



# DREAM 2047

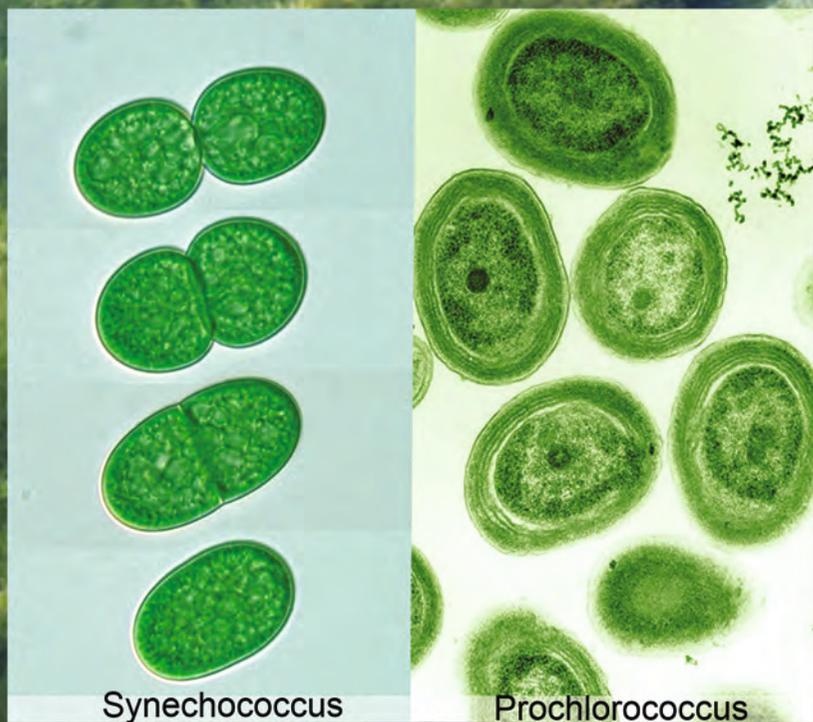
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## Two Key Organisms that May Save the Earth



Synechococcus

Prochlorococcus

<i>Editorial: Silver Jubilee of a Novel Activity to Groom Budding Scientists</i>	35
<b>Dr. L.A. Ramdas – Father of Agricultural Meteorology in India</b>	34
<b>Two Key Organisms that May Save the Earth</b>	32
<b>Tobacco – A dangerous companion: Say NO to tobacco in any form</b>	29
<b>Irritable bowel syndrome — Causes, triggers, red flags and more</b>	25
<b>Recent developments in science and technology</b>	21

... think scientifically, act scientifically... think scientifically, act scientifically... think scientifically, act...

# Silver Jubilee of a Novel Activity to Groom Budding Scientists



**Chander Mohan**

Children's Science Congress (NCSC) is a novel pan-India initiative of Government of India for students in the age group of 10 to 17 years which was initiated in 1993 with an aim to provide a forum to budding scientists to pursue their natural curiosity and quench their thirst for creativity by experimenting on open-ended problems using the method of science. It provides a unique opportunity for children to use their knowledge, skills and scientific temper to undertake hands-minds-on projects and thus give wings to their creativity & innovation.

The main objectives of CSC, a prestigious program of National Council for Science & Technology Communication (NCSTC), Department of Science and Technology (DST), is to relate learning of science with the environment around by encouraging children to understand its challenges and help them find feasible solutions and in the process stimulate scientific temper. Its basic tenets thus are the use and internalisation of the method of science, which encompasses observation, collection of data, experiments and analysis and then arriving at conclusions.

Every year, the CSC program starts from the District level and some of the

selected projects then participate first at State level and subsequently the best are presented at the National Children Science Congress, which is held during 27-31 December. After a thorough scrutiny at district and state levels, about 700 children take part in this five-day long deliberations and fun-filled science activities. The program entails close and keen observation by the child scientists, promotes raising pertinent questions, making models and predicting solutions, trying out various possible alternatives and arriving at optimum solution using experimentation, field work, research and innovative ideas. It also emboldens the participants to question many aspects of our progress and development and express their findings, even in vernacular.

Every year, at least half a million students take part in the three stages of the CSC and over 100,000 teachers guide & mentor these students in their projects. The content and methodology helps the students and teachers to create a culture of research at the school level. For last couple of years, the students and teachers of SAARC and ASEAN countries are also participating in it. In NCSC, students can present their projects in vernacular and

not just English and Hindi, which were earlier the only languages of presentation. NCSC has so far covered 13 focal themes with topics like Environment, Nutrition, Clean-up India, Water Resources, Biodiversity, Land Resources, Energy, Weather and Climate, etc., during its 25-year journey

The National Children's Science Congress of 2017, held in Gandhinagar from 27 to 31 December marked the Silver Jubilee of the annual event. The focal theme of this marquee event was "Science, Technology and Innovation for Sustainable Development: With special focus to Accessibility for Persons with Disabilities". It was organised in Science City by DST through the aegis of Gujarat Council of Science & Technology (GUJCOST) and Department of Science & Technology, Government of Gujarat.

Let us all continue to celebrate this novel event by initiating and egging on the budding scientist in every child around us so that we can steadily build an India which has a strong foundation of scientific temperament.

Email: [chander.m@nic.in](mailto:chander.m@nic.in) ■

*Editor* : Chander Mohan  
*Associate editor* : Rintu Nath  
*Production* : Manish Mohan Gore and Pradeep Kumar  
*Expert member* : Biman Basu  
*Address for correspondence* : Vigyan Prasar, C-24,  
 Qutab Institutional Area, New Delhi-110 016  
 Tel : 011-26967532; Fax : 0120-2404437  
 e-mail : [rnath07@gmail.com](mailto:rnath07@gmail.com)  
 website : <http://www.vigyanprasar.gov.in>

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# Dr. L.A. Ramdas – Father of Agricultural Meteorology in India



*N. Manikandan and Dr. A.S.R.A.S. Sastri*

*Dr. Ramdas is well known for discovering the atmospheric phenomenon of the ‘Ramdas Layer’ or lifted minimum temperature. Ramdas along with his colleague Atmanathan, published a paper in the German journal ‘Beitrag Zur Geophysik’, reporting that in the winter season (in India) the ground is at a higher temperature than the air immediately above (20-50 cm) during clear nights. The phenomenon was replicated in other countries by several scientists in the succeeding decades.*

Dr. L.A. Ramdas was an Indian physicist and meteorologist and one of the cult figures in the fraternity of agricultural meteorology in India and as well in the world as a whole. He was born on 3 June 1900 at Palghat, Kerala. He did his graduation in physics and began his career as a research scholar during 1923-1926 under C.V. Raman and discovered the phenomenon of the “scattering of light by pure liquid and sound surface”. Ramdas conducted several fundamental investigations on surface phenomena, scattering of light by gases and other optical phenomena. He got his doctoral degree in physics from Calcutta University in 1928 for recording the Raman Effect for the first time in ether vapour.



*Dr. L. A. Ramdas (Courtesy: <http://photodivision.gov.in>)*

Dr. Ramdas joined as Assistant Meteorologist in India Meteorological Department (henceforth IMD) in 1926 at Shimla. During his initial period of service, he did research in the field of aviation meteorology and micro-climatology – an unfamiliar subject at that time. He also worked in Karachi (then part of India and now in Pakistan) and Alipore (Kolkata) before coming to Pune in 1931.

In 1932, on the basis of recommendations by the Royal Commission on Agriculture, Indian Council of Agricultural Research (ICAR) initiated the scheme of agricultural meteorology, a very new research field. Dr. Ramdas, began his project on “weather in relation to crops” under this scheme. This project later transformed into “Agrimet” division of IMD, and India became one of the few countries in the world where exclusive research set-up was available in agricultural meteorology. Dr. Ramdas was actively involved in fundamental researches in micro-climatology, crop climate, thermal and moisture balances near the ground and statistical research in crop-weather



*Headquarters of IMD Agrimet Division, Pune (Courtesy: IMD, Agrimet website)*

N. Manikandan is Scientist (Agricultural Meteorology), ICAR-Indian Institute of Water Management, Bhubaneswar, Odisha.  
Email: metsate@gmail.com

Dr. A.S.R.A.S. Sastri is retired Professor (Agrometeorology), College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh.

relationships. Because of these works in this less known field of agricultural meteorology, he became famous internationally and his studies were extensively cited in Rudolf Geiger's monumental work "The climate near the ground". The results of his meticulous research have been discussed in more than 250 original papers and reports which have won laurels for India, a leading country in agricultural meteorology.

Dr. Ramdas in his communication to the *Current Science* journal (January issue, 1933) narrated how the "Agrimet" division in IMD had started. According to him, Dr. C.W.B. Normand, the then Director General of Observatories in India attended the International Meteorological conference at Copenhagen and the conference of Empire Meteorologists in London during 1931. In both the conferences, agricultural meteorology was one of the subjects for discussion. After returning to India, he discussed the issue with Imperial Council Agricultural Research and submitted

a scheme on agricultural meteorology on the basis of the recommendations made by the Royal Commission on Agriculture in India. This scheme was sympathetically considered by the Council and official sanction was given during 1932 for a period of five years. Unfortunately, the scheme had to be held up owing to the retrenchment campaign of the then Government of India and it was decided that instead of postponement, the scheme be reduced to three years and budget allotment was curtailed by half. Finally, the new branch of agricultural meteorology began functioning in August 1932 at the Meteorological Office, Pune.

The major contributions of Dr. Ramdas for development of agrometeorology in India include the following:

- Setting up of agrometeorological observatories in a farm environment for recording observations of interest to agriculture and recording the data manually at 0700 and 1400 hrs LMT (Local Mean Time).
- Adoption of 'Standard Week' as the time unit for agrometeorological work in India.
- Commencement of weather services to farmers in the form of "Farmers' weather bulletin" in the year 1945.

- Preparation of crop-wise, region-wise crop weather calendars.
- Development of gravimetric and volumetric lysimeters for daily measurement of evapotranspirational losses of both aerobic and anaerobic crops.
- Commencement of All India Coordinated Crop Weather Scheme



*Dr. L.A. Ramdas (sitting fourth from right side) with participants of the first session of Commission for Agricultural Meteorology held at Paris during 3-20, November 1953 (Courtesy: WMO Report No 999 on first fifty years of Commission for Agricultural Meteorology)*

covering rice, wheat, jowar, cotton, and sugarcane crops.

- Designing of sampling procedure for recording observations on crop attributes at weekly intervals.

### Discovery of Ramdas Layer or lifted minimum temperature

Dr. Ramdas was well known for discovering the atmospheric phenomenon of the 'Ramdas Layer' or lifted minimum temperature. In 1932, Ramdas along with his colleague Atmanathan, published a paper in the German journal '*Beitrag Zur Geophysik*', reporting that in the winter season (in India) the ground is at a higher temperature than the air immediately above (20-50 cm) during clear nights, based on the observations taken at four locations, viz., Pune, Agra, Madras, and Bhadrachalam (Andhra Pradesh). The results of their work were doubted and it was believed that the temperature at night is lowest at the ground and increases with altitude.

The phenomenon was replicated in other countries by several scientists in the succeeding decades. Interestingly, the most convincing observations came again from India and were published by Klaus Raschke

in 1957, a young German agronomist who spent three years with Ramdas in Pune on scholarship. From his observations the existence of the Ramdas Layer was established beyond doubt. The phenomenon is attributed to the interaction of thermal radiation effects on atmospheric aerosols and convection transfer closer to the ground.

### Later stages of service

In 1953, Dr. Ramdas became Deputy Director General of Observatories (Climatology and Geophysics) at the Meteorological Office, Pune and he had to look after the climatological, geophysical and agricultural meteorological programmes of the IMD. During this period, he also was made the Head (Director General of Observatories) of the IMD for a short period.

Dr. Ramdas was a fellow of the National Institute of Sciences of India (later changed in to Indian National Science Academy in 1970).

He was also President of the physics section of the Indian Science Congress. He was member of many international scientific societies, and attended many seminars/conferences as a delegate from India. In 1951, he participated in the ninth Assembly of the International Union of Geodesy and Geophysics at Brussels as chief delegate of India. He was a member of the Radiation Commission of the IUGG (International Union of Geodesy and Geophysics). He presided over the committee which dealt with all technical and scientific issues of the first session of the Agricultural Meteorology Commission (CAGM) of the World Meteorological Organization (WMO) during held in November 1953 in Paris. In this session, he acted as chairman of scientific and technical matters and presented a report on progress of agricultural meteorology in India. He was invited by the UNESCO to take part in the Symposium on Arid Zone Climatology with special reference to microclimatology, which was held in Canberra, Australia in 1956.

Dr. Ramdas retired from IMD in 1956 and after retirement he worked at National

*Continued on page 19*

# Two Key Organisms that May Save the Earth



*Felix Bast*

*Single-celled marine cyanobacteria commonly found in the world's oceans Prochlorococcus and Synechococcus are the key to all the life forms in the Earth. If these two picoplanktons perish, all aerobic organisms including us will be asphyxiated to death in a short period. These picoplanktons convert atmospheric CO<sub>2</sub> into the food that feeds the whole marine ecosystem. Increased CO<sub>2</sub> in atmosphere and associated global warming are threatening these two key organisms to perish. How to save these two key organisms?*

When I say a word like “environment,” or “plant,” what is the first image that comes to your mind? A nice park or garden full of green vegetation, a forest with rich canopy and tall trees, or a panorama of landscape with forests, mountain, and a flowing river ... Yes, that is the mental imagery that most of us subconsciously construct about the world of plants. We all know how important the trees are; they photosynthesise to make the food that we eat, and also release the oxygen that we inhale. We plant trees on special occasions like every 5th of June, the World Environment Day, to affirm our allegiance with environmental consciousness (but sadly, everyone forgets about them soon afterwards, and they would discover dead saplings in the next year!) In my science outreach talks to students and common people on this subject, I ask the audience at first to name the tallest tree in the world. Many of them in unison would answer ‘Giant Sequoia’ or ‘Californian Redwood Tree,’ jubilantly of course! Sequoia is the reigning king of plants; even a primary school student has heard its name as it often appears in quizzes. I would then ask, what if every single tree in the world (of which around 60,000 species are documented to date) including those giant sequoias perishes? We all will die because of no oxygen, right?

Wrong. Before I elaborate on this, let me share how my typical day begins. I wake up and spend a minute or two meditating; I practice a form known as ‘compassion meditation’ (alternatively called ‘loving-kindness meditation’). Many peer-reviewed

psychological studies have shown that empathy and compassion are two essential skills that one should possess to foster emotional intelligence and overall well-being. Compassion meditation is in fact very simple and straightforward; anyone can do this by thinking of something or someone that you are thankful about and expressing our gratitude towards the person or thing.

These days when I practise compassion meditation in the morning, I think of two very small beings, and I profusely thank them—for without them, there won't be any life (forget humanity!) on planet Earth. Two diminutive, inconspicuous critters that no one knows or bothers about; these are single-celled marine cyanobacteria commonly found in the world's oceans: *Prochlorococcus* and *Synechococcus*.

Let's return to our earlier petrifying proposition; what would happen if all of the world's trees and forests perish? The impact would be enormous for sure; as the whole wildlife and forest ecosystem is dependent upon trees and other green plants. However, destruction of forests is unlikely to wipe out humanity (at least for a few years); we would be just fine as long as crop plants support us with food. How about oxygen? This might surprise you; contribution of trees and the world's forest ecosystem for oxygen in the air is in fact very minimal (approximately 5%); the vast majority (around 80%) of oxygen in the air is produced by marine algae, amongst which the two abovementioned species alone contribute up to 65% of the total oxygen in the atmosphere. Now, perhaps you will

Dr. Felix Bast is a popular science writer and a scientist based at Central University of Punjab, Bathinda, India. His new book *Voyage to Antarctica* is expected to be released later in 2017. Email: felix.bast@gmail.com

appreciate the quantum of help that these minuscule plants do for us and all life forms on Earth. If these two picoplanktons (floating microscopic plants), namely *Prochlorococcus* and *Synechococcus* perish, all aerobic organisms including us will be asphyxiated to death in a short period, as we all depend on oxygen in the air to 'burn' the food and produce energy. There might be survivors even in this doomsday, of course; a very few organisms—especially bacteria and very small marine sediment-dwelling animals called "Loricifera"—which are anaerobic and can survive a world without oxygen. Except for these Lilliputians, life on Earth will be gone without the giant oxygen generating natural factory on Earth run by *Prochlorococcus* and *Synechococcus*.

These two wonder organisms are cyanobacteria, a subgroup of single-celled bacteria. It was only cyanobacteria like these two species that pumped oxygen into the early anoxic atmosphere of our planet's early history, around 3.8 billion years ago. The oldest known fossils in the world, known as stromatolites (around 3.7 billion years old), are nothing but layers upon layers of these oceanic cyanobacteria that later turned into rocks. Cyanobacteria are indeed a kind of bacteria, and most bacteria live in nature in so-called biofilms. Ever felt a slimy layer down the walls of our buckets—that we left with some water in it—after a vacation? That indeed is biofilm. Now you got the idea!

*Prochlorococcus* and *Synechococcus* are abundant in the world's oceans; these can be found virtually everywhere from the Arctic, through the tropics, up to the Antarctic Ocean. These are found only on the sea surface though. Wonder why? Obviously, picoplanktons are photosynthesising organisms and need sunlight to live! Sunlight can penetrate only the first 200 metres down the ocean surface; if one can dive that deep using SCUBA and special dive-suits to protect from immense pressure (the deepest verified dive till date is 332 metres), one will see nothing there but pitch darkness—a region known as the dysphotic zone. This dark, abyssal zone extends all the way down to the seabed—deepest point of which is Challenger Deep of Mariana Trench at 10,916 metres, off the coast of Japan. Ironically, instead of diving that deep, if we decided to fly up in a rocket to outer space like Rakesh Sharma did in

1984, the situation is similar; it is pitch dark there too!

Because Earth's surface is mostly water (around 71%) and as these picoplanktons are abundant in the surface layers of oceans, their contribution to oxygen generation can be easily surmised. However, these two key plants remained elusive to the humanity; most of us may not have heard these names before. Many participants in my outreach talks say the name *Prochlorococcus* is a tongue-twister for them, like the sentence 'she sells seashells on the seashore'! By the way, the person who invented seashell tongue twister also happens to be a palaeontologist, Mary Anning by name! Wonder why no one heard of these little plants while everyone heard of sequoias?

There are some biases that our intellect subconsciously and covertly resorts to that our conscious self is unaware of – the so-called cognitive biases. One among the well-known cognitive biases is called 'confirmation bias' in which we recall, look-up or interpret information in such a way that confirms our pre-existing beliefs or notions. Suppose you are a vegetarian; would you enjoy reading articles or watching any TV programs that explains why human beings have never been a vegetarian in our evolutionary history? Rather, you will look up and enjoy reading articles that explains why being a vegetarian is a healthy choice and why it is good for the environment. Vegetarian or nonvegetarian – we all live on this planet Earth – our only home, and we all love this home. Would you like to read an article that says the Earth is not that important; it is merely a planet revolving around the Sun? In fact, no one listened when Aristarchus first objected to the geocentric system (where the Earth is the centre of the universe) in 280 BCE. Religious intolerance was so extreme in the Middle Ages that Aristarchus was dismissed as a heretic and his claims nonsensical until Nicholas Copernicus for the last time proved that Aristarchus was right all along and the Earth was merely a planet in solar system and revolved round the Sun. In other words, humanity was under the clutch of confirmation bias throughout the Middle Ages until Copernicus made us aware of our bias.

Similar had been the case before Darwin published his *Origin of Species* in 1859. When his theory of evolution through natural selection dismissed human beings

as one mere animal amongst ten million other species currently living on planet Earth, humanity was furious (many are still; for example, Turkey recently banned teaching Darwinism in schools). Because we are human beings, we tend to consider ourselves the reigning king of all living things. This human-centric worldview, the so-called 'anthropocentrism', is in fact a subset of confirmation bias. Similarly, it just so happens that we are a land-dwelling species and naturally, we want to declare that land-dwellers rule the world. Like the proverbial frog in a well, we believed that Earth is all land, and the watery part of it was inconsequential.

Departments of Botany (or Plant Sciences) exist throughout world's universities and colleges. Surprisingly, almost the entire resources – faculties, research projects, etc., are mainly concerned with land plants, especially agriculture, for it gives the food that sustains us. How many of these departments have faculties working on marine botany – scientists working on those tiny, inconspicuous plants mentioned above? Probably very few. People working on cyanobacteria and algae are called phycologists (discipline is phycology), and in India there are around 20 living phycologists who have made significant contributions to the discipline, myself included, an endangered 'species' indeed! A consensus among the scientific community is that we now know more about the Moon than our oceans. This is all because of confirmation bias of anthropocentrism and madness after scientific disciplines that are 'applied.' This madness after utilitarianism, the selfish quest on how it will improve survival and reproduction of one lone species by the name of *Homo sapiens*, is the cause of all the troubles. Science had originally been curiosity-driven (not utility-driven), and the basic sciences like evolution, taxonomy, phycology, mathematics, astronomy, etc., remain curiosity driven. The significance of marine botany is indeed tremendous to the whole humanity and life on Earth because algae produce most of the oxygen that we all breathe and our breath is as essential as our food for the sustenance of our life!

That leads to the other side of the coin; an equally important side. The two organisms we have been talking about account for the vast majority of CO<sub>2</sub> fixation on planet Earth – around 65%. Along with

other phytoplankton communities, these plants convert atmospheric CO<sub>2</sub> into the food that feeds the whole marine ecosystem. In fact, phytoplankton are at the base of what scientists refer to as oceanic biological productivity. Small marine insects called zooplanktons feed on these algae, which, in turn, get sequentially fed by larger fishes... the pyramid extends all the way to sharks and whales (technically whales are not top predators; they eat small crustaceans called krill, which feed directly on algae and picoplanktons). Therefore, if these two species are gone, the ocean would become barren and lifeless! Picoplanktons and other algae fix a lot more CO<sub>2</sub> than what is required to sustain the life in world's oceans, and the rest simply sinks down when they die, and their cadavers pile-up on the ocean bed. In the past, over millions of years, these sunk cadavers, full of fixed atmospheric carbon, got compressed and turned into a stinky black fluid. The black fluid the whole humanity (no, not any other species) is currently dependent upon is the "black-gold" – crude oil, and its refined cousin petroleum fuels. Next time you smell that typical smell of petrol at a petrol pump don't forget to remember these two species, as what you smell is nothing but their dead bodies! You smell nothing but fossils – fossilised cadavers of these two key organisms mostly. Thus "Fossil Fuels"!

In Earth's history, we are in an extraordinary time; never in its 4.543 billion-year-old history has the smell of petrol ever been sensed by any living creature. The times were good back then when the so-called global carbon cycle was going on smoothly. Excess CO<sub>2</sub> in the atmosphere (most of which were produced when a volcano erupted) could easily be fixed by the picoplankton, and the carbon thus removed from atmosphere got sunk deep down to the oceanic abyss with their dead bodies. This 'fixing' of excess CO<sub>2</sub> in the atmosphere is what is technically called "carbon sequestration" and vast majority of carbon sequestration in the world is done by these two algal species.

The cycle was smooth indeed, until the 18th century when the use of coal as a fuel in England gave rise to what we refer to as the 'industrial revolution'. As we know, coal is fossilised plants that had lived millions of years ago and had accumulated carbon through photosynthesis. Like picoplankton,

trees and large plants also sank to the ocean floor when they died and turned into coal over millions of years, which we are mining now.

When we burn a fossil fuel such as coal or petroleum the carbon trapped in the fossils are released into the atmosphere leading to a net rise in carbon dioxide in the atmosphere. Whenever we burn a fossil fuel, we must remember that each molecule of carbon that is being released as CO<sub>2</sub> or CO (carbon Monoxide) had originally been fixed by green plants and phytoplankton millions of years ago. Thus burning fossil fuels wreaks havoc on the global carbon cycle, as the huge amounts of CO<sub>2</sub> released by burning fossil fuels are too much for the two key species of phytoplankton to fix. As a result, excess CO<sub>2</sub> started building up in the atmosphere. The consequences were immense. The continuum of this story from this moment onward is well known – rising CO<sub>2</sub> levels in the atmosphere, climate change, global warming... we all know. However, is it the total picture?

Unfortunately, most of us are unaware of the most dangerous consequence of the rising CO<sub>2</sub> levels. No, it is not global warming. The effect is more a subtle chemical phenomenon. Ever had sparkling water, the soda? It is nothing but CO<sub>2</sub> dissolved in water. When you mix CO<sub>2</sub> with water, some of the CO<sub>2</sub> molecules react with water molecules to form carbonic acid. The same process happens on the surface of world's oceans too; atmospheric CO<sub>2</sub> gets dissolved into the ocean raising the acidity of oceans. Acidity is a problem, be it in your stomach (ever had antacid?) or in the ocean. In the ocean, it kills algae including our two key species. That is the end of our story, unfortunately, the doomsday, for without them there would be no aerobic life on Earth. Effect of rising acidity in world's oceans is a well-known phenomenon over the last two decades, a phenomenon known as 'ocean acidification.' Rising acidity has already killed most of the tiny algae called zooxanthellae that live inside coral reefs. Coral reefs are, as you might already know, a symbiont; it is a part animal (cnidarians) and part plant (the algae). The animal houses these algae, and algae supplies the animal with food; a good combination. It is like a rose and butterfly; quid pro quo. (Flowers like roses are benefitted from pollinators like a butterfly for transfer of pollen from

one flower to another. For this favour, flowers 'bribe' the pollinators with what the insects love most, the nectar.) Rising acidity in the world's oceans was, unfortunately, very bad for these dinoflagellate algae – partners of corals. Algal symbiont started dying, and corals started dying too, a phenomenon known as coral bleaching (for a diver's perspective, corals turn from a vivid technicolor to a hazy white.

We all are aware of the rising atmospheric temperatures, but ever wondered where most of this temperature goes? No. Not to outer space, for space has got no gases to store this energy in its molecules. It is now confirmed beyond any doubt that most of it is absorbed by the world's oceans, and that leads to rise in ocean temperature. Now it is a double whammy; acidity and high temperature!

As of this writing, most of the corals of our Lakshadweep Islands have already been bleached to a hazy white blob and are no more attractive to divers. The Great Barrier Reef off the Australian northeastern coast – the world's largest coral reef system – also had gone awry, making them unattractive to divers. Diving for oceanic life is "on the verge of extinction" (other than at a few clandestine spots!) With algal partners mostly gone all because of this double whammy of rising ocean acidity and ocean temperature, next on our hit list is, as most of the phycologists agree, our two key picoplankton species. The clock has started ticking almost a century ago, and we are in the final stages, even when looking through my too optimistic, too positive glasses of wisdom. I can guess your question, the final question, how to save them?

Unfortunately, we cannot plant them on World Environment Day. We cannot water them, or put some organic manure, for phytoplankton needs none of it. As if a recalcitrant, 'difficult' personality! We have only one solution; the solution that I learned during my PhD time in Japan can be abridged to three R's: Reduce, Reuse and Recycle. As the big data and statistics say, the most important conscious life decisions that we can adopt to fight the climate change can be summarised as follows:

1. Refrain from, or reduce, international air travel, as per capita CO<sub>2</sub> emission is the highest for such air travels.

*Continued on page 22*

# Tobacco – A dangerous companion

## Say NO to tobacco in any form

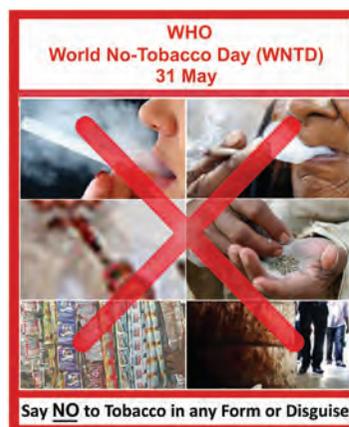


*Dr Man Mohan Singh*

*Smoking accounts for more than 30% of all deaths from cancer, almost 90% of deaths from lung cancer and about 75% of deaths from chronic bronchitis and emphysema. Passive smoke is considered more dangerous than active smoking, because one could inhale toxin deposits of the smoker(s). Non-smoker(s), who live with smoker(s) and inhale passive/environmental tobacco smoke, even though they may never have smoked a single cigarette, increase their risk of lung cancer by 20-30%.*

Tobacco is the leading preventable cause of death and disability, killing nearly 6 million people each year worldwide, which is more than combined deaths due to tuberculosis, HIV/AIDS and malaria, with 50% of these occurring in just four countries: China, India, US and Russia. According to WHO estimates, every 5-6 seconds one person dies due to tobacco use, people initiating tobacco use during their young years and continuing for two decades die 20-25 years earlier than non-tobacco users, and there were 100 million tobacco-related premature deaths globally during 20th Century and if this trend of tobacco use continues, the number is expected to rise to approximately one billion in 21st Century.

India is second largest consumer of tobacco globally and accounts for approximately one sixth of world's tobacco-related deaths. Hefty taxes levied on tobacco products, while may have generated some revenue for health and development work, has by-and-large not been consequential deterrent to tobacco consumption. In fact, India's tobacco problem is complex and unique with uncontrolled availability and



*WHO - 'World No-Tobacco Day' held every year on 31 May since 1989*

use of variety of smoking (cigarette, *bidi*, cigar, *hookah*, *chillum*, pipe, etc.) as well as an array of smokeless tobacco products (*zarda*, *kimam*, *khaini*, *mawa*, *naswar*, *gutkha*, *pan masala*, betel quid, etc.), many being manufactured in cottage/small-scale industries and even in unrecognised sector. These products are available over-the-counter and through online purchase, and there is significantly higher prevalence of tobacco use among rural population, slum dwellers, and older age groups. Since 1989, 'World No-Tobacco Day' is being observed on 31 May to stress on the ill effects of tobacco use on health.

### Tobacco use

Tobacco was originally thought to have medicinal qualities and continues to be referred to as 'Forgotten healing plant' in some texts, but there were some who considered it evil. Over time, people and scientists understood its harmful effects. Of the total annual production of tobacco (about 800 million kg) produced in India (second largest after China's 2,800 million kg), about 48% is used as chewing tobacco,

Dr. Man Mohan Singh was formerly ICMR Emeritus Medical Scientist, Chief Scientist & Head, Endocrinology Division, CSIR-Central Drug Research Institute, Lucknow, and Director R&D, Saraswati Dental College, Lucknow. Email: singhmm46@gmail.com.



Tobacco cultivation and curing of leaves

38% as *bidis*, and only 14% as cigarettes; *bidis* and chewing tobacco forming bulk (86%) of India's tobacco production. In comparison, in the rest of the world, production of cigarettes is around 90% of total production of tobacco-related products.

## Smoking tobacco

According to Global Burden of Disease study published in *Lancet*, India was among top 10 countries accounting for almost 2/3rd (63.6%) of tobacco smokers in 2015. According to a recent WHO report, tobacco sends \$1 trillion up in smoke every year. Tobacco smoking in any form poses significant health risk depending on dosage: risk being greater for those who start smoking earlier in life, smoke for more number of years, smoke more cigarettes/ any other smoking form (especially with higher tar content) per day, smoke for longer durations and inhale more volume of smoke.

Tobacco products being one of two categories (other being alcoholic beverages) exempt from labelling, their ingredients are usually laden with more than 600 intentional additives, though approved for use by FDA-GRAS, but not in products intended to be burnt/inhaled, as burning may alter these additives into potentially harmful/carcinogenic products.

## Smoking tobacco forms

Cigarettes are made out of cut processed tobacco leaves with white paper wrapping.

Historically, while West Indians, Aztecs and Mayans had used hollow reeds/canes/maize to fashion cylindrical tobacco-holders, an Egyptian artilleryman during Turk/Egyptian war is credited with inventing cigarette as we know it today. It is said that during siege of Acre (1799), Egyptian cannon-crew had improved rate of fire by rolling gunpowder in paper tubes and were rewarded with a pound of tobacco. Since their sole pipe was broken, they took to rolling pipe tobacco in paper and the invention spread among Egyptian and Turkish soldiers. Later during Crimean war (1853-1856), British soldiers learnt about cheap and convenient cigarettes ('*Papirossi*') used by their Turkish allies and brought the practice to England.

*Bidi* (Poor man's cigarette) is believed to have been created when tobacco workers rolled leftover tobacco in leaves. Traditionally, *bidi* is a slim hand-rolled, unfiltered Indian cigarette filled with tobacco flakes, wrapped in sun-dried Tendu (*Diospyros melanoxylon*), Temburni (*Diospyros tomentosa*) or Bidi leaf-tree



Bidi rolling and smoking by men and women

(*Bauhinia racemosa*) leaves tied with string. Unlike cigarette, bidi requires frequent puffing to keep it lit, and doing so not only requires greater effort, but also causes greater smoke inhalation. Though much cheaper than cigarette making them greatly popular among poor masses, bidi delivers more nicotine, carbon monoxide and tar and may thus be more harmful than other forms of tobacco consumption. Studies show that cotinine (a tobacco/nicotine metabolite) levels in body fluids of workers, who rolled 500-1000 bidis handling 225-450 g of tobacco flakes per day, are elevated even among those who never ever use tobacco. Recently, leading oncologists and 108 Cancer Hospitals led by Dr. R.A. Badve, Director,

Tata Memorial Hospital under the aegis of State-Funded National Cancer Grid have in the interest of citizens requested Govt. of India to include all tobacco products, especially bidi, which according to them is the single largest cause of smoking-related deaths in India, in the list of demerit goods under the GST regime.

Cigar is a tightly-rolled bundle of dried and fermented whole tobacco leaves, rolled in a series of types and sizes. While its exact origin remains unclear, Cigar smoke is typically not inhaled into lungs. Smokers usually swirl the smoke around in the mouth before exhaling it, partly through nose so as to smell as well as taste it. Smoke in cigar is produced by incomplete combustion of tobacco, with each gram of smoked tobacco emitting about 120-140 mg carbon dioxide, 40-60 mg carbon monoxide, 3-4 mg isoprene, 1 mg each of hydrogen cyanide and acetaldehyde, smaller quantities of volatile *N*-nitrosamines, organic compounds and odorous pyridines and pyrazines. Smoking cigars made from fermented tobacco produces several tobacco-specific nitrosamines – the most potent carcinogens known. Cigar smoke, being more alkaline than cigarette smoke, gets readily dissolved and absorbed through oral mucous membrane, making it easier for the smoker to absorb nicotine without inhaling the smoke.

*Hookah* is a big version of the pipe with water container at its base through which the smoke bubbles before it reaches the smoker's mouth. The hookah is believed to have originated in Safavid Dynasty of Persia, from where it eventually spread to East into India and then to Egypt and Levant during Ottoman Dynasty, where it became popular and its mechanism was perfected. In recent years, hookah smoking has gained popularity, especially among youngsters, including women. As a consequence, Hookah-Bars/Cafes/Clubs/Lounges that offer single/multiple-hose hookahs with variety of flavours and handy services have sprung up in large numbers to serve as chief gathering places for party/recreation/social/leisure pastime. Hookah smoking is somehow considered a safe, risk-free practice. However, it is only a misconception that hookah is safer than smoking cigarette/bidi/cigar as vapour/smoke is drawn through a water basin before inhalation. Actually, water only cools

and humidifies smoke and removes some suspended particles, but does not filter its toxic ingredients. Current evidence indicates smoking hookah may also cause numerous health problems with added risk of exposure to multiple toxic ingredients that come from burning tobacco, charcoal and flavourings, and infectious diseases as hookah pipes may not be properly cleaned, coupled with prevalent hookah-sharing habit.

*Chillum* is a straight conical pipe with end-to-end channel, traditionally shaped out of fired clay with a chillum stone – much like screen/filter in other pipes – often inserted to prevent direct inhaling of debris. Filter stone is generally tight-fitting, flat-topped conical piece with a small hole drilled down through its middle and slits down the sides to allow smoke to pass freely. Smaller chillums bring hot smoke directly into lungs. With larger chillum, while smoke gets cooled, more smoke gets into lungs. Chillum smoke is as toxic as any other smoking tobacco form. Chillums are thought to have originated in India or South America, and have been an age-old tool used by Indian monks for spiritual and group-smoking sessions at least since 18th Century.

A ‘Pipe’ comprises of a chamber for tobacco from which a hollow stem emerges, ending in a mouthpiece. Pipes can range from very simple machine-made ‘Briar Models’ to highly-prized hand-made artisanal implements made by renowned pipe makers, which are often expensive collector’s items. The wood of Briar (Giant Heather, *Erica arborea*), a flowering plant native to Mediterranean forests, used for making smoking pipes is extremely hard and heat-resistant, and does not affect aroma of smoke. Pipe smoke is as toxic as any other smoking tobacco form.

### Passive/involuntary smoking/ environmental smoking

Passive smoking is involuntary exposure of non-smoking individuals to substances produced by tobacco combustion. To check passive smoking, Govt. of India has since 2008 banned smoking in public places. Despite overwhelming majority of people favouring regulations prohibiting smoking at public arenas, 5-20% adults continue to be exposed to passive smoking. Tobacco smoke can migrate through

windows and ventilation systems, and affect people at places far away from the place of smoking. Indoor environmental tobacco smoke concentration depends on number of cigarettes/other tobacco forms smoked in a period of time, volume of environment, ventilation rate and processes that eliminate pollutants from air.

Smoke inhaled by non-smoker(s) is a mixture of stream of smoke exhaled from smoker’s lungs (mainstream) and smoke emitted into environment directly from tip of burning cigarette/bidi/cigar, etc. while smoking and during passive combustion between puffs (sidestream



*Some other smoking tobacco forms:  
Cigar, Hookah, Chillum, Pipe*

smoke). Chemically, sidestream smoke constituents are different and may have 2-6 times more condensate per gram than mainstream smoke. In an Italian National Cancer Institute study, three cigarettes left smouldering one-after-the-other in garage with limited air exchange produced more particulate-matter pollution than an idling low-emission diesel engine. Moreover, due to incomplete combustion during creation of sidestream smoke, there may be exposure to higher concentrations of carcinogens than directly inhaled mainstream smoke. According to International Agency for Research on Cancer, sidestream smoke condensates exhibit significantly higher carcinogenic effect in mice than mainstream smoke condensates. Thus sidestream smoke may be more harmful per gram than mainstream smoke. US Environmental Protection Agency has classified sidestream as well as environmental tobacco smoke as ‘Class-A carcinogens’ along with asbestos, arsenic, benzene and radon.

### Smokeless tobacco products

Smokeless tobacco products have been in existence for thousands of years in South America and Southeast Asia. In fact, flavoured tobacco (also known as *zarda*) has been an essential part of royals and the upper class since time immemorial and was believed to possess digestive properties. Besides tobacco, they often contain menthol, spices and/or exclusive herbs for unique flavour. Ironically, most of these products are being sold under the disguise of mouth fresheners resulting in rapid rise in their overall consumption and regular increase in demand. According to recent estimates, global sale of STPs, including smokeless inhalers, has grown to about \$3 billion and continues to grow. According to Centre for Disease Control and the National Cancer Institute, almost entire concentration of STP users in the world lies in Southeast Asia, with India with Bangladesh constituting about 80% of users. Smokeless tobacco is consumed without burning the product, and can be used orally or nasally. Mostly people keep smokeless tobacco between teeth and cheek/lip, suck/chew it and spit out black, tarry substance that forms when tobacco combines with saliva. This highly intoxicating substance is rapidly absorbed into bloodstream through lining of mouth, making it far more addictive than smoking.

In India, tradition of chewing mouth fresheners after meals dates back to eras much before regular dental hygiene became available. Sight of people, irrespective of age, education or economic strata, chewing such products throughout day in disguise of mouth freshening, mood enhancing, anti-fatigue and/or anti-stress feeling is not uncommon. Promoted by some as safer alternative to smoking, STPs have not proven to be any safer. Users consider STPs advantageous over smoke-emitting tobacco as these do not cause environmental pollution like smoking tobacco or trouble for others as passive smoking does, can also be used in ‘No-Smoking Areas’, and above all user’s hands remain totally free for other jobs as they do not need to hold it during consumption. Globally there is a large variety of commercially available tobacco containing preparations. Details of some STP (Figure 9), which may deliver nicotine

hit, often equivalent to 100 cigarettes, are summarised below:

**Zarda/Jarda:** Tobacco leaves seasoned with natural flavours and herbs and marketed with free lime.

**Qiwam/Kimam:** Purified tobacco blended with saffron (spice derived from flower of *Crocus sativus* or *Saffron crocus*) and certain other spices for taste and essence. Also used as an ingredient in Betel quid, it has intoxicating effect.

**Khainil Moist Snuff:** Raw/flavoured chewing tobacco mixed with lime in the palm of user just before use and kept between lip and gum.

**Naswar**, also known as snuff: Available in black and green colour as powder, paste or cake, people usually use black naswar (black snuff), prepared by grinding dried tobacco, wood ash and lime, mixed with water using rollers for around 20-25 minutes until paste is prepared and made into balls of 2-3 g each. The dry powdered material is also inhaled or sniffed into the nose.

**Gutka or Gutkha:** Generic name for product containing refined tobacco, areca nut, catechu, slaked lime, flavouring agents and perfumery compounds sold in powdered/granulated form in small sachets.

**Pan Masala:** It is primarily a mixture of nuts, seeds, herbs and spices. A typical Pan Masala contains fennel seeds as base ingredient and sugar-coated sesame, fennel and coriander seeds, mint leaves, cardamom, powdered lime, menthol, catechu and areca nut. Flavourings such as sandal wood oil, *Kewra* (*Pandanus odoratissimus*) may also be added. In chewing segment, Pan Masala is a favourite in India, Middle East and parts of Southeast Asia and is served after meals depicting hospitality and equality. Concerns have been expressed over some Pan Masala mixtures that include tobacco products.

**Betel quid/Paan:** Betel quid is a mixture of catechu, a reddish-brown astringent substance extracted from heartwood of *Acacia* species in water and sliced areca nut with/without tobacco wrapped in lime-coated leaf of betel vine (*Piper betel*). Spices (cinnamon, cardamom, saffron, cloves, fennel, aniseeds), sweeteners (coconut, dried dates, *gulkand*), aromatic oils (rose, sandal, geranium, linalool) and essence (rose water/essence/petals, menthol, mint) may be added depending on local/individual taste.

Quid without tobacco is considered natural mouth-freshener and is offered to visitors. According to recent estimate, ~600 million people worldwide chew betel quid, making it the fourth most commonly used stimulant and psychoactive substance after tobacco, alcohol and caffeinated drinks. In parts of Asia, betel quid is used as herbal remedy for anything from toothache to acne and is even believed to possess aphrodisiac properties.

## Major aggressive components of smoking and smokeless tobacco

Tobacco smoke is a dynamic, heterogeneous and complex mixture consisting of more than 4,700 aggressive chemicals including more than 70 known carcinogens and over 400 other toxins in the form of gases (about 60%) and particles (about 40%) generated during burning of products derived from tobacco and intentional/unintentional chemicals/



*Betel vine (Piper betel) cultivation, harvested Betel leaves (Inset). Constituents and preparation of Betel quid*

additives that affect the organism by direct action on tissues, interfering with enzymatic reactions, or indirectly reacting with other environmental elements overtime.

Major aggressive components of tobacco smoke include nicotine, a strong addictive, psychoactive substance that causes physical and psychological dependency; carbon monoxide, a colourless, odourless and tasteless toxic gas that can cause direct tissue damage/hypoxia because of its high affinity for haemoglobin; and seven most important carcinogens (1,3-butadiene, acetaldehyde, acrolein, acrylonitrile, ethylene oxide, formaldehyde, isoprene), which get easily absorbed into our blood stream and cause DNA damage – the primary underlying cause of cancer. Besides, tobacco smoke

contains many other confirmed carcinogens and toxic elements including benzopyrene, dibenzoanthracene, nitrosamines, and tar. Smokeless tobacco is known to contain more than 28 cancer-causing agents including benzo[a]pyrene and other polycyclic aromatic hydrocarbons and certain radioactive substances, and may contain up to 15-times more nicotine than cigarette.

## Major adverse health effects of tobacco use

Smoking accounts for more than 30% of all deaths from cancer, almost 90% of deaths from lung cancer and about 75% of deaths from chronic bronchitis and emphysema. Passive smoke is considered more dangerous than active smoking, because one could inhale toxin deposits of the smoker(s). Non-smoker(s), who live with smoker(s) and inhale passive/environmental tobacco smoke, even though they may never have smoked a single cigarette, increase their risk of lung cancer by 20-30%. Smoking (active/passive) can have many adverse effects during a child's development and growth. Millions of children, without having freedom of choice, continue to be dangerously exposed to passive smoking ever since their conception. Since children have greater ventilation rate than adults, they receive proportionally greater doses during exposure because they inhale more polluting elements on body weight basis. Milk of lactating mothers exposed to active/passive tobacco smoke contains many of its components (nicotine, benzene, formaldehyde, cyanide, carbon monoxide, etc.) that can be transferred to nursing infant and cause adverse effects. Maternal smoking may also alter composition of maternal milk and reduced prolactin and milk production leading to early weaning. All kinds of STPs and nicotine are extremely toxic to the entire human body. STPs kept under lips/tongue cause burns locally. Besides, prolonged tobacco use in any form is associated with increased risk of cancer and many other health hazards.

*Note:* Information contained in this article is intended for educational purposes only and is not intended to provide medical advice, diagnosis, treatment or directions of any kind on personal health matters, which should be obtained directly from a specialist.

# Parkinson's Disease— All You Want to Know About



*Dr Yatish Agarwal*



*Parkinson's disease usually begins between the ages of 50 and 65, striking about 1 per cent of the population in that age group; it is slightly more common in men than in women. Current estimates place the number of people affected in the country at 1.36 million. The trend is on the rise and both an increased age expectancy and the poor increasingly toxic environment may be contributing to this growing burden.*

Largely thought of as a movement disorder, Parkinson's disease is a intricate neurological condition which tends to spill onto many spheres of life. Mostly a disease of the older people, it can also occur in younger adults. The first signs are likely to be barely noticeable — a feeling of weakness or stiffness in one limb, a fine trembling of one hand when it is at rest or slowness in the initiation of such movements as walking or rolling over in bed. Eventually, the shaking or tremulousness worsens and spreads, muscles become stiffer, movements slow down, and balance and coordination weakens.

The symptoms are the result of the gradual degeneration of nerve cells in the portion of the midbrain that controls body movements. As the disease progresses, the thinking process, memory and emotions all may suffer producing an intellectual slowdown, depression, and other mental or emotional problems.

Parkinson's disease usually begins between the ages of 50 and 65, striking about 1 per cent of the population in that age group; it is slightly more common in men than in women. Current estimates place the number of people affected in the country at 1.36 million. The trend is on the rise and both an increased age expectancy and the poor increasingly toxic environment may be contributing to this growing burden.

A progressive disorder, Parkinson's disease tends to follow a broad pattern. While it moves at different paces for different people, changes tend to come on slowly.



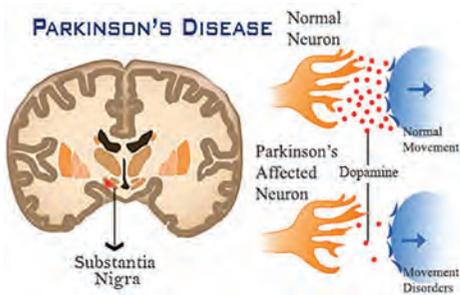
Symptoms usually get worse over time, and new ones probably will turn up along the way. Even though no recipe can work a cure, medication can treat its symptoms and decrease the disability.

Parkinson's doesn't always affect how long you live. It can, however, change the quality of life in a major way. After about 10 years, most people will have at least one major issue, like a dip in higher intellectual function or a physical disability.

## What causes Parkinson's disease?

Body movements are regulated by a portion of the brain called the basal ganglia, whose cells require a fine balance of two chemical messengers namely dopamine and acetylcholine, both involved in the transmission of nerve impulses. In Parkinson's disease, nerve cells (neurons) that produce dopamine begin to break down or die. As a result, the dopamine levels decrease. This causes abnormal brain activity, leading to signs of Parkinson's disease.

The author is physician and teacher at New Delhi's Safdarjung Hospital. He has authored 47 popular health-books.  
E-mail: dryatish@yahoo.com



The cause of Parkinson's disease is unknown, but several factors appear to play a role, including:

### Genetic flaws

More than a dozen gene mutations associated with familial forms of Parkinson's disease have been described. However, in the general population, these flaws are found far and few.

In total, fewer than 10% of all cases of Parkinson's disease can be explained by genetic abnormalities.

### Environmental triggers

Exposure to certain toxins or environmental factors may increase the risk of development of Parkinson's disease at a later age. These triggers may include certain viral infections or exposure to such environmental toxins as pesticides, carbon monoxide, or the metal manganese.

However, in the great majority of Parkinson's cases, the cause is difficult to determine.

### Deciphering the mysterious brain changes

Some researchers have observed certain changes in the brains of people with Parkinson's disease. Although, the basis and mechanism of why these changes occur is still not clear, they may hold the key to its causation and potential cure. These changes include:

### Lewy bodies in the nerve cells

Lewy bodies are abnormal clumps or aggregates of protein that develop inside nerve cells in Parkinson's disease, Lewy body dementia, and some other disorders. They are identified in the brain tissue when the tissue histology is examined under the microscope. They appear as spherical masses that displace other cell components, and may be found in

the brainstem (within the substantia nigra) or within the cortex. Believed to represent an aggregation of misfolded proteins in the cell, Lewy bodies are formed when the protein-degradation system of the cell is overwhelmed. Researchers believe these Lewy bodies may hold an important clue to the cause of Parkinson's disease.

### The A-synuclein protein

Of the many substances found within the Lewy bodies, bio researchers believe an important one is the natural and widespread protein called alpha-synuclein (A-synuclein). Currently an important focus among Parkinson's disease researchers, it is found within all Lewy bodies.

### Risk factors

Some factors, which are mostly beyond one's control, have been found to exacerbate the occurrence of Parkinson's disease. These factors include:

#### Middle to late age

Young adults rarely experience Parkinson's disease. It ordinarily begins in middle or late life, and the risk increases with age. People usually develop the disease around age 60 or older.

#### Heredity

Having a close relative with Parkinson's disease increases the chances that you'll develop the disease. However, your risks are still small unless you have many relatives in your family with Parkinson's disease.

#### Gender

Men are more likely to develop Parkinson's disease than are women.

#### Exposure to toxins

A prolonged exposure to certain herbicides and pesticides may put a person at a slightly increased risk of Parkinson's disease.

### Recognizing the mimics

A number of conditions can produce set of symptoms which may closely mimic those associated with Parkinson's disease. Identifying these mimics is vital because some of these other causes may well respond to a specific treatment or medication. These mimics include:



### Ill effects of certain medications

Some prescription medicines may produce an adverse reaction which closely mimics symptoms associated with Parkinson's disease. These medications include many of the antipsychotics, typically given in psychological illnesses including chlorpromazine, promazine, haloperidol, perphenazine, fluphenazine, pimozide and risperidone; gastrointestinal motility drugs, including metoclopramide, levosulpiride, clebopride, itopride, and domperidone, often prescribed to treat nausea, vomiting, and indigestion; anti-epileptics like valproic acid; antihistamine and calcium channel blockers like cinnarizine and flunarizine used in the treatment of problems affecting the inner ear and balance, such as dizziness; and the anti-depressant lithium prescribed in bipolar disorder.

Stopping and substituting the culprit drug can often relieve the individual of these drug induced Parkinson like features.

### Use of illegal drugs

#### Methamphetamine or speed

Hydrochloride methamphetamine, known as "meth" or "speed", is an addictive, highly water-soluble central nervous system stimulant which is found in the powder state, compressed into tablets or capsules of 10 to 15 mg, or used in a purer crystalline form. Taken by abusers for several desired effects: euphoria and a sense of well-being, increased physical activity and energy, and decreased anxiety, which appear immediately after drug consumption and can last for several hours, the drug can produce several adverse effects and in the long run produce parkinsonism.

#### MPTP

Recently, a street-drug contaminant has also arrived on the scene that can cause parkinsonism in drug abusers. The compound N-methyl-4-phenyl-1, 2, 3,

6-tetrahydropyridine (MPTP) has produced sporadic outbreaks of MPTP-induced parkinsonism among drug abusers in California, Maryland, and Vancouver, British Columbia. MPTP-induced parkinsonism in man is remarkably similar to idiopathic Parkinson's disease. All the major clinical features of Parkinson's disease are present: generalized slowing and difficulty moving, rigidity, resting tremor, flexed posture, and loss of postural reflexes.

## Other conditions

A host of neurological and other conditions can also produce Parkinson like features in an individual. These conditions include:

- Exposure to environmental toxins
- Stroke
- Thyroid and parathyroid disorders
- Repeated head trauma (for example, the trauma associated with boxing and multiple concussions)
- Brain tumour
- An excess of fluid around the brain (called hydrocephalus)
- Brain inflammation (encephalitis) resulting from infection
- Neurological conditions, including Alzheimer's, Lewy body disease, Creutzfeldt-Jakob disease, Wilson's disease, and Huntington's disease.

## Recognizing the symptoms and signs

Parkinson's disease is a movement disorder that progresses slowly. The symptoms and signs may vary from person to person. Early signs may be mild and may go unnoticed. Symptoms often begin on one side of your body and usually remain worse on that side, even after symptoms begin to affect both sides. Some people will first notice a sense of weakness, difficulty walking, and stiff muscles. Others may notice a tremor of the head or hands. The general signs symptoms of Parkinson's disease may include:

### Tremulousness

A tremor, or shaking, usually begins in a limb, often in the hand or fingers. A person with Parkinson's disease may notice a back-and-forth rubbing of the thumb and

forefinger, known as a pill-rolling tremor.

The other characteristic of Parkinson's disease is a tremor of the hand noticed when the hand is at rest and relaxed.

## Slowness of voluntary movements

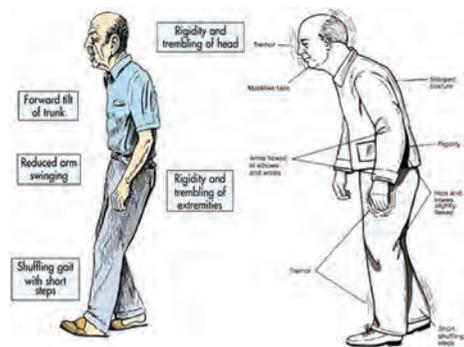
Over time, Parkinson's disease may reduce a person's ability to move and slow his/her movement, making simple tasks difficult and time-consuming. You may find it difficult to get out of a chair, roll over in bed, and when you walk, the steps may become shorter.

Besides the shorter steps, you may drag your feet as you try to walk, making it difficult to move. A shuffling gait with poor arm swing and stooped posture is a typical feature of Parkinson's disease.

## Rigid muscles

Muscle stiffness may occur in any part of the body. The abnormal tone or stiffness in the trunk and extremities can limit the range of motion and cause pain.

## Unsteady balance



As a result of Parkinson's disease, you may have problems which affect the body's balance.

## Loss of automatic movements

In Parkinson's disease, you may have a decreased ability to perform unconscious movements, including blinking, smiling or swinging your arms when you walk. The decreased facial expression may produce a mask like face.

## Speech changes

You may have speech problems as a result of Parkinson's disease. You may speak softly, quickly, slur or hesitate before talking. Your speech may be more of a monotone rather than with the usual inflections.

## Writing changes

You may have enjoyed a most perfect calligraphic handwriting, but as the symptoms progress, it may become hard to write, and your writing may appear small and irregular.

## Swallowing problems

As your condition progresses, you may develop difficulties with swallowing. Saliva may accumulate in your mouth due to slowed swallowing, leading to drooling.

## Sleep problems and sleep disorders

People with Parkinson's disease often have sleep problems, including waking up frequently throughout the night, waking up early or falling asleep during the day.

People may also experience rapid eye movement sleep behaviour disorder, which involves acting out your dreams. Medications may help your sleep problems.

## Bladder problems

Parkinson's disease may cause bladder problems, including being unable to control urine or having difficulty urinating.

## Constipation

Many people with Parkinson's disease develop constipation, mainly due to a slower peristaltic function within the digestive tract.

## Changes in blood pressure

Some people with Parkinson's disease may feel dizzy or lightheaded or faint when they stand. This happens due to a sudden drop in blood pressure. The condition is called orthostatic hypotension.

## Smell dysfunction

A person with Parkinson's disease may experience problems with their sense of smell. They may have difficulty identifying certain odours or the difference between odours.

## Fatigue

Many people with Parkinson's disease lose energy and experience fatigue, and the cause isn't always known.

## Pain

Many people with Parkinson's disease experience pain, either in specific areas of their bodies or throughout their bodies.

## Sexual dysfunction

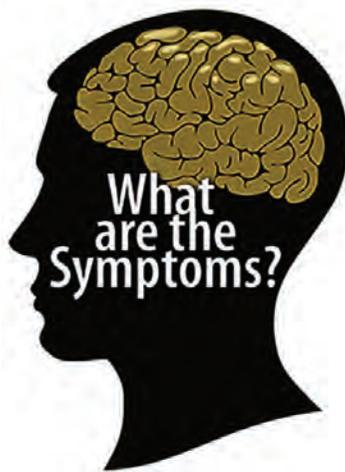
Some people with Parkinson's disease notice a decrease in sexual desire or performance.

## Intellectual and emotional dysfunction

A person with Parkinson's disease may be faced with a deterioration of the higher cerebral function and suffer depressive and emotional changes.

## Thinking difficulties

Some people with Parkinson's disease may experience thinking difficulties, memory loss, and cognitive decline. This usually occurs in the later stages of Parkinson's disease. Unfortunately, such cognitive problems aren't very responsive to medications.



## Emotional changes and depression

People with Parkinson's disease may experience emotional changes, such as terror, anxiety or loss of motivation. Doctors can give medications to treat these symptoms.

Some people with Parkinson's disease may suffer with depression. This might

require a consultation with a psychiatrist, a specialist doctor trained in handling mental health issues. By taking the recommended treatment, including anti-depressant pills, it can make it easier to handle one's feelings and at the same time cope with the challenges of Parkinson's disease.

Overall, as a general rule, the signs and symptoms in Parkinson's disease tend to get worse with passage of time. There are no medications which can check the progression of the disease and none which can work a cure. Still, in a large number of people with Parkinson's disease, medications taken in consultation with a specialist doctor, preferably a neurologist, can markedly improve the quality of life. Many people can lead a useful life full of joy and happiness for many years.

**{Next month: Living with Parkinson's disease}**

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## Two Key Organisms that May Save the Earth *(Continued from page 30)*

- Reduce domestic air travels as well. Shed your false ego and vanity. Your mileage frequent flier cards that sit in your wallet confirm that you are a big contributor to the death of our two key species. What if you don't fly? Hardly matters, other than to impress your colleagues and friends. Stamps on your passport tell only one thing; the more stamps, the more you did damage to our two organisms. (Willi Hennig, the most revered father of my discipline of phylogenetics – a merger of statistics, genetics, evolutionary biology and computational sciences – had never been out of Germany. What were the implications? None!)
2. Walk to supermarkets, walk to work. Or cycle. I cycle to my work, while many students in my university come by big cars! Cycling helps you in two ways; first of all, you save the world by helping these two key organisms, and it helps your health and extends your life.
  3. Always use public transport. Trains are a very good choice of transportation.

- Buses too. Again, let your vanity of owning a car disappear into the oceanicabyss! Owning a car will no longer remain trendy, after this article, I hope.
4. Other conscious practices include: Using water bottles filled with local water rather than buying packaged water that on its transit burns a lot of fossil fuel; using less plastics and avoiding consumer goods like cosmetics with 'microplastics' altogether for these have impacts on marine life – possibly our two species as well (research is so barren in this field that great opportunity exist for prospective researchers); 'dressing with the local tradition', avoiding suits with neckties altogether in summer to reduce perils of airconditioning and instead going with local, Indian costumes; travelling in sleeper class rather than AC-3 in trains; buying local products, and wrinkle-free clothes that need no ironing, to mention a few.
- As per the famous biologist Paul

Ehrlich, climate change works like an aircraft disaster. First, its hydraulic systems fail. Then, one engine fails. Passengers feel nothing extraordinary, until a crucial system, be it a nut on the wings, break, and the aerodynamics fail and the passengers feel extraordinary turbulence – but by then it is already a catastrophe, complete disaster within next few minutes. We can do nothing to save it from a crash. Another analogy would be the detection of the final stage of metastatic cancer. We are, unfortunately nearing the stage 3 of metastatic cancer as of this writing.

If you cannot accept any of the above four suggestions, do what I do every morning after I wake up – compassion meditation. That might do the trick, subconsciously, at least saving your sanctity. Because this planet Earth – referred to as "mostly harmless" (by Douglas Adams, although I would rather refer to it as a 'planet where humanity is driving towards mass extinction of aerobic life including itself') – is our "only home."

# Recent Developments in Science and Technology



**Biman Basu**



*Neutron stars are the smallest, densest stars known to exist. A teaspoon of a neutron star has a mass of about a billion tons. But the more curious fact is that the neutron star merger also create heavy elements such as gold and platinum, spewing them into space. According to astrophysicists, a single neutron star-neutron star merger can create about 20 times the mass of the Moon in gold alone.*

## An Earthly search for gold's cosmic origins

Human craze for gold has long been known. One of the rarest and precious metals on Earth, gold is one of the heaviest stable, naturally occurring elements found on Earth. Apart from its common use in jewellery for its glitter and permanence, gold remains incredibly valuable for its scientific, physical and chemical properties as well.

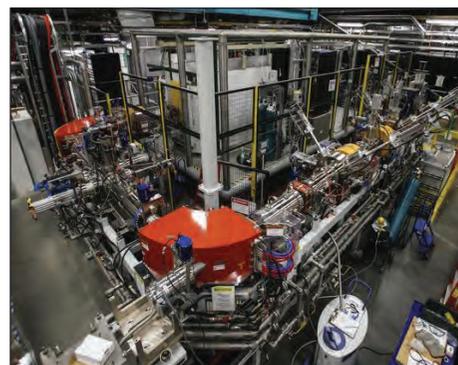
But the origin of gold has remained a mystery. Although it has been speculated that the yellow metal is formed within stellar interiors, it did not provide the full explanation. While it is true that stars like our Sun fuse light elements into heavier ones, that will typically produce only a handful of elements: helium, carbon, nitrogen, oxygen, and then neon, magnesium, silicon, sulphur, iron, nickel and cobalt; nothing heavier. That is, nuclear fusion is only responsible for a tiny fraction of the elements known today.

But there could be another source – a supernova, the last stage of a very massive star. At the end of its life the core of a massive star will implode, creating a spectacular type II supernova explosion! This runaway reaction produces either a neutron star or a black hole at its centre, and causes a runaway fusion reaction in the outer layers, which blows the star apart. In addition to blowing the star apart, however, it also produces tremendous numbers of free neutrons, and it produces them extremely rapidly, enabling much heavier elements like gold to be made and in much greater abundance. Vast amounts of cosmic gold come from supernovae, but there is still one more method that is more

productive – the collision of neutron stars, the first of which was observed in August 2017.

In August 2017, astronomers announced that they had observed two neutron stars merge, giving rise to gravitational waves that were detected by the US-based Laser Interferometer Gravitational-Wave Observatory (LIGO). The event was simultaneously observed in multiple electromagnetic wavelengths – gamma rays and X-rays. For the first time in history, an astronomical phenomenon has been first observed through gravitational waves and then seen with telescopes. But the more curious fact was the observation that the neutron star merger also created heavy elements such as gold and platinum, spewing them into space.

Neutron stars are the smallest, densest stars known to exist. A teaspoon of a neutron star has a mass of about a



*One of the two beamlines at the Facility for Rare Isotope Beams (FRIB) at Michigan State University in USA (Credit: Matthew Dae Smith/Lansing State Journal)*

The author is a former editor of the popular science monthly *Science Reporter*, published by CSIR, He is a winner of the 1994 'NCSTC National Award for Science Popularisation'. He is the author of more than 45 popular science books. Email: bimanbasu@gmail.com

billion tons. To find out how neutron star collision produces heavy elements, nuclear physicists at Michigan State University in USA are building an atom smasher – the \$730 million Facility for Rare Isotope Beams (FRIB) – that could decipher exactly how those elements are forged in neutron star collision. The 500-metre-long linear accelerator of FRIB will provide intense beams of rare isotopes (that is, short-lived atomic nuclei not normally found on Earth) to shoot a graphite target to blast out short-lived new isotopes. The researchers hope FRIB data will be the key to understanding how neutron-star mergers make heavy elements (*Science*, 24 November 2017 | DOI: 10.1126/science.358.6366.981).

According to astrophysicists, a single neutron star-neutron star merger can create about 20 times the mass of the Moon in gold alone, meaning that even though there may be thousands of times more supernovae than neutron star-neutron star mergers, the latter is the primary source of elements at the highest end of the periodic table like gold, platinum, tungsten as well as the radioactive elements like thorium and uranium here on Earth.

## How geckos regrow its tail

Some species of geckos have an interesting defence mechanism of “dropping” their tail when they feel threatened. The dropped tail will actually wiggle and twitch on the ground as though it were still attached to the body of the gecko to distract potential predators and allow the gecko to get away while the predator is left with just the tail. Tail dropping is a type of defence called autotomy. Gecko tails are designed to do this and have special connective tissue inside them that creates a location where the tail breaks off readily. If a gecko drops its tail, the blood vessels to the tail immediately constrict and very little blood loss occurs. Geckos are able to re-grow a new tail within 30 days – faster than any other type of lizard.

The interesting thing about this unusual behaviour of geckos is that the animal can self-detach their tails without employing much effort, making them incredibly easy to study. This is what prompted Matthew Vickaryous, a developmental biologist at the University of Guelph in Canada to explore the process. Vickaryous’ team studied this phenomenon by literally pinching a bunch



*Geckos will regrow their tail but it might look different from its original colour.*  
(Credit: Auscape / UIG / Getty Images)

of geckos’ tails and seeing what happened on the cellular level.

It has been known that a gecko’s tail is actually an extension of its spinal cord. Scientists knew the gecko’s spinal cord could regenerate, but did not have any idea about which cells were playing a key role. However, based on previous research on other limb-regenerating species, scientists had assumed that some types of stem cells must be involved. Stem cells are essentially cells that can grow into a variety of different cell types – like skin, muscle, or heart cells – depending on the need. The researchers discovered that the spinal cord of the tail houses a special type of stem cell known as the radial glia, which have been identified as a major source of neurons during development. These stem cells are normally fairly quiet, “but when the tail comes off everything temporarily changes. The cells make different proteins and begin proliferating more in response to the injury. Ultimately, they make a brand new spinal cord. Once the injury is healed and the spinal cord is restored, in the span of a month, the cells return to a resting state”.

Most intriguing, they found, was that when the tail comes off, a blood clot quickly develops, sealing in the injury. If the team attached a piece of skin to the area as the clot was forming, the tail would fail to regenerate. They say this suggests that the open wound itself helps send out the signal that something needs replacing. If you cover that wound, those signals are halted, which stops the regeneration process.

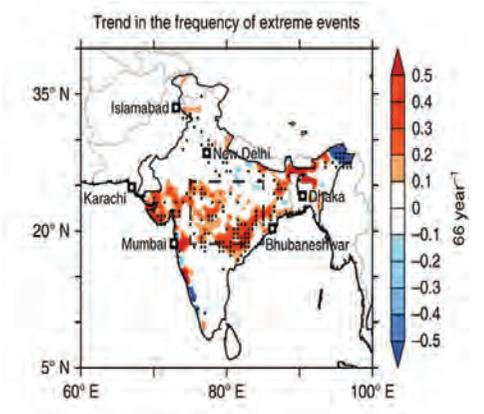
Now that researchers have a better understanding of what cells make this regeneration process possible, they think this information could help us find better ways for humans to heal themselves. They are hopeful that understanding the secrets

of gecko tails could help find ways to heal human spine injuries.

## Extreme rainfall events in India linked to warming of Arabian Sea

Predicting the Indian summer monsoon has always been tricky. Despite significant advances in monsoon prediction models developed by India Meteorological Department there still remain uncertainties regarding spatial distribution of rainfall. Summer monsoon rainfall in India has been showing an unusual trend in recent years with localised spells of extremely heavy rainfall in a short span of time in certain pockets, leading to widespread flooding and damage to life and property, while leaving some regions with scant rainfall leading to droughts. A recent study by an international team, comprising scientists from Indian Institute of Tropical Meteorology, Pune; IIT, Mumbai; Cochin University of Science and Technology, Kochi; University of Maryland, USA; and Sorbonne Universites, France, has revealed that widespread extreme rain events over central India have increased three-fold in the 66-year period between 1950 and 2015. The study notes a 10-30 per cent increase in rainfall events over the region where more than 150 mm of rain is registered in a day has been occurring despite a general weakening of monsoon circulation (*Nature Communications*, 3 October 2017 | DOI: 10.1038/s41467-017-00744-9).

The study has brought out that global economic losses from floods exceeded \$30 billion per year in the past decade, with some of the largest losses linked to extreme rainfall



*Most of the extreme rainfall events are widespread across a large area over central India, resulting in large-scale floods.* (Credit: Nature)

events in Asia. Floods attributed to extreme rain events in India alone amounted to losses of about \$3 billion per year, which is 10% of the global economic losses. The study found the plains of central India to be largely flood-prone where flash floods, landslides and torrential rains often kill thousands and displace millions of people as well as animals. There have been 268 reported flooding events in India during 1950-2015 affecting about 825 million people, leaving 17 million homeless and killing 69,000 people. Many of these events which caused large loss of life, property and agriculture occurred across central India. Unfortunately, till now it was not possible to predict these extreme events.

A few studies in the past had suggested that the rise in extreme rainfall events over central India is due to an increase in the moisture content, probably due to the rapid warming of the equatorial Indian Ocean. Other studies propose that the local surface warming over the Indian subcontinent and the corresponding rise in humidity levels have a role in the increasing frequency of events. It is generally presumed that many of these heavy rainfall spells result from low-pressure systems (depressions and cyclones) that develop in the Bay of Bengal, with typical time scales of 3-5 days, and move north-westward bringing moisture into the central Indian subcontinent.

In the recent study the scientists found that despite negative trends like a weakening monsoon circulation and less inflow of moisture from the Bay of Bengal, there has been a three-fold increase in widespread extreme rain events over central India. According to them, the rise in these events has been “due to an increasing variability of the low-level monsoon westerlies over the Arabian Sea, driving surges of moisture supply, leading to extreme rainfall episodes across the entire central subcontinent”. According to the scientists, the homogeneity of these severe weather events and their association with the ocean temperatures underscores the possibility of predicting these events two-to-three weeks in advance, which offers hope in mitigating their catastrophic impact on life, agriculture and property.

### There is order in complex patterns of river deltas

If we look at an image of the Ganges delta taken from space we see what looks



Part of the Ganges Delta as seen from space.

like a maze of randomly arranged channels. Although they appear to have been formed by random processes, an international team of scientists from the University of California, Irvine and other institutions in the US, Switzerland and Italy have found order in the apparent chaos. Through field studies and mathematical modelling, they have concluded that deltas “self-organise” to increase the number, direction and size – or diversity – of sediment transport pathways to the shoreline, boosting their ability to withstand human disturbances and naturally occurring factors. The scientists used concepts from information theory to show that “a range of field and numerically generated deltas obey an optimality principle for self-organisation” (*Proceedings of the National Academy of Sciences*, 16 October 2017 | doi/10.1073/pnas.1708404114).

River deltas are critically important geological features at the land-water interface that occupy only 1 percent of the world’s land surface; but they are home to more than half a billion people and are the source of vast amounts of food and

other natural resources. Deltas are highly productive regions that support extensive agriculture and aquaculture and diverse ecosystems and contains natural resources such as hydrocarbon deposits. Deltas exhibit complex channel networks that decide how water, sediment, and nutrients are spread over the delta surface. In the last few decades, many deltas of the world have come under threat from a range of stress factors, including sea-level rise caused by climate change, human actions like upstream dam construction, and local exploration. These have had deleterious effect on these landscapes, necessitating a thorough understanding of these complex systems and their response to perturbations.

Lead author of the *PNAS* paper Alejandro Tejedor wanted to find out “if there could be some common ‘goal’ on the part of deltas to sustain their existence by diversifying the spread of their fluxes to build land on their way to the ocean”. He sought to solve this riddle by applying statistics and mathematical modelling. Looking at 10 major river deltas around the world, the researchers determined the probability of flows dividing into smaller channels and merging again at confluences and discovered that all but one, the Niger Delta in Africa, exhibited a large diversity of delivery pathways to the sea. The team confirmed these findings through numerical models, demonstrating that even when change in course of major channels take place – leading to network reorganisation – flows tend to re-create diverse water routes there by maintaining the flow of water and sediments. ■

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## Dr. L.A. Ramdas – Father of Agricultural Meteorology in India (continued from 33 page)

Physical Laboratory, New Delhi and became Professor Emeritus in 1965. During this period, he devoted his time on evaporation control problem, especially the influence of wind on stability of monomolecular films of long chain alcohols. He was awarded with M.B.E. (Member of the order of the British Empire) by the then Government of India in 1946 for his pioneering researches in agricultural meteorology.

Dr. Ramdas was the first person from the IMD to be honoured with Padma Shri

award in 1958 for his contributions in the field of agricultural meteorology. He is known as the Father of Agricultural Meteorology in India. He died on 1 January 1979. In order to honour this great personality, the Association of Agrometeorologists started the “Dr. L.A. Ramdas Memorial Lectures” in 2008 to be presented in National/International Symposia which are regularly organised by the Association of Agrometeorologists. ■