confluence of science and humanities as a response to this never before phenomenon. At this momentous juncture when entire humanity is passing through challenging times, wisdom lies in understanding vision and action of this exceptionally brilliant scientist and humanist and celebrate and acknowledge Prof. Geddes' extraordinary life as 'A Science Generalist Par Excellence'.

In a meeting with Geddes at Paris, Swami Vivekananda discussed various topics including transitions occurring in Europe, ancient Greek civilization and its impact on shaping modern Europe. And, the most important of them was evolution of races. Swamiji's thoughts on Raja Yoga impressed Prof. Geddes and his wife Anna so much that for the French translation of Raja Yoga, Geddes wrote a preface.





# Prospects of Plasma Therapy for COVID-19 patients

**In the absence of a vaccine or any specific antiviral medications for the treatment of COVID-19, convalescent plasma therapy is being seen as a promising therapeutic option.**

As the deadly COVID-19, caused by the novel coronavirus, SARS-CoV-2 continues to wreak havoc across the globe, the experts are rushing to develop cure for this disease. So far, there is neither any vaccine nor any effective antiviral medication for the treatment of this disease, although some medical practitioners are using certain antiviral drugs, and the age-old drug hydroxychloroquine, used for the treatment of malaria, is also being used by some doctors.

While the search continues for a vaccine or an effective antiviral drug to cure the deadly disease, a treatment called plasma therapy has received a lot of attention. The treatment has shown some promise and given some encouraging results in few countries, including India. Recently, a 49-year-old patient became the first COVID-19 patient to be administered plasma therapy in a hospital in Delhi. Reports of some COVID-19 patients having responded favourably to the therapy have also come from China.

The Indian Council of Medical Research (ICMR) has recently given a go-ahead to five states – Delhi, Punjab, Kerala, Gujarat, and Karnataka – to start clinical trials of plasma therapy to study how safe and effective the therapy is in treating COVID-19 patients.

## What is plasma therapy?

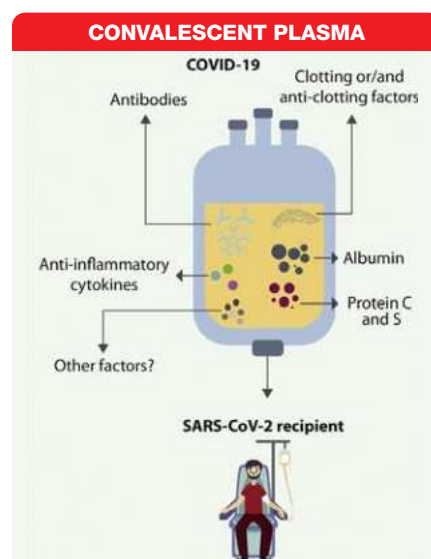
It is an experimental procedure for COVID-19 patients. In this therapy, plasma from a COVID-19 patient, who has recovered from the disease, is transfused into a critically affected COVID-19 patient. The therapy can also be used to immunise those at a high risk of contracting the virus, such as health workers, families of the patients and other high-risk contacts.

The plasma from the recovered patient is called convalescent plasma and the treatment is known as convalescent plasma therapy (CPT). Plasma is the (yellowish) liquid part of blood and constitutes about 55 per cent of the total blood volume. It has high concentration of neutralising antibodies that fight infections caused by bacteria and viruses.

The concept behind the therapy is simple and is based on the premise that the plasma of a patient who has recovered from COVID-19 contains antibodies with the specific ability to fight the novel coronavirus. When it is transfused into a critically ill COVID-19 patient, it will start targeting and fighting the virus.

## How plasma is donated?

The process of donating plasma is similar to routine blood donation. A small device is attached to the donor in which a tube of fresh blood drawn from him is made to spin using a centrifuge until the red blood cells fall to the bottom of the tube.



Source: <https://www.sciencedirect.com/science/article/pii/S1568997220301166>

The blood plasma is then drawn off and the red blood cells are simultaneously returned to the donor. The whole process takes about an hour. Unlike regular blood donation, in which donors have to wait for red blood cells to replenish between donations, plasma can be donated more frequently, as often as twice a week. A single donor can donate 400 ml of plasma. Hence, plasma from a person who has recovered from COVID-19 can help two COVID-19 patients to recover as 200 ml is sufficient to treat one person.

## Plasma therapy vis-a-vis vaccine

Plasma therapy is a preventive measure as it provides passive immunisation against the disease. On the other hand, vaccine provides active immunisation. When a vaccine is administered, the immune system starts producing the antibodies. When the vaccinated person, on a later date, is infected by the same pathogen (bacterium or virus), the immune system neutralises the infection by releasing antibodies. However, while vaccine provides lifelong immunity, the effect of plasma therapy lasts till the time the antibodies ingested into the infected person remain in his/her bloodstream. Therefore, as against vaccine, the protection given by the plasma therapy is only temporary.

## CPT trials in other countries

Plasma therapy's potential as a treatment of COVID-19 was first explored in China where coronavirus outbreak first emerged in late last year. Two trials of plasma therapy were conducted on 15 and 10 COVID-19 patients respectively. Another trial conducted by researchers in Shenzhen, China treated five critically ill COVID-19 patients with plasma therapy and found "improvement in (their) clinical status."

After China's success in plasma therapy, other countries, including the

United States, the United Kingdom, and South Korea have also started plasma therapy trials.

Although these trials have sparked a ray of hope, researchers say that the sample sizes in these trials are too small to arrive at definite conclusions about the efficacy of plasma therapy against COVID-19. According to a report published in Mayo Clinic's Research Magazine, researchers across the world have also raised the point that there are too many unknowns about the therapy right now. For instance, which is the optimal dose of antibodies? At what point during a patient's illness should plasma therapy be given? These issues need to be addressed before reaching concrete conclusions.

The researchers also noted that "some participants had also received other experimental drugs such as antivirals, making it hard to tease out the precise effect of convalescent plasma." It is, therefore, difficult to make out the exclusive effect of plasma therapy on the patients.

The risks associated with routine blood transfusion are also present with plasma transfusion. Hence, adequate safety measures need to be taken.

### Issues and risk factors

According to doctors and researchers, the foremost consideration for plasma therapy to be effective is that the plasma should contain sufficient antibodies against the infection the recipient is suffering from. The antibody titre is a test that detects the presence and measures the amount of antibodies within a person's blood and can be used to detect the presence and measure the amount of antibodies within a person's plasma.

In a recent study made by Arturo Casadevall and Liise-anne Pirofski that appeared in the 1 April 2020 issue of Journal of Clinical Investigation, the authors write that for effective therapy "a sufficient amount of antibody must be administered when given to a susceptible person; this antibody will circulate in the blood, reach tissues, and provide protection against infection. Depending on the antibody amount and

## History of convalescent plasma therapy (CPT)

The plasma therapy was discovered by a German physiologist, Emil von Behring, in 1890. He found that the serum (plasma without clotting factors) obtained from a rabbit infected with diphtheria was effective in preventing diphtheria infection. Behring was awarded the first-ever Nobel Prize in Physiology or Medicine in 1901. Since 1892 till the development of effective antimicrobial therapy, serum therapy was used effectively to treat many bacterial (e.g., diphtheria, pneumococcus, meningococcus) and some viral (e.g., measles, mumps, etc.) infections. Serum therapy was used to advantage to treat contact infection disease – pertussis – until about 1970. Also, horse serum was used to treat tetanus until the 1970s.

During the avian-borne flu, called Spanish flu that resulted in 50 million deaths worldwide, plasma therapy was used to save lives. This flu was first observed in 1918 in Europe, the United States and parts of Asia and then it swiftly spread around the world (the pandemic did not originate in Spain, but Spain during World War I being neutral did not impose press censorship, and a report of the 1918 flu in a Spanish press led to the pandemic being called "Spanish flu"). In the 1920s, plasma therapy was used to treat scarlet fever and in the 1930s, doctors like J. Roswell Gallagher effectively used the therapy against measles.

By the 1940s and 1950s, antibodies and vaccines began to replace the use of plasma therapy for treating any infectious disease outbreaks, but the old-fashioned methods came in handy yet again during the Korean War, which started in June 1950. During the war, thousands of United Nations troops were struck with the so-called Korean haemorrhagic fever caused by a virus known as hantavirus. With no other treatment available, field doctors transferred plasma to sickened patients and saved umpteen numbers of lives.

Plasma therapy was also deployed against 21st century outbreaks of SARS, H1N1, MERS and Ebola – all novel viruses that spread through communities with no natural immunity, no vaccine, and no effective antiviral treatment.

In 2014, the WHO had recommended the use of plasma therapy to treat patients with the antibody-rich plasma of those who had recovered from the Ebola virus disease (EVD). Today, the best treatment for Ebola is still a pair of "monoclonal antibodies"— individual antibodies isolated from plasma and then cloned artificially in a lab.

composition, the protection conferred by the transferred immunoglobulin (antibody) can last for weeks to months."

As with routine blood donation, the blood from the cured patients of COVID-19 is screened for the presence of any disease-causing agents, such as Hepatitis-B, Hepatitis-C, HIV, malarial parasite, and so on. Although the proper screening of blood can eliminate transfer of blood-borne infections, transfer-related reactions, including immunological reactions, such as serum sickness and allergic reactions can also pose threat to the recipient.

In a study conducted at the Johns Hopkins University immunologists have stated some other potential risk factors. According to them, the antibody administration may end up suppressing the recipient's natural immune response, leaving the patient vulnerable to subsequent re-infection. But the biggest

risk factor is that the therapy might fail for some patients and can result in an enhanced form of the infection as has actually been observed in the case of dengue virus.

So, plasma therapy does not seem to be a fool-proof therapy as many issues and risk factors are involved in the administration of this therapy to critically ill COVID-19 patients. The results of trials from five states approved by ICMR on potential use of plasma therapy on critically ill patients of COVID-19 are yet to come. In the meantime, the All India Institute of Medical Sciences (AIIMS) is planning to conduct a clinical trial on the efficacy of CPT in the treatment of COVID-19 patients and necessary approvals are being taken from the Drug Controller General of India (DCGI).

# Perils of over-sanitation

**Humans need an evolution-informed fine balance; neither too much nor too little but just right sanitation. Most of the microbes are our friends; we should get back those long-lost friends.**



The widespread practice of sanitation, once heralded as one of the biggest leaps medicine has ever had and saved millions of lives, resulted in a general averseness towards microbes and ultimately lead to over-sanitation in the latter half of 20th century. It was only recently that the biggest organ of human beings has been discovered—the human microbiome. Recent studies have revealed that changes in human microbiome are associated with a large number of physiological and lifestyle diseases such as obesity, diabetes, heart disease, cancer, Alzheimer's disease and even human behavioural diseases such as depression and autism. Like the rest of our organs, transplantation of human microbiome through faecal transplantation has various ethical and legal ramifications.

Importance of sanitation remained virtually unknown until Ignaz Philipp Semmelweis, the 19th century Hungarian doctor, introduced the simple practice of washing hands of medical professionals to drastically reduce incidences of childbed fever—a lethal form of bacterial infection originating in the hospitals. The story behind that finding is indeed illuminating. He noticed a very high mortality rate among women in the maternity ward of Vienna General Hospital where he worked. Women who went to the hospital for childbirth were far more likely to die from the puerperal sepsis—a lethal form of bacterial infection post-delivery—than the women who had childbirth in their homes.

He also noticed a difference in death

rates between different wards within the hospital; the wards in which doctors and medical students attended the delivery had almost five times mortality rates than the ward attended by midwives. He conjectured that the disease might have been spread by medical professionals who also attended post-mortem procedures. Note that during those days, the role of microbes in causing the disease was not known. According to Semmelweis, doctors transferred an invisible death particle from dead-bodies to healthy women causing them to die, an approximation scientifically sound even today (what he was referring as the particle was the microorganism, especially bacteria). He instructed the medical professionals to wash their hands before attending the delivery, a simple practice that drastically reduced the mortality rates.

The term antiseptics refers to the practice of using antiseptics to ward off microbes that cause various diseases. Antiseptics came into existence with Semmelweis and since then has been hailed as a first-line defence against microbial infection. Semmelweis' contemporary, the British physician Joseph Lister is considered as the pioneer in antiseptic surgery and antiseptics, as he introduced various antiseptic compounds that are applied on the skin to reduce microbial infections.

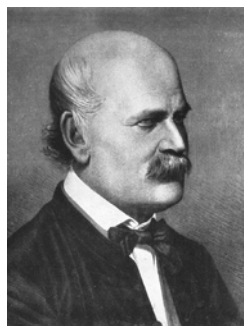
While antiseptics are applied on the skin, an entirely new class of compounds produced by microbes to kill other microbes, the so-called antibiotics, got serendipitously discovered by Scottish

microbiologist Alexander Fleming. Antibiotics too became widely used throughout the world to fight bacterial infections and indeed saved millions of lives worldwide to herald its discovery as one of the most profound in the history of science. Yet another class of compounds, disinfectants, were also developed that can be used on surfaces to ward off microbes. Alcohol-based antiseptic hand sanitizers appeared in the markets since the 1980s and its use have now become a regular practice among many of us around the world. Over these years, the words 'microbe' and 'bacteria' became synonymous with 'germ'—with negative connotations. Overprotective parents restricted their children from playing with dirt and dirty surroundings. The impact of widespread use of antiseptics, antibiotics, disinfectants and the general averseness to dirt were indeed profound.

It was only in the 20th century that a battery of studies revealed that gnotobiotic animals, animals that were grown in aseptic conditions (i.e., since birth, never exposed to microbes), were highly likely to get infected and die when they were introduced to the outside world. The role of the immune system has been known since the time of Edward Jenner who first introduced vaccination in the 18th century. Vaccination worked because it exposed our bodies to the sub-lethal doses of (or non-living remains of) the pathogens or its close relatives.

Today, science informs us that periodic exposures to infectious agents are essential for our immune system to develop its own immunity against these microbes and allergens. Microbes educate our immune system to develop various antibodies that confer resistance against them. Modern lifestyle and spending much of our times inside hermetically sealed spotless indoors have made us very much like those gnotobiotic animals with inadequate immune systems.

The so-called 'hygiene hypothesis' postulate that overly clean environments, especially during childhood, would lead to decreased immunity later in the life. Our own body harbours a rich diversity of bacteria and other microbes. Estimates suggest bacteria outnumber



Ignaz Philipp Semmelweis

cells in our bodies by almost ten times; total cells in the human body is around 10 trillion, while that of bacteria living on and inside our body is 100 trillion, the far majority of them live inside our gut (intestine). Human gut alone harbours around 1,000 species of bacteria which together constitutes 100 times more genes than that of our own body cells. Many new species of bacteria are being discovered right from the human body many of which are being proven beneficial. Scientists call these normally living bacteria as “microflora” (in a strict sense, microflora is a misnomer as flora refer to plants; a vast majority of bacteria are non-photosynthetic), “microbiome” or “microbiota”.

Prevalence of C-section (Caesarean) deliveries in modern times has led to associated problems as well. As children born out of C-sections had never been exposed to the mother’s own natural microbial environment of her vaginal canal, these children’s microbial constituents tend to be drastically different from their mothers. Studies indicate that the risk of developing various ailments such as obesity, autoimmune diseases such as type-1 diabetes and allergic diseases such as asthma are much higher for children born out of C-sections than the ones born in normal deliveries.

Yet another problem of modern times is the unnecessary and prolonged use of antibiotics. The major impact of the indiscriminate use of antibiotics is that it not only kills the pathogens, but also the normal microflora. Injudicious antibiotic use led to the emergence of drug-resistant microbes, for example, Multi-drug-resistant tuberculosis (MDR-TB).

Many recent studies suggest that microflora is essential to maintain normal physiology of human bodies. When these microflorae are impacted, we get several diseases and most of these diseases were previously thought to be physiological or lifestyle diseases, with no involvement of bacteria. Recent research has revealed that change in gut microbiome constitution is involved with diseases such as cancer, heart disease, Alzheimer’s disease and diabetes.

The gut microbiome could change not only in response to antibiotic treatment but also in response to the kinds of food that we eat. For example, a landmark paper in 2014 published in Nature revealed that when subjects take artificial sweeteners or products having such sweeteners, it drastically changes the gut microbiome such that the subjects develop insulin resistance, the so-called Type-2 Diabetes. New research suggests that fibrous foods are generally good for the gut microbiome, compared to processed foods and refined carbohydrates. Periodic and

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New research suggests that fibrous foods are generally good for the gut microbiome, compared to processed foods and refined carbohydrates. Periodic and intermittent fasting has also been proved to be beneficial to maintain a healthy human gut microbiome.

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intermittent fasting has also been proved to be beneficial to maintain a healthy human gut microbiome. The vermiform appendix, a finger-like abdominal organ that was previously thought to be a vestigial organ (useful in past, useless now), is now thought to function as a refuge for several useful gut microbes. Its unnecessary removal, as practised by Antarctic expedition members before visiting Antarctica, might do us far more harm than benefits.

Perhaps you have heard the term ‘the gut feeling’, a feeling in our guts at times when we have an anxiety or psychological stress; expecting some bad news. But why gut? Common sense tells us that human emotions have more to do with our brains rather than guts. However, recent research has revealed a surprising connection between the gut microbiome and human behaviours. Studies have revealed how a change in microbiome causes a number of behavioural and psychological diseases,

including depression, ADHD (Attention Deficit Hyperactivity Disorder), amnesia, cognitive impairments, and autism. Signals from the human gut induced by its microbiome transmit directly to our brain via the vagus nerve.

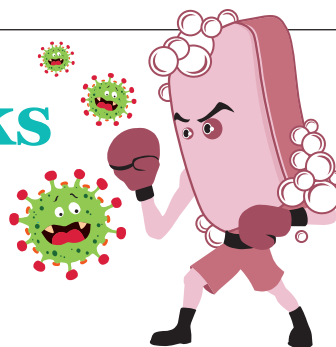
Reinstating lost microbiomes (for instance, in response to long-term antibiotic usage) is an active area of research in contemporary science. Probiotics such as curd and other supplements containing good bacteria had been proposed as one way to replenish the microbial flora. However, recent research suggests these are not as effective as earlier believed. A newer development is the introduction of faecal transplant; a transplant like any other organs. Faecal transplant is the transfer of stool from a healthy donor into the gut of the patient. However, legal and ethical ramifications of this procedure could be enormous.

All these findings point the finger in the same direction; over-sanitation is indeed highly detrimental to our bodies. As microbes do us more good than harm, blindly killing them all would remove many beneficial species, leading to the development of diseases. Bathing in an antiseptic solution or using a disinfectant soap would remove many good bacteria from our skin and thereby would effectively pull us back to the time of Semmelweis; those dark days of infectious diseases and high mortality rates. What we need is a fine balance; not too much a sanitation, not too little too, but just right. A good rule of thumb is to stick with Semmelweis’ original recommendation, good old handwashing with a soap and drying the hands on a towel (hand drying on paper or cloth towel is more effective than drying with electric hand dryers). We should also periodically emulate the life our great ancestors in African savannah had to go through; for example, barefoot running, intermittent fasting and so on.

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# How soap works in the defence against germs



This article tells us how a simple public health practice of handwashing with soap and water can keep us safe in many ways during outbreaks of deadly diseases.

Handwashing with soap and water is a familiar and common hygiene habit. The practice not only cleans our hands of the grease, grime and dirt but also keeps the germs at bay. It turns out that good old soap is an excellent ammunition to combat COVID-19 as well. Hence, the health advisories are promoting handwashing as a frontline defence in the battle against the novel coronavirus pandemic. Frequent handwashing with soap and water is said to cut the rate of the disease spread, thereby minimising the havoc it wreaks.

The coronavirus is a respiratory virus which spreads quickly through droplets expelled from sick people which settle on surfaces. When healthy people unwittingly touch these contaminated surfaces, the virus sticks to the hands and gains entry into the body through the eyes, nose or mouth (when touched). Once inside, it lodges itself onto respiratory cells, hijacks the cell machinery and replicates itself. Handwashing with soap and water goes a long way in breaking the transmission chain of the contagion – from surfaces to our body cells.

## The art of soap making

Soap is an age-old recipe of a mixture of fatty acids (either plant oils or animal fats) and alkalis called lye, a strong solution of sodium or potassium hydroxide in water. Although it appears simple, soap making is an art which requires right proportion of the ingredients to promote a chemical reaction called ‘saponification’. Saponification happens when fats are mixed with strong alkalis like sodium or potassium hydroxide. The strong hydroxides breakdown the hydrocarbon

chains of the triglycerides in the fats. The fats hydrolyse to form glycerol (alcohol), soap and water.

Different types of fats have different saponification values – the amount of lye required to yield good quality soap. Else, the soap can be harsh and irritate the skin.

There are different methods of making soap. A quick, commonly used way is the hot process. Here, the ingredients are mixed and heated to 80-100°C. The high temperature aids in saponification, along with evaporating the water in the mixture. The mixture is poured into moulds to cool. As soon as it cools down, the soap can be used. Most commercial soaps are made by the hot process.

In the cold process, the lye is mixed at room temperature with the oils for natural saponification to happen. The process is aided by continuously stirring the mixture. It is then poured into moulds to set. The liquid soap, called clean soap, takes a few weeks to solidify and cures as the water evaporates naturally.

In both the processes, the aromatic oils and moisturisers are added before the soap solidifies. The cold process is a long and arduous method as it takes a few weeks for the soap to cure and set; whereas, in hot process soap is ready in a couple of days.

In yet another method, the saponification occurs in two stages. In the first step, the fats are steam-hydrolysed to produce an intermediate acid (carboxylic

acid) and glycerol. In the next level, salts are added to neutralise the acids to produce soap. The two-step method is also time-consuming but has the advantage of a superior quality soap as the acids are purified in the first step before yielding soap. Several industrial applications such as lubricants and thickeners are used in this method for processing the specially formulated soaps.

## Soap bridges the gap

What happens when oil is poured over water? We all know that they don’t mix and there is a distinctly visible layer that separates the two liquids. A peek into the atomic level reveals the causes.

Water and oil are poles apart at the molecule level. Water is made up of two hydrogen atoms that bind with one oxygen atom. The outer electrons involved in binding of these atoms are such that there is an uneven distribution of electron density around them giving rise to what is called a hydrogen bond. The uneven chemical bond gives a ‘polarity’ to the water molecule, although overall, water does not carry



a charge. This charged state leads to an electrostatic attraction between the water molecules, which tend to huddle together into clusters. Also, it is this polarity that makes other substances dissolve in water.

On the other hand, the hydrocarbon molecules in oil are formed by chemical bonds, making them non-polar. Due to this non-polarity, oil repels water. It tends to clump together with other oil molecules forming a separate layer.

However, the presence of soap changes all that. Soap is an emulsifier, i.e., it is capable of dispersing or suspending immiscible liquids like oil in water.

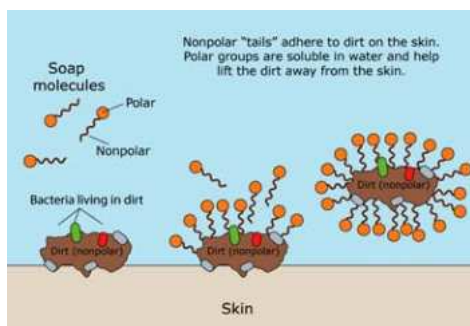
### The science of soap

Soap is a fatty acid salt and is found to be an amphiphile. That is, it is a combination of both polar and non-polar molecules, making it water-loving at one end. The other end repels water and is attracted to fats. Soap molecules are naturally-assembled nanoparticles with a unique structure resembling a pin or a lollipop. The 'head' part of the soap molecule is polar, charged, and hydrophilic; whereas the 'tail' end is non-polar hydrocarbon chain of the fats and hydrophobic. In the presence of water, the tails attract each other due to dispersion forces and form clusters called micelles. Together, micelles appear as spheres, with a negative charge on them. Due to the negative surface charges, the micelles repel each other, thereby remaining dispersed in water.

When soap molecules come in contact with grime, which is oily by nature, the tail ends within the micelles get attracted to the fats in the vicinity and move toward them. They cleave through the grease molecules, breaking them apart. The soil-bits get trapped within the micelles. When a surface or an object treated with soap is rinsed with water, the hydrophilic parts readily mix, thereby carrying with them the entrapped grime and washing them away.

### How soap works on germs?

Germs such as bacteria and viruses reside on surfaces in an inactive state and get transferred to our hands when we touch them. Dirt, soil and grime also trap germs within them. When soap comes in contact with soiled surfaces such as hands, the non-polar tails of the soap molecules swim toward the oily parts due to their nature. They



### A word of caution...

**A** quick wash with soap and water may not produce the desired results. The folds in our skin and between fingers are traps for grime and germs. Soap needs to penetrate well into these regions to be effective in clearing them. Also, soap needs a bit of time to tear the germs apart. So, 20 seconds of scrubbing – and vigorously, to dislodge the stuck-up grime from the folds – is the golden recommended rule. And, don't forget to towel dry the hands! Again, wet hands can transmit germs more easily than dry hands!

### Soap or sanitizer?

**A**ny day, soap is a better choice. Sanitizers are effective in killing the germs only when they have a high alcohol content (60-90 per cent). Moreover, sanitizers cannot remove grime. Sanitizers come in handy in places where there is no access to water to wash hands – such as public places or clinical setups, for a quick scrub.

wedge themselves in the dirt and grime and tear away scraps of the soil, which get enveloped in the micelle. The polar heads are away from this surface. While rinsing with water, the polar particles begin to attach themselves to the water molecules. In doing so, the grime is carried away along with the tail ends.

Most viruses have a protective coat of lipids or fats around their genetic material bound by a chemical bond. The fats not only shield and preserve the inner genetic material but also help in multiplying once the virus invades the host cell.

Viruses are also nanoparticles that self-assemble their basic units – RNA, proteins and lipids. In enveloped viruses such as the spherically shaped coronavirus, the RNA is covered by a thin twin lipid layer and spiky proteins that protrude from it. The spiky proteins anchor to the host cells. In this assembly, the lipid layer has the weakest chemical bond.

When viruses do not have a host cell to invade, they remain as assembled, non-living entities on surfaces. The viral lipids are similar to the hydrophobic fatty tails of soap. Hence, when we scrub with soap, the lipid-attracting rear ends immediately interact to the outer fat layer of the virus. The tails rip apart the lipid layer of the virus. When the outer layer gets broken, the virus becomes denatured. In other words, the nano-assembly is destroyed, in turn, annihilating the viral particle.

The soap micelles trap the bits of the viral particles, and when we rinse with

water, they get washed away. Hence, soap not only cleans our hands but is potent enough to destroy the viruses that stick to our hands. By frequently washing with soap and water, the viral transmission can be arrested to a large extent.

When the disease rate slows down, it ceases to overwhelm the medical services, thereby allowing them to provide attention to the needy patients.

So, be at it and wash your hands often. Stay safe!

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## The Myth of Immune-Boosters

**Artificial immune boosting may not be the right strategy to fight against COVID-19. Staying calm, maintaining social distancing and hygiene and using protective gear will help us in the long run.**

The human immune system (inherited from gazillions of its preceding species in evolution) consists of a rather well-endowed immune response network. A network composed of cells (neutrophils, eosinophils, T cells, B cells, macrophages, and other cells) and non-cellular molecules (cytokines, leukotrienes, enzymes, etc.) form a formidable resistance, which intensely and strategically defend the wonderful bulwark that the human body is. This network however is useful and wonderful so long as it starts and ends on cue and does not overstay its welcome or overdo what is expected of it. In other words, balance is the key.

“Immune boosting” would therefore mean artificially getting it all excited and ready to fight. Fight it must but only when it is necessary against a defined adversary, as much and as long as it requires to reinstate a desired state of health. Not

more. Not less. This well-orchestrated response by a disciplined battalion of the immune army requires a band of well-trained scouts, elite strategists, and some seriously effective mobilisation of foot soldiers (granulocytes), mounted soldiers (antibody-dependant cell cytotoxicity), archers (inflammatory mediators and their receptors), powerful cannons (histamine, bradykinin), missiles (IL-6, IL-1, TNF- $\alpha$ , IFN- $\gamma$ , chemokines), and target-locked nukes (antibodies). This arsenal in the immune repertoire (as is apparent from the analogies) must be kept under check. If not, tremendous and uncontrolled bombardment by its own defence system shall devastate the body’s ramparts (auto-immune response).

We do not want that to happen under any circumstances because that will be disastrous!

Now, to define “boosting” we revisit the original task, that of keeping the

body in a state of preparedness but not draw first blood. Thus, (i) a “well-oiled” group of scouts (cells that are part of the first line of defence in our innate immune network and generally shoot from the hips but do manage to come back with useful information about a novel enemy) must be maintained such that even if an insidious attack is able to breach the body’s security system, it will not be allowed to penetrate too deep; (ii) the level of co-ordination among this network of immune players (innate and acquired immunity, long-term and short-term immunity, memory-directed immune stratification and new game plan against an unforeseen intruder) must be clear and specific such that no confusion (usually created by an intruder to set off false alarms) maybe unduly provoked. Thus, no immunosuppressant, no immunedepletion to red herring signals staged by sneaky pathogenic microbes maybe unduly evoked; and (iii) when the time comes, action is swift and lethal and cleanly eliminates the intruder.

At last we come to the main point of this long prologue—SARS-CoV-2 and its pet scourge COVID-19. SARS-CoV-2 enters the human cell via a membrane-bound enzyme angiotensin converting enzyme 2 (ACE-2) and a transmembrane serine protease 2 that its spike protein combines efficiently with to initiate a smooth endocytosis reaction and the viral payload gains unobstructed entry into the cell. The receptor-binding spike making up its corona is the key to the host cell’s aforementioned lock. The droplet-borne virus enters through the lung and quickly infiltrates circulation via its chosen portal and spreads systemically.

ACE-2 being a blood pressure regulator, for the host humans, COVID-19 that may start with all the hallmarks of pneumonia, quickly and silently takes over multiple organs entering their cells via the endothelial lining of blood vessels, all of which express its chosen receptor protein. And all hell breaks loose! A severe “cytokine storm” starting with low levels of IFN- $\gamma$  and high levels of IL-6, TNF- $\alpha$ , IL-1 $\beta$ , CCL2, CCL3, CCL5 in huge amounts like a tsunami of powerful missiles by the body’s own defence



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system completely overwhelms the immune system. This is what kills us—a total failure of our espionage system (scout cells), all the trained commandos, the diplomats, the strategists, and the entire security is breached and arson of the main weapon’s manufacturing units of the body leads to mayhem. Complete immune depletion due to foolish and explosive squandering of precious defensive resources turns into our own nemesis. And a final fatal blow jeopardises the thing called life from the poor human host.

Thus, immune boosting, I feel, maybe accomplished simply by leading a balanced life—good nutrition (building, repairing and maintaining all the important faculties of the body and not just the immune system since it is not an isolated one), optimum and enjoyable activities (moderate exercise such as walking, swimming, yoga, pranayam and intellectually or creatively stimulating tasks that generate the happy 'hormones') and sufficient and quality sleep (that recharges, replenishes and regenerates the expenditure in the aforementioned enterprises).

Ayurvedic knowledge (curcumin

in turmeric, fisetin in apple and strawberry, piperine in black pepper, etc.), local and seasonal food (raw fruits and coloured vegetables high in flavonoids, phenolic compounds rich in anti-oxidants), clean lifestyle sans the redundant practices (avoiding nothing but excess), and effective armament (of offensive attack against the infectious agents) supplemented by western medicine (antiviral drugs such as avifavir, ritonavir, remdesivir, and others like hydroxychloroquine and azithromycine combination therapy, convalescent plasma therapy, intravenous immunoglobulin (IVIG) by recombinant DNA technology and support from ventilator, extracorporeal membrane oxygenation (ECMO) and excellent supportive care) may yet save us even if that wicked and troublesome rogue virus the SARS-CoV-2 manages to gain entry. A vaccine (such as Moderna’s mRNA1273 or Oxford University’s ChAdOx1, which are in various stages of clinical trial) may take long to come and offer a shield against COVID-19.

And while we are at it, may I warn against frivolous advertisements claiming immune boosting because

there is nothing to gain from a “boosted” immunity other than expediting and intensifying a pro-inflammatory disease like COVID-19. We do not want our immunity to be unnecessarily boosted. We want it to stay calm and in a state of preparedness so that it will not be fooled and respond to provocation and spend itself unnecessarily. We want the casualties of war (immune maintenance and immune surveillance circuits) to be efficiently replenished, replaced and regenerated and rejuvenated to remain healthy and balanced. We want capacity to generate and maintain a diverse immune weaponry, not necessarily in a state of preparedness but skilled and fit and there in case they are called into action. And most importantly, we want the regulatory mechanisms to remain alert and effective such that even if we need to go into a well-thought-out war (innate and acquired immunity including but not limited to inflammation and T and B cell-mediated cytotoxicity or humoral response, the designated cells with very specific and specialised immune functions, signalling peptides, receptors that regulate intercellular cross-talk, etc.) they are efficiently regulated and brought down to normal levels when it is over.

Thus, balance is the key to a healthy ability to mount anti-viral immunity, rather than “boosting” it. I’d say, stay calm, stay safe, and stay alert, but most importantly, stay clean (social distancing, protective gear, hygiene) and “immune boosting” or not, we shall be able to keep the COVID-19 at bay.

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## INBOX



### Watching of Solar Eclipses

June Dream2047 issue on Annular Solar Eclipse was such a welcoming change, when we could read such beautiful articles on solar eclipse. All the articles were informative and interesting. It is wonderful to note how far we have come from watching movies on Doordarshan (we watched Pather Panchali in Kolkata Doordarshan!) instead of watching a Total Solar Eclipse in 1980 to preparing well in advance for an Annular Solar Eclipse! Hope

we all march forward with the same scientific temper in future.

**Ambarish Roy, Bankura**

### Activities for watching ASE

The activities described in the article were extremely interesting yet easy. Are these available in a kit form so that we can preserve them and carry out experiments later with a group of children? Also, do you have more such kits which can be used for conducting science experiments and exhibitions?

**Hrishikesh Senapati, Nagpur**