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A Newsletter by the Department of Biotechnology, TERI School of Advanced Studies, New Delhi

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Editor's Note:

Embark on a thrilling journey as Department of Biotechnology, TERI SAS, unveils the second edition of 'Envelope,' where each page promises a tale of excitement. Letters brim with intrigue, and manuscripts beckon discovery in this captivating scientific voyage. Themed 'Environment Biotechnology,' this edition showcases how the cutting edge of innovation meets sustainability, exploring the harmonious synergy between biology and the environment.

Dropping our letters on- LIQUID 3 project, which is seamlessly merging

Nitrogen-Fixing Bacteria: Fertilizer





"In soil's embrace, I'm Nostoc, a poet so small, Fixing nitrogen's dance, I answer

nature's call. With fungi as my partner, a silent ballet, I thrive in the soil, quietly at play."

Image Reference: iStock

Meet the unsung heroes in your garden nitrogen-fixing _ bacteria. They're like nature's own fertilizer factories, ensuring plants get the nutrients they need to thrive. Plants crave nitrogen, but they can't grab it from the air. That's where these bacterial magicians step in. They take nitrogen from the air and turn it into a plant-friendly form, like solving a puzzle. In a cool partnership with plants, these bacteria get cosy homes in the roots of plants like peas and beans. In return, they work their transforming air's magic, nitrogen into a plant feast. Think of it as having tiny nitrogen factories right in the soil, helping plants grow big and strong.

I think you will love reading about these before you dive into the ocean ahead

Bioremediation: Nature's Cleanup Crew Imagine a superhero cleanup crew for the environment. That's exactly what fungi are! Picture a polluted area – oil spills, toxic mess. Now, enter fungi. These tiny heroes have a knack for breaking down and gobbling up the bad stuff, like a living cleaner. They vacuum turn harmful substances into harmless ones, leaving a cleaner, healthier space. **Scientists** even fungi use intentionally to clean up pollution. Nature's cleanup crew doesn't need hard hats — just a touch of fungus magic! So, when you hear about a polluted place getting a makeover, thank the fungi for making it greener and cleaner.

nature and innovation in our urban landscapes, come discover whats inside the world of sustainable PERMACULTURE PRACTICES perfectly aligned with nature's rhythm. Uncover the transformative impact of TERI's TADOX technology and within the pages of envelope's manuscript section, accompany us on a profound exploration of the life of Dr. M.S. Swaminathan. As the distinguished inaugral guest of our Biotikos Lecture Series, we pay tribute to his enduring contributions to agricultural science and sustainable development.

Packed with a delightful mix of fun, fascinating facts, mind-teasing riddles and art, this newsletter stands as a collaborative achievement. Sincere appreciation to every contributor, the dedicated students of MSc Biotechnology, esteemed faculty members, and the entire department. On everyone's behalf, we extend an invitation to savor this edition of 'Envelope.'

Join in as we reveal the enclosed!





POSTMASTERS

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LETTER DROP

Flip your way through interesting scientific discoveries and breakthroughs via this newsletter.

LIQUID 3: A Revolutionary Solution for Urban Air Quality

In an era where pollution-related deaths far surpass those caused by HIV/AIDS, tuberculosis, and malaria combined, addressing air quality has become paramount. Belgrade, Serbia, home to two major coal power plants, grapples with severe pollution levels, making it one of the most contaminated cities in the country. With urban areas responsible for a significant share of global CO2 emissions, finding space for greenery in densely populated cities has become a pressing challenge. Fortunately, Serbian scientists have unveiled a groundbreaking solution: the "LIQUID 3" urban photo-bioreactor.

Pollution-related deaths in Serbia have reached alarming levels, with the nation ranking highest in Europe for pollution-related fatalities. The concentration of PM 2.5 in the air, a key pollutant, exceeds the WHO guideline value by nearly five times. This dire situation calls for innovative solutions to combat pollution and improve air quality.



Enter "LIQUID 3," a brainchild of Dr. Ivan Spasojevic and his team at the Institute for Multidisciplinary Research, University of Belgrade. This pioneering urban photo-bioreactor, affectionately termed the "liquid tree," houses micro-algae within a 600-litre water tank. Through photosynthesis, these microalgae bind carbon dioxide and release pure oxygen, effectively emulating the function of trees in urban environments.

LIQUID 3's micro-algae outshine traditional trees in their capacity to purify the air. They are up to 50 times more efficient at sequestering carbon dioxide, making them a powerful tool in combating urban pollution. This innovation aims not to replace forests but to target urban pockets where tree planting is impractical, particularly in heavily polluted areas where trees often struggle to survive.

Installed in the bustling Makedonska Street in Belgrade's Stari Grad Municipality, "LIQUID 3" serves as a testament to innovative urban planning. It's not just an air-purifying marvel; the photo-bioreactor also doubles as a bench, equipped with mobile phone chargers and illuminated at night by a solar panel.

The use of single-celled freshwater algae, naturally abundant in Serbian ponds and lakes, makes "LIQUID 3" a sustainable solution. These resilient algae can thrive in tap water and withstand extreme temperatures. Maintenance is minimal; clearing out excess biomass and replenishing water and minerals keeps the system thriving indefinitely.

Shreya Joshi

Beyond its immediate air-purifying benefits, "LIQUID 3" paves the way for broader applications of micro-algae technology. From wastewater treatment to biomass and biofuel production, the potential uses of this innovative solution are extensive.

"LIQUID 3" has garnered well-deserved recognition as one of the top II innovative and climate-smart solutions in the Climate Smart Urban Development project, a collaboration between UNDP and the Ministry of Environmental Protection, with support from the Global Environment Facility (GEF). The Municipality of Stari Grad played a crucial role by providing the location and facilitating the installation.

"LIQUID 3" stands as a testament to the power of innovation in addressing critical environmental challenges. By harnessing the potential of micro-algae, this urban photo-bioreactor offers a practical and efficient solution for combatting pollution in densely populated cities. As Serbia takes steps towards a cleaner and healthier future, "LIQUID 3" serves as an inspiration for urban centres worldwide grappling with similar environmental issues.

Refrences-

I. https://worldbiomarketinsights.com/a-liquid-tree-scientists-in-serbia-make-incredible-innovation/

- 2. https://www.undp.org/serbia/news/first-algae-air-purifier-serbia
- 3. https://liquid3.rs/

Koshika Chhabra M.Sc. Biotechnology **TERI School of Advanced Studies**

PERMACULTURE: RETREATING BACK TO NATURE



Fair Share

by intertwining the land's elements, plants, trees, and animals into a example, under the sheltering canopy of a mango tree, a diverse community of beetroot, kohl rabi, and beneficial flowering plants Despite its potential, permaculture remains a realm largely accessible to the farming model, deeply rooted in the ideas of Australian environmentalists from 1978, embodies a sustainable lifestyle reaching back to ancient Indian texts from 400 B.C. Yet, it's much approach that values Earth care, people care, and fair sharing. Influenced by the ethos of 'do-nothing farming' championed by Japanese farmer Masanobu Fukuoka, permaculture offers families a pathway to seasonal, nutrient-dense sustenance. A small expanse of 1-2 acres can supply a five-member family's yearly fruit and For now, it remains a conscientious lifestyle choice for those seeking a closer cereal crops. While smaller farms are more manageable, larger ones tend to yield more profit with increased production capacity and diverse activities. Although permaculture farms sustain themselves well, generating a steady income proves challenging.

References: I. https://www.britannica.com/technology/permaculture

2. https://www.permaculturenews.org/what-is-permaculture/

Permaculture, an ingenious agricultural approach, crafts 'food forests' To bridge this gap, many have embraced innovative strategies—opening their farms to experiential stays, hosting educational workshops, and creating self-sustaining, nature-harmonious haven. Beyond growing food, it's value-added products. Some have even expanded their offerings to include a living art form with principles based on natural ecosystems. For bite-sized online learning modules and farm-to-plate cafes showcasing local cuisine from their own produce.

thrives, effectively controlling pests and fostering soil fertility. This urban elite—those who are financially capable of venturing into this form of sustainable farming. While a growing number of city-dwellers seek refuge in rural permaculture, traditional farmers find the transition daunting due to the substantial investment of time and resources required for land regeneration more than just a means to cultivate food; it embodies a holistic from mono-cropping practices. However, the payoff of this sustainable farming model is promising once the initial hurdles are surmounted. Demonstrated by pioneers who've transformed arid wastelands in regions like Telangana and Andhra Pradesh into thriving food forests, the potential for permaculture as an alternative to conventional farming is budding.

vegetable needs, but larger plots of 3-5 acres might be necessary for bond with nature and possessing the means to step away from urban life's promises. The true potential of this agricultural revolution, still in its early stages, promises a meaningful life intertwined with nature, nurturing resilient and sustainable communities as it flourishes.

> Rashi Gupta Artwork by Ritika Kalra M.Sc. Biotechnology **TERI School of Advanced Studies**





READER'S COMPENDIUM

The Brain by David Eagleman

The human body is a marvel of intricate design and elegance, a harmonious interplay of forty trillion cells working together. In his book The Brain, author David Eagleman explores the human mind from a fascinating angle. He begins by comparing humans and animals and explains how our brains are different. Right off the bat, the reader is made to realise how little one truly knows about the brain— a child aged two has one hundred trillion synapses, which is double that of an adult. The real work begins after that, as the brain begins to whittle down those

THE STORY OF YOU



DAVID EAGLEMAN

connections to shape our identity. The book then delves into a compelling inquiry of how a mass of tissue inside a bony box processes the plethora of inputs to turn them into signals for the brain and the amazing ways in which the brain seems to bend the limits of what it can and cannot do.

Our brain, as we know, is a computer of unmatched prowess. A simple everyday task that we may not think twice about, for example, would need dozens of the world's fastest supercomputers to be carried out, simply to match our brain's computational speed.

If you read a book this year, let it be this one. One is sure to not regret the choice made in devoting time to a book as engaging as this one. The book was also made into a PBS documentary in 2015, with Eagleman stepping in to narrate the series. Readers of this column who find themselves running short on time may choose to enjoy the documentary. But for those who stay on to give the book a chance will find themselves suitably rewarded, for it is a masterpiece of scientific text written in simple language. No heavy words or scientific jargon stand in between you and this book.

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BIOCODE CHALLENGE



Down:

I. Investigating entire genetic codes.

2. Pioneering effort to decipher and analyze the entirety of the human genome, abbreviated form.

3. Ecologically rich regions face the greatest threat due to species diversity.

4. A multitude of distinct single-stranded DNA fragments organized on a glass slide grid, employed for detecting and quantifying gene expression.

5. Genes that encode identical proteins, notwithstanding potential differences in base sequences, are termed as ______ genes.

6. Products from transgenic organisms used in commerce or agriculture, abbreviated as

Across:

2. Unlawful hunting or capturing of wild animals contributing to mass extinction

8. The collective advantages, both living and non-living, derived from organisms within a specific area.

II. An enzyme crucial for binding DNA fragments, employed in the creation of recombinant DNA to connect foreign DNA with vector DNA.

12. Successive occurrence of a repetitive DNA sequence within the same chromosome region.

13.The utilization of animal organs, as opposed to human organs, for transplantation into

Deep in the sea all molecules repeat the patterns of one another till complex new ones are formed. They make others like themselves and a new dance starts. Growing in size and complexity living things masses of atoms DNA, protein

dancing a pattern ever more intricate.

— A Universe of Atoms, An Atom In The Universe, Richard Feynman

human patients.

I4. _____ loss emerges when natural habitats can no longer sustain the existing species.Answers are provided at the end.

Pavni Rekhi M.Sc. Biotechnology TERI School of Advanced Studies

DID YOU KNOW ?

Marie Curie was the first woman to win a Nobel Prize and remains the only person to win Nobel Prizes in two different scientific fields (Physics for her work on radioactivity, and Chemistry for discovering the elements Polonium and Radium).



MANUSCRIPT

Dr. M.S. Swaminathan: An Inspiring Journey from a Scientist to a Revolutionist



From the

history

A Snapshot of laboratory notebook, IARI (1960)

M.S. Swaminathan or Mankombu Sambasivan Swaminathan is popularly known as the "father of the Green Revolution". Just as significant as his contributions to the field of agriculture and sciences have been, the journey to this milestone must have been inspiring too.

Belonging from a background of doctors and surgeons, one must think that he should have pursued a degree in medicine as it was more prestigious and noble in those times. But, after experiencing the daily life problems of a farmer and the impacts of the Bengal Famine of 1943 during the Second World War, he went the unconventional way, Agriculture. Moving forward, he moved to the Indian Agricultural Research Institute (IARI), New Delhi to pursue higher studies in cytogenetics (1949). But, at a point in life, one must face a fork of decision, and similar was the case with M.S. Swaminathan. Due to social stigmas, he competed in Indian Police Service (IPS) examinations and was selected as well. But his calling for sciences never left him alone. At the same time, he was offered a UNESCO fellowship at Wageningen Agricultural University's Institute of Genetics in the Netherlands. So far, what we have learned about him, he again chose Agriculture. These decisions helped him pursue his interests as well as excel in the field of agriculture. In due course of time, he worked on various projects such as gene adaptation in golden nematodes which had caused havoc in potato crops during the Second World War, his dissertation titled "Species Differentiation and the Characteristics of Polyploidy in specific species of the Solanum genus -Tuberarium section while he obtained a Doctor of Philosophy degree from University of Cambridge in 1952.

Failure of Monsoon in Central and North western Hundaya and its Impact on Agriculture -1987 multidisciplinary In 1987, during the course of owny studies related to envoionmental sensitivity of the Gaviganga river Catchment area, I had the opportunity to visch hill districts of Nainital, Almorah, and Pithoragarh in Kumaon region. Two rivers, Dhank and baiganga make important tributories to river Kali, which is named as Sharda Sarda near Tanak pur in fortills The field visits were in the months of June, July and october. Following are the observations on the situation of agriculture during this period: 1. Until the months of May-June scattered showers due to western disturbances and local causes, occurred Throughout the central and northwestern Himalaya. With no prior knowledge of the likely pattern J the forthcoming monsoon, the farmers had tilled the land and sown the usual crops of millets, Soyabean, maize, amaranths etc in oreas lying M Sule-tropsical - Warm temperate zones (1000-2300) In the higher reaches of temperate some (to maximu of 3000 m), potato, wheat, barley, and buck wheat were Sown

Figure: Research note concerning Failure of Monsoon in Central and North Western Himalaya and its Impact on Agriculture from M.S. Swaminathan's academic work

After spending years of research abroad, it was time in 1954, that he now decided to return to his motherland, India. This was also the time when he noticed the worrying condition that India was facing in terms of grain imports along with natural calamities and famine-like situations. This was a thought-provoking situation and therefore, he collaborated with Norman Borlaug and convinced him

Reference:

I. https://catalogue.archives.ncbs.res.in/repositories/2/digital_objects/299

2. Gopalakrishnan, G (2002). M.S. Swaminathan: One Man's Quest for a Hunger-free World. Education Development Centre

to send supplies for a range of Mexican dwarf varieties of wheat, which were to be bred with Japanese varieties for which later, Nobel prize was awarded to Norman Borlaug in 1970.

Dr. M.S. Swaminathan not only revolutionised India but also bridged the societal gaps as well as helped us understand the value of self-sufficiency (Atma-Nirbharta)!

Even though we had to witness his demise on 28th September 2023, he will always be remembered as a remarkable personality in the revolutionary history of our country.

> Pavni Rekhi and Shreya Joshi M.Sc. Biotechnology TERI School of Advanced Studies

TERI POST

Reporting to you the advancements straight from The Energy and Resource Institute, New Delhi

TERI'S ADVANCED OXIDATION TECHNOLOGY (TADOX®) FOR WASTEWATER TREATMENT



NEWS TERI UPDATES



- ✓ Wastewater Treatment (WWT) has following major issues:
- ✓ (1) Colour & toxicity,
- ✓ (2)Sludge,
- (3) Low biodegradability,
- ✓ (4) Fouling of membranes,
- ✓ (5,6) Highly resource & energy intensive tertiary treatment, which makes ZLD costlier, unsustainable, unacceptable and







Solution



POLLUTANT

Benefits of TADOX[®]

- ✓ Removal of color & organics
- Improved shock load bearing capacity of biological treatment systems
- Improved biodegradability
- ✓ Less use of chemicals, hence less sludge $-0.5 \, \text{Kg/m}^3$



Addressing the complex water sanitation and challenges requires collective action and collaboration at all levels. TERI being a premiere multidimensional organization is actively working in the domain of wastewater treatment and water reuse and has developed a technology called TERI Advanced Oxidation Technology (TADOX®)

(https://youtu.be/tCt5rxC7eik) provides treatment wastewater generation; for e.g. from avg. 30-40 Kg/m³ to 0.2 stream containing high colour, chemical oxygen demand Photo catalysis ✓ Clean & green approach (COD),biochemical oxygen ✓ No start up time demand <u>(BOD), total</u> oxygen ✓ Stream specific treatment leading to reduced dissolved demand (TOC), total treatment time from avg. 36-48 h to 4-5 h organics, micropollutants, nonsplitting bond ✓ High resource & energy efficiency biodegradable and persistent HO' 02 organic pollutants (POPs) in Small footprint / land requirement effluents from grossly polluting ✓ Reduced capital expenditure by 15-20% and CO2, H2O, NH4, NO3, SO4, CI industries and municipal operational expenditure by 20 - 30% wastewater. TADOX® is under While access to clean water and sanitation is a fundamental human right, billions of TERI's Patent and a registered people across the world still face dire situation of water scarcity and inadequate Trademark and involves UVsanitation conditions. The rapid population growth, climate change, pollution, and Photocatalysis as an advanced inefficient water management practices will further exacerbate the problem. India is oxidation Nanotechnology setting a positive example at the Global level towards efficient water resource (AON), leading to oxidative management through its National Missions which are centred around the theme of degradation and mineralization 'Water' like the NamamiGange Programme or the NationalMission for Clean Ganga, of targeted pollutants.





Also, it involves novel approaches that make very This project is funded by the National Mission for little use of chemicals in the overall treatment Clean Ganga (NMCG), Ministry of Jal Shakti (MoJS), leading to a much reduced quantity of sludge, Govt. of India. It becomes imperative for us to preventing secondary pollution and providing enhance the quality and quantity of treated highly resource- and energy-efficient treatment. wastewater, such that it becomes available to various TADOX® technology is truly clean and green, stakeholders for non-potable reuse while the involving very little use of chemicals, less sludge freshwater sources are available for potable use, generation and associated secondary pollution groundwater depletion could be prevented and and aesthetic issues. Industrial effluents from overall water conservation could be envisaged highly polluting sectors like textiles, tannery, through advanced technology adoption. TADOX® pharmaceuticals, oil & gas, chemical & fertilizers technology is an advanced clean and green solution, involving very little use of chemicals, less sludge have been treated by TADOX® technology to generation and associated secondary pollution and achieve Zero Liquid Discharge(ZLD) mandate in a much more affordable and sustainable manner aesthetic issues. Treatment within a few hours holds a and also enhance treated wastewater reuse. A great scope of augmentation and enhanced 10,000 litre per day (10KLD) TADOX®-based treatment capacity of existing STPs, ETPs and CETP. wastewater treatment plant has been running The high quality of treated water not only meets the successfully since August 2020 for the treatment NGT and CPCB surface discharge norms but also for of mixed sewage that is composed of wastewater reuse for high-end non-potable water reuse from toilets, research laboratories, hostels, applications thus reducing the dependence on canteens, laundry etc. No stream segregation of freshwater. The technology is ready for field any kind is required. Another 20,000 litres per implementation through licensee partners. The first day (20 KLD) TADOX® Plant at Textile CETP in license has been signed with Dew Projects and Kanpur has been developed and commissioned Chemicals Pvt. with the objective of optimizing the wastewater treatment efficiency, improving the quality of Dr. Nupur Bahadur & Team treated water and increasing water The Energy & Resource Institute, India reuse efficiency of this cluster.

ENVELOPE TERI SAS UPDATES TERI SAS UPDATES TERI SAS UPDATES TERI SAS UPDATES TERI School of Advanced Studies in a nutshell

Journey Through Microbial Pathogens, Collaboration, and Research Insights with Dr. Sitaraman



Sitaraman, Ramakrishnan Dr. Professor Department of Biotechnology, TERI School of Advanced Studies, is an avid researcher with deep rooted interest microbial pathogens and in restriction-modification enzymes. His journey into this field was spurred by a fascination with biology, leading him to specialize in microbiology

and the study of microbial pathogens during his doctoral lab rotations. Specializing in microbial pathogenesis, Dr. Sitaraman employs genetic approaches to unravel the strategies of microbes, focusing particularly on *Helicobacter pylori* and *Bacillus anthracis*. His research on *H. pylori* delves into the role of phospholipases as virulence determinants, considering its unique association with gastric cancer. In *Bacillus anthracis*, he investigates restriction-modification systems to understand its biology within the *B. cereus* group. His diverse research also extends to practical applications, including the development of a plate-based system for synergistic hemolysis assays and the innovative use of azobased food colors as cost-effective tracking dyes for electrophoresis.

Throughout his research career, Dr. Sitaraman has faced challenges, enduring periods of monotony before achieving breakthroughs and navigating the patience-testing waiting game for material orders. These challenges, though demanding, have instilled in him a deep sense of perseverance. Collaborative and interdisciplinary work has enriched Dr. Sitaraman's research journey. His partnership with Prof. Vineet Ahuja from the All India Institute of Medical Sciences, New Delhi, on projects related to *H. pylori* has provided valuable insights. This collaboration has exposed him to the concerns of clinicians and patients, offering a perspective often overlooked in basic research and guiding him towards endeavors with immediate clinical relevance.

For aspiring scientists, Dr. Sitaraman recommends a multifaceted approach, including engaging in the creation of synthetic reviews, formulating hypotheses, and sharing knowledge through teaching or consulting. He emphasizes the therapeutic value of nature walks for inspiration.



2nd-year M.Sc. Biotechnology students attended the 13th India Probiotic Symposium on "Science-Based Benefits of Probiotics for Human Health" at the Institute of Liver and Biliary Sciences.



The Department of Biotechnology at TERI School of Advanced Studies celebrated Teachers' Day with heartfelt gratitude and joy. On this special occasion, we extended our warmest wishes to the remarkable teachers who have left an indelible mark on our lives.



Team Biotikos organized a lecture by Dr. Malathi Lakshmikumaran on the Crucial Role of Biotechnology Patents, which took place on October 4th. Dr. Lakshmikumaran's engaging talk immersed us in a wealth of knowledge, and her powerful message, 'Invention is a Problem-Solving

In closing, Dr. Sitaraman shares some of his favorite reads, including "Flowering Earth" by Donald Culross Peattie, "The Life of the Bee" by Maurice Maeterlinck, and "Microbe Hunters" by Paul de Kruif.

Answers to BioCode Challenge:

Down:

I. Genomics; 3. HGP; 4. Hotspots; 5. Microarrays; 6. Homologous; 7. GMO Across:

2. Poaching; 8. Ecosystem; 11. Ligases; 12. Tandem Repeats; 13. Transgenics; 14. Habitat

Approach,' ignited our minds to innovate and protect.

<u>For previous edition, click here</u>



Team Biotikos organized a lecture by Dr. Deepak Prem on October II. Dr. Deepak Prem's talk illuminated diverse career paths in biology and highlighted the potential for impact in life sciences and industry.

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<u>We value your feedback. Click here to give your valuable review.</u>

