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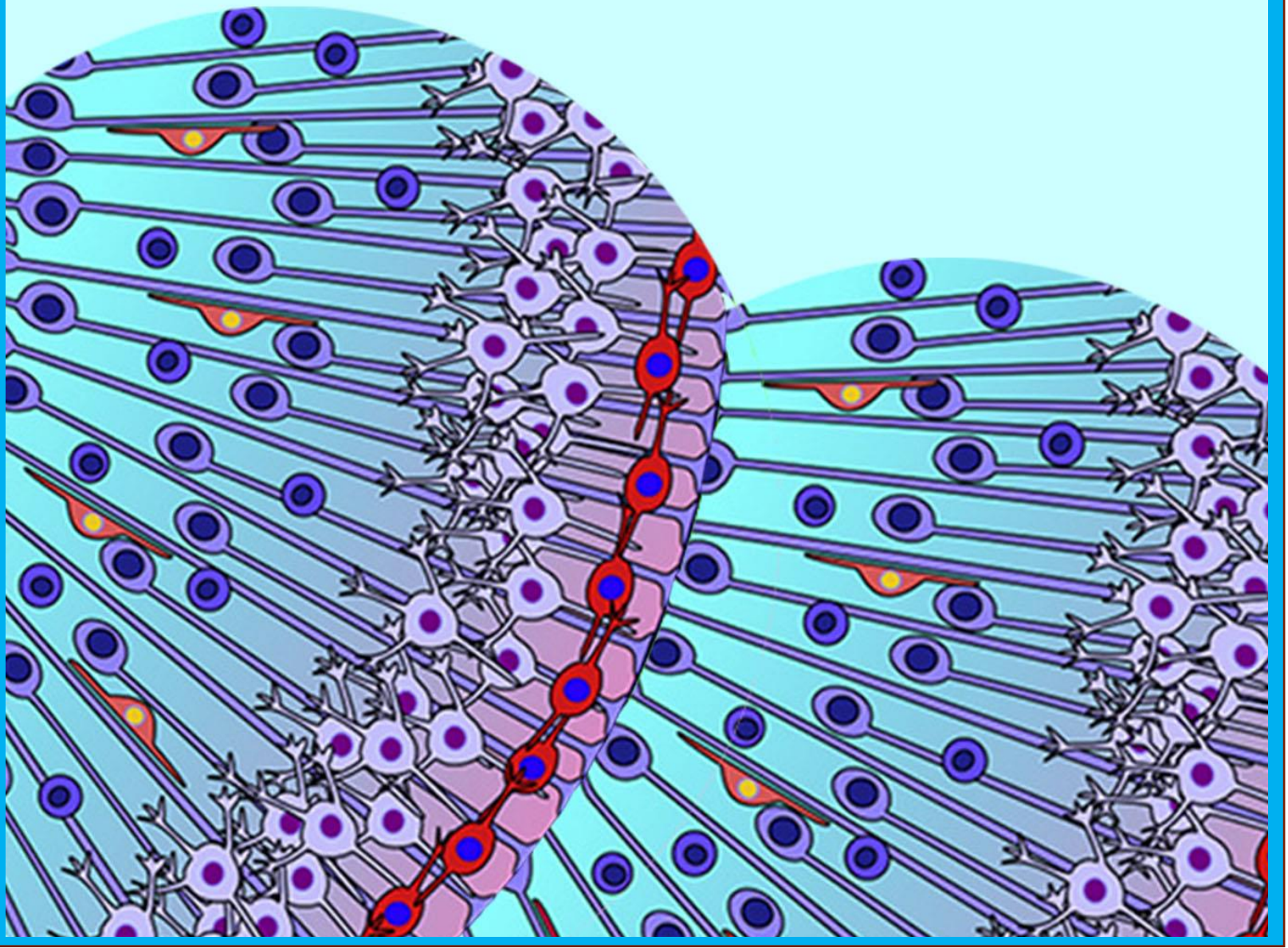

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From the Publisher's Desk

Welcome to Biotechnology Kiosk!

The 9th issue of Biotechnology Kiosk (BK) is ready for our readers with the regular features that include high-end editorials by experts, biotechnology advances around the world and industry news from pharma and biotech sectors.

This issue contains several scholarly editorials on the cutting edge topics including neural tissue engineering, advances in enzyme technology and geomicrobiology and microbial biotechnology along with editors' pics on oceanography and fisheries science, stem cells and neurodegeneration and many more reporting on research breakthroughs from around the world.

We are happy to announce that we have now added sections on 'Aims & Scopes and Editorial Policies to BK. Please check out these additions by going to the menu of BK on the website (https://biotechkiosk.com/). We are now open to consider manuscripts in all areas of biotechnology for publication in BK. Please go to the sections 'Aims and Scope' to submit your manuscripts to BK. We are also proud to announce partnering with a very well-known trade magazine in the United

States, Vacuum Technology & Coating (https://www.vtcmag.com/) to launch a special edition of Vacuum Advances in Biotechnology. Please check out the call for papers that is posted to BK's website. We look forward to receiving your contributions. We are tirelessly working to make BK better and better with all the required information that our readers may need to update about the latest discoveries and inventions happening around the world.

We do hope that you will enjoy reading this issue of Biotechnology Kiosk. Please do write to us with your comments and feedback. Your suggestions are always appreciated. **Dr. Megha Agrawal and Dr. Shyamasri Biswas**

Executive Publishers and Editors

Contents

VOLUME 2, ISSUE 2 FEBRUARY 2020

COLUMNS

Regenerative Medicine

By Megha Agrawal, PhD

Executive Editor

Can Neural Tissue Engineering Lead to New Type of Central Nervous System?

Generation of Biologically Relevant Architecture to Repair Damaged Tissue in the Central Nervous System

Several studies have shown that neural damage is one of the most untreatable causes of long-term disability in patients that have suffered moderate to severe destruction of the tissue architecture in the neural system. This damage in the neural system can occur via slowly progressing neurodegenerative medical conditions such as Alzheimer's disease, which is perceived as the initiator of disorganization of the neural tissue structure [1, 2]. There are several mechanisms that have been studied including the accumulation of extracellular amyloid plaques and the overexpression of laminin. The production of intracellular aggregates of hyperphosphorylated tau protein has also been considered as a factor causing neural tissue damage. Such aggregation of tau protein along with other factors can lead to modulation of the cell function, which eventually results in damage in the surrounding tissue architecture in the central nervous system (CNS) [2, 3].

Researchers have shown the possibility to regenerate large sections of lost or damaged CNS tissue mostly in animal models [4]. However, during regrowth of the CNS tissue, it results in disorganized tissue architecture that does not produce the desired function of the CNS [2]. An alternative route that has been proposed to overcome this limitation of loss of function includes generation of biologically relevant tissue architecture for prime tissue regeneration. This can be done through incorporation of engineered tissue microenvironments [2, 5]. However, to achieve best results, it is suggested to gain the ability to control over the generation as well as delivery of patterned microenvironments into tissues that are targeted for regeneration [2].

It is believed that the ongoing advances in developing cutting-edge biomaterials for regenerative medicine can prove to be a game changer that can pave the way for neuron replacement therapy. It can lead to new types of CNS for effective treatment of neural tissue damage [6]. To this end,

researchers are currently focusing on the development of bio-techniques and processes to create and use multiphase microstructured hydrogels (mostly granular hydrogels or microgels) [2]. This is expected to enable researchers to generate cultures with more biologically relevant architecture. The use of these structured hydrogels is believed to be critical for the development of new types of CNS culture models and therapies [2].

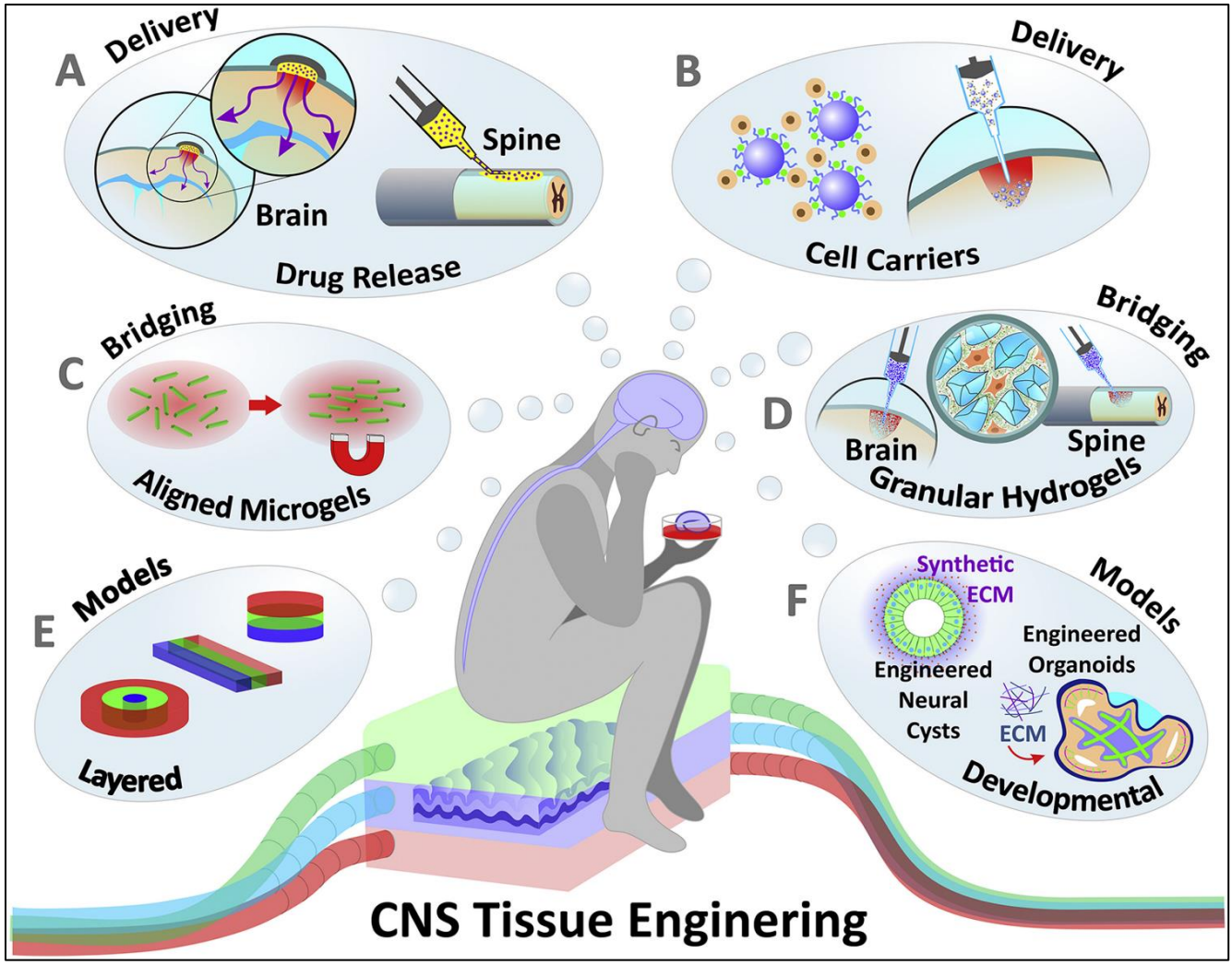

Figure 1: The production and applications of structured hydrogels in CNS models and therapy. (A) Hydrogels for controlled release of soluble factors for drug delivery applications. (B) Drug carriers that support cell transplantation. (C) Production of aligned hydrogels that can guide axon growth and neurite orientation. (D) Applications include bridging scaffolds composed of microgels and granular gels for neuronal growth across damaged tissues. (E) Production of layered hydrogel architectures to spatially confine neurons to mimic in-vivo tissue structure. (F) Hydrogels for the generation of neuroepithelial cysts and CNS organoids [Source: Biotechnology Advances (2019)].

Tissue Engineering of CNS Using Advanced Hydrogels

Cells are the principal agents of tissue function. Other important agents are the dynamically changing extracellular matrix (ECM) and the hierarchically structured arrangement of cells and ECM within the extracellular environment. This structural arrangement of cells and extracellular matrix (ECM) changes constantly throughout the tissue building process [2]. Hence, this poses a significant challenge for in-vitro controlling of the 3D structural arrangement of cells that can replicate natural tissue physiology [2].

The application of hydrogels in tissue engineering has shown a lot of promise to overcome the challenges in controlling 3D structural arrangements of cells. These hydrogels are commonly chosen for their extraordinary functional properties and they are adapted for use as support matrices for neural cultures (Figure 1) [2]. Researchers have employed a number of different techniques to impart the required microstructure to hydrogels for different applications [2]. Some of the approaches include the addition of microscale particles that have anisotropic shape that allows to align with physical force. This helps physical confinement of the hydrogel to create aligned fibrils. Other techniques include applications of magnetic fields to directly modulate the alignment of magnetic particles within a hydrogel or indirectly align hydrogel fibrils [2]. Researchers have also demonstrated the possibility of producing arbitrarily complex microscale patterns within hydrogels [2, 7].

Embryonic Development: Producing CNS Organoids

An embryonic organization as well as tissue function in adulthood can be achieved by gene expression and different stages of patterning. To this end, researchers have conducted investigation of in-vitro models of early development to better understand these principles of replication. In this regard, different organoid models have been highlighted for producing different types of CNS organoids in healthy and disease states [8]. The availability of stem cells and early stage differentiation protocols have facilitated innovation to develop organoids for a new type of CNS [2]. Matrigel that belongs to the family of hydrogels has been leveraged to support the polarization of surface cells into organized cell sheets that form the basis of downstream organoid patterning [2]. Matrigel is known for its structural versatility that is composed of a mixture of biological components. Researchers have investigated synthetic PEG hydrogel in combination with a library of purified proteins that were derived from or related to the constituents of Matrigel. This was aimed to generate neuroepithelial cysts from mouse stem cells encapsulated within the hydrogel (Figure 2A) [2].

Scientists generated the neuroepithelial cysts from an encapsulated population of single cells to produce organoids that were formed from clusters of 2000 or more cells encapsulated within a drop of Matrigel [2]. This approach allowed neural induction that was followed by organization of the neuroepithelial cyst on the surface of the organoid. The surrounding Matrigel coat provided support in a similar way to basement membrane in-vivo (Figure 2B), and the polarized cell sheets replicated the formation of cell sheets within the early

embryo (Figure 2C) [2]. In the more mature organoid, these neuroepithelial-like sheets were shown to undergo developmental patterning similar to early neural tube growth in embryogenesis (Figure 2D) [2]. Further, it was observed that the Matrigel coat weakened with the increase in size of the organoid tissue. Figure 2E shows an early embryo, in which the neural tube is surrounded by a laminin rich basement membrane [2].

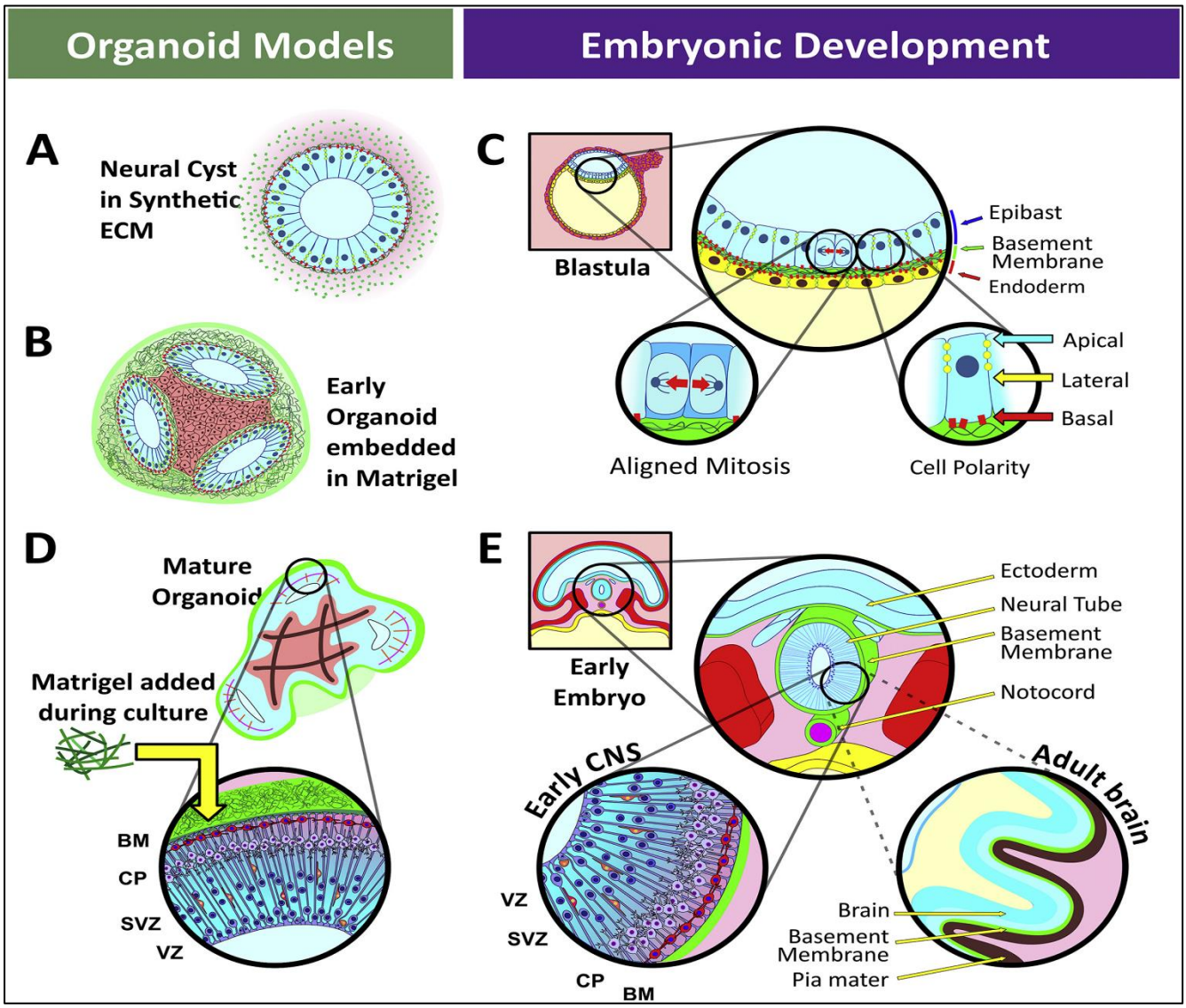

Figure 2: Comparative hydrogel based models for embryonic development [Source: Biotechnology Advances (2019)].

Concluding Remarks

The current research and developments in CNS organoids have shown tremendous promise that could pave the way to the discovery of how of relevant biological patterns needed to replicate and repair the complex tissue microenvironment for

regrowth of a new type of CNS. Such medical breakthroughs in neural tissue engineering could provide solutions to the complex and untreatable problems of CNS tissue damage that results in the loss of neuronal and glial cells.

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Microbiology & Climate Change

By Shyamasri Biswas, PhD

Executive Editor

Role of Microorganisms in Climate Change Biology

Microorganisms and Microbial Biodiversity

Microorganisms are believed to have existed since the origin of life on Earth, which dates back to at least 3.8 billion years ago [1]. They are the sole life forms in all environments and they thrive in all environments including the deep subsurface and extreme environments that are occupied by macroscopic organisms on earth [1]. Microorganisms are usually invisible to the naked eye. But, their abundance and robust presence (~1030 total bacteria and archaea) along with the appreciable diversity make them critically important and significant contributors in maintaining a healthy global ecosystem [1-4].

Thus, it is believed that the microbial world constitutes the life support system of the biosphere. Microorganisms are also believed to be crucial in regulating climate change. They make major contributions in carbon and nutrient cycle. Particularly, they are known for their contribution to carbon sequestration, especially marine phytoplankton that consume as much net CO2 as terrestrial plants [1]. In addition, they play key roles in animal (including human) and plant health, agriculture and the global food web [1].

However, there is a major concern that the current rapid pace of changes in microbial biodiversity and activities globally could potentially affect the capacity of all other organisms that could eventually diminish their ability to respond to climate change. For example, unfavorable environmental changes that negatively affect marine microbial photosynthesis and subsequent storage of fixed carbon in deep waters could bring catastrophic effects to the global carbon cycle [1]. So, currently there is a significant emphasis on undertaking research to understand human effects on microorganisms that have been less studied and characterized so far [1-4].

There are many research questions that need to be addressed including influencing factors that can balance the microbial greenhouse gas capture versus emission. Especially, it is critical to understand the biome, the local environment, food web interactions and their responses in

addition to anthropogenic climate change and other human activities [1]. So the goal is to understand how microorganisms affect climate change (including production and consumption of greenhouse gases), and also how microorganisms will be affected by climate change and other human activities [1].

Microorganisms and Climate Change With Respect To Marine and Terrestrial Biomes

About 70% of Earth's surface is covered by marine biomes. This include coastal estuaries, mangroves and coral reefs to the open oceans (Figure 1) [1]. The sun's energy in the top 200 m of the water column is used by phototrophic microorganisms. On the other hand, it is believed that marine life in deeper zones uses organic and inorganic chemicals for energy [1, 5]. The composition of marine communities is influenced by sunlight and other available forms of energy water temperature (ranging from approximately −2 °C in ice-covered seas to more than 100 °C in hydrothermal vents) [1, 6].

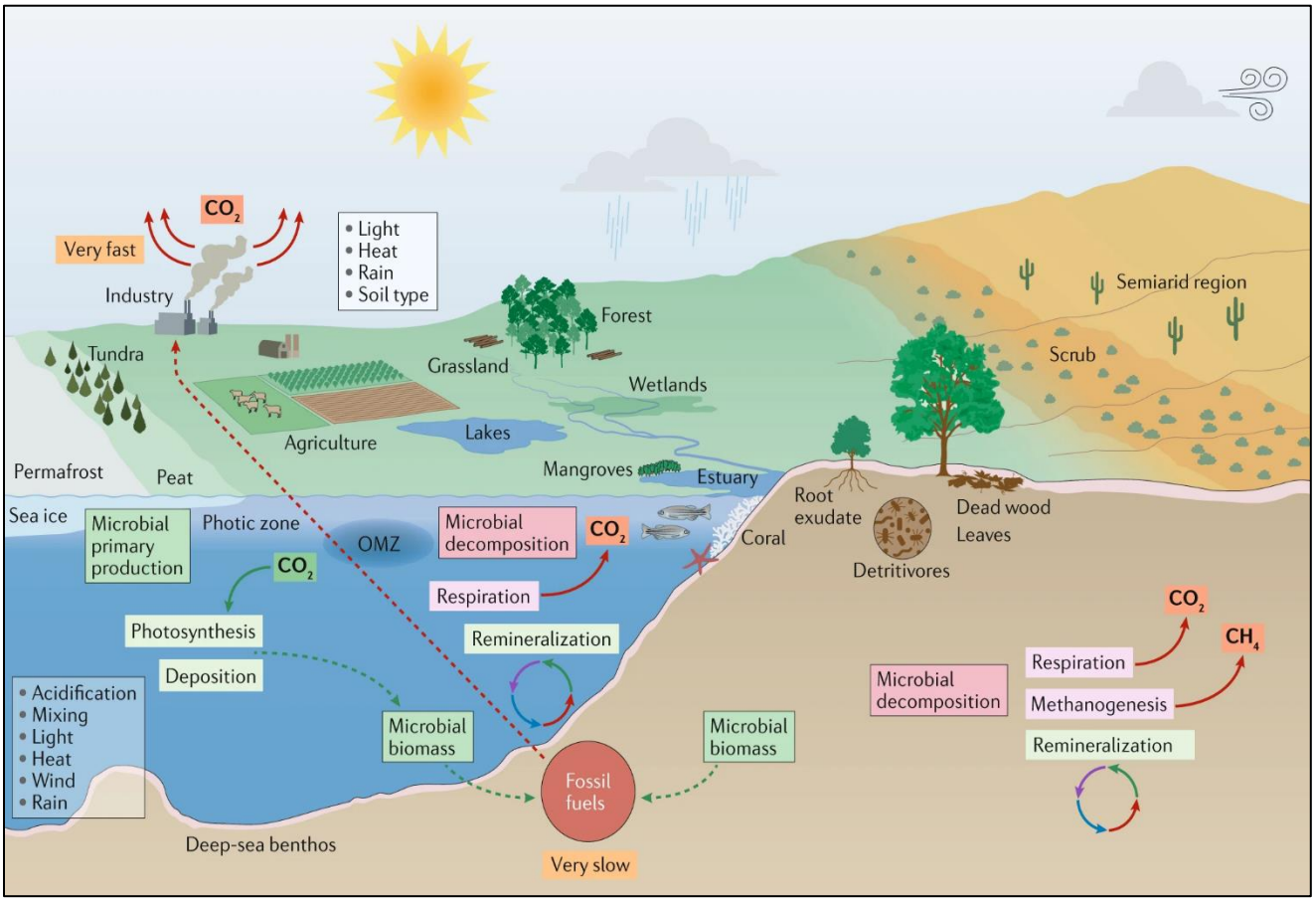

Figure 1: A pictorial depiction showing how microorganisms and climate change occur in marine and terrestrial biomes [Source: Nature Reviews Microbiology (2019)].

Previous studies have shown that rising temperatures not only affect biological processes but also it can reduce water density [1]. This can result in stratification and

circulation affecting organismal dispersal and nutrient transport [1]. Stratification, mixing and circulation are also affected by precipitation, salinity and winds. Further, it has been found that microbial community composition and function all are affected by nutrient inputs from air, river and estuarine flows, and climate change affects all these physical factors [1].

Researchers have shown microbial primary production contributes substantially to CO2 sequestration in marine environments (Figure 1) [1]. During the process of releasing CO2 to the atmosphere, marine microorganisms also recycle nutrients for use in the marine food web. It has been observed that microorganisms are the key decomposers of organic matter in a broad range of terrestrial environments, where they release nutrients in the soil for plant growth as well as CO2 and CH4 into the atmosphere (Figure 1) [1]. Studies have confirmed that over millions of years, conversion of microbial biomass and other organic matter (remnants of plants and animals) to fossil fuels has been happening at a regular pace. By contrast, it has been found that burning of fossil fuels liberates greenhouse gases in a small fraction of that time [1]. This puts the carbon cycle out of balance, and as a result, it is predicted that atmospheric CO2 levels will continue to rise as long as fossil fuels continue to be burnt (Figure 1) [1]. Additionally, the complex network of microbial interactions that occur with other microorganisms, plants and animals are significantly influenced by the effects of human activities, including agriculture, industry, transport, population growth and human consumption. This can also be combined with local environmental factors, including soil type and light [1]. All these observations on interactions indicate that how such microorganisms respond to variations and it affects climate change including for example, through greenhouse gas emissions [1]. This also strongly suggests how climate change including higher CO2 levels, warming, and precipitation changes can affect microbial responses [1].

Microorganisms and Climate Change With Respect To Agriculture and Other Human Activities

Microbial communities are influenced by various agricultural practices influence in specific ways [1]. For example, plant type and land usage and sources of pollution including chemical fertilizers can significantly alter microbial community composition and function. This can result in perturbing natural cycles of carbon, nitrogen and phosphorus transformations [1]. Further, it has been observed that methanogens can produce substantial quantities of methane directly from ruminant animals including cattle, sheep and goats. This also includes saturated soils with anaerobic conditions, which are basically rice paddies and constructed wetlands. It can be concluded then from this observation that lesser human activities that cause a reduction in microbial diversity can also simultaneously reduce the capacity for microorganisms that can help support plant growth [1].

In addition to the anthropogenic methane production associated with standard fossil fuels, studies have shown that methanogens can also produce methane in natural and artificial anaerobic environments

including sediments, water-saturated soils such as rice paddies, gastrointestinal tracts of animals (particularly ruminants), wastewater facilities and biogas facilities (Figure 2) [1, 7]. It is to be noted that atmospheric oxidation and microbial oxidation in soils, and sediments and water act as the main sinks for CH4 [1, 7]. Recent studies have indicated a sharp rise in the atmospheric CH4 levels in recent years (2014–2017). However, the reasons for this rise are unclear so far. It is generally believed that such rise in CH4 levels might involve increased emissions from methanogens and/or fossil fuel industries and/or reduced atmospheric CH4 oxidation, which indicate a potential major threat to efforts in combatting climate warming (Figure 2) [1, 8].

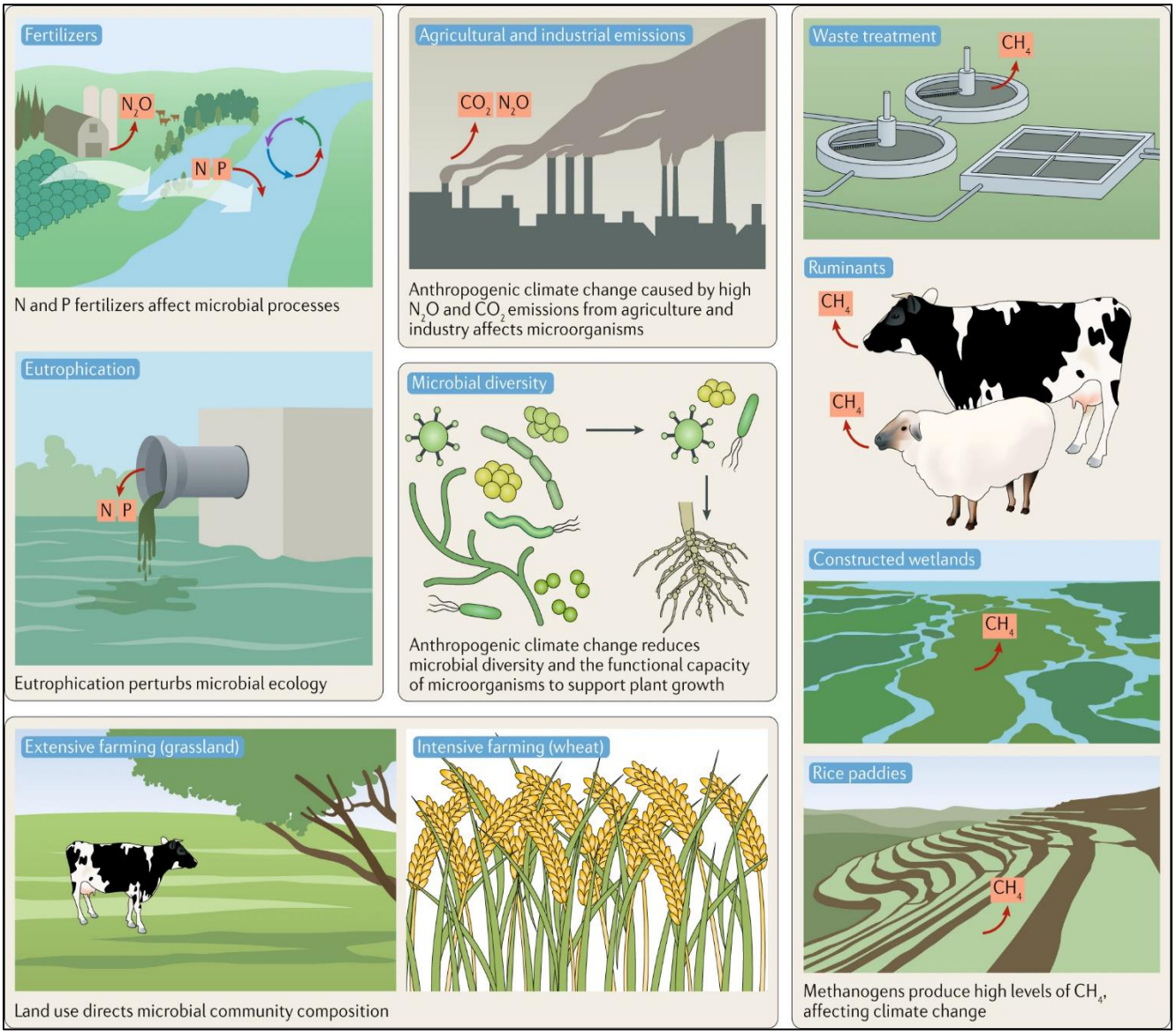

Figure 2: Agriculture and other human activities are shown that can affect microorganisms [Source: Nature Reviews Microbiology (2019)].

Concluding Remarks

The ongoing research efforts have clearly indicated the central role and global importance of microorganisms in climate change biology. Researchers have apparently established a consensus on the observations that responses of microorganisms will heavily impact and govern climate change. A positive and favorable scenario in the responses of microorganisms to the changing climate could essentially achieve an environmentally sustainable future.

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Geomicrobiology & Microbial Biotechnology

Balaram Mohapatra, PhD & Pinaki Sar, PhD

Microbial directors re-direct underground arsenic (As) horror story scaring millions of inhabitants worldwide

Arsenic horror story: Hundreds of millions are trapped

We are blessed because of our science discoveries and inventions and especially the chemists for letting us know about the periodic table of the elements. But, what if one of the member of the table is cruel to us. Yes!!!!! its Arsenic (As), a metalloid of the Nitrogen family and present in Earth's crust, sediment minerals, many pesticides/fertilizers, plasticizers and it is toxic and carcinogenic; means can cause cancer in humans and other animals. But over-burdening of As in groundwater and related health hazards are becoming a high-profile problems throughout the world and is called as "Worst mass poisoning in 21st Century". Horror stories of arsenic (As) poisoning in drinking water and groundwater have appeared in many news and press articles. The Economic Times in politics and nation section on Dec 24th, 2017 stated that 239 million people across 153 districts of 21 states in India drink water that contains unacceptably high levels of arsenic (> 10 µg/Litre) means being slowly poisoned, and 19 % Indians drink water with lethal As levels (https://economictimes.indiatimes.com/news/politics-and-nation/19-of-indians-drink-water-with-lethal-levels-of-arsenic/articleshow/62228448.cms) In Lok Sabha (the upper house), Ministry of Water Resource stated that 65 % of Assam's population, or about 21 million people drinking arsenic-contaminated water, while it's 60 % in Bihar, 44% in West Bengal, 7.4% I Punjab, M.P, 7 % in Gujarat and Haryana, and 4 % Andhra Pradesh, and Tamil Nadu. Uttar Pradesh has the largest number of people, over 70 million, exposed to arsenic-contaminated water, in absolute terms. The horror also applies to cross-border/neighbours in South-East Asia where 60 million inhabitants in Pakistan, 77 million in Bangladesh, another 150-200 million in China, Cambodia, Vietnam are under high risk of developing As health hazards, and it goes on. Other countries are not spared from its grudge, because many South-American and European countries are also affected with groundwater As problem and it has gone

global and will be bigger in future. Because As is in our every commodities, many new reports have come highlighting many cases of As in food and food products. UK's largest daily INDEPENDENT reported 80 % of infant formulas, 60 % of 530 different snacks, cereals, formulas and drinks shows levels of As. Another report in INDEPENDENT published three quarters of rice products sold as baby food found to contain illegal levels of arsenic marketed throughout European countries. Even, scientists are warning that common method of cooking rice (parboiling) leaves levels of arsenic in food and many feeds supplements for poultry are with dangerous levels of As and Bottled water of famous brands found to have high levels of arsenic and hence pulled from stores in many countries, thus As is everywhere now in the food chain and it will be there through root-to-gut.

Sources, causes and factors: Who to blame???

In India, until 1960 people were relying on surface water as primary water resources but due to intestinal disease incidents like cholera and diarrhoea, people started using groundwater by installing tube-wells/hand pumps of lower depth. In 1980s, cases of As in the urine and blood samples of inhabitants opened the eyes of scientist and policy makers to look deep into the problem and retraced its path to groundwater (1). The toxic As present in groundwater or drinking water comes from natural source that is geogenic (geological) means this As is naturally present in the sub-surface sediment of the aquifer (underground layer of water-bearing permeable rock). The sediment hosts or composed of various minerals rich in Fe, Al, Mn in the form of Fe-oxides, hydroxides, their pyrites, carbonates, sulphides, and other silicate minerals like phyllosilicates, onto the surface of which arsenic (As) adsorbs or precipitates or co-precipitates (2). It is long way back in geologic past of around million years back, where major rivers like The Ganges, Brahmaputra and several others were evolved from Himalayan glaciers and carried/transported all the sedimentary deposits with them (fluvial deposit) and deposited along their flow paths along the planes of India and Bangladesh and same with other countries. In the due course, the minerals weather, oxidize, precipitates with As and form sedimentary deposits with As in them. But, microbial members/community key players interact with sediment minerals to release the As and other sources like mines (coal, fossil fuels) activities, agricultural activities and run-off, severe groundwater abstraction, irrigation of As contaminated water, lesser groundwater recharge, contaminant percolation to sub-surface aggravates the situation further, which is depicted in Figure 1.

Microbial directors underground: Arsenic story makers

Several hydrogeologists have described certain sub-surface geological factors to be the main cause of As problem in the groundwater. But, in the recent decade geomicrobiologists have proved that microbial community members and their dynamic physiological role to be one of the key driver of As solubilisation or mobilization from sediment to the groundwater. As we all know that microbes are omnipresent and omnipotent.

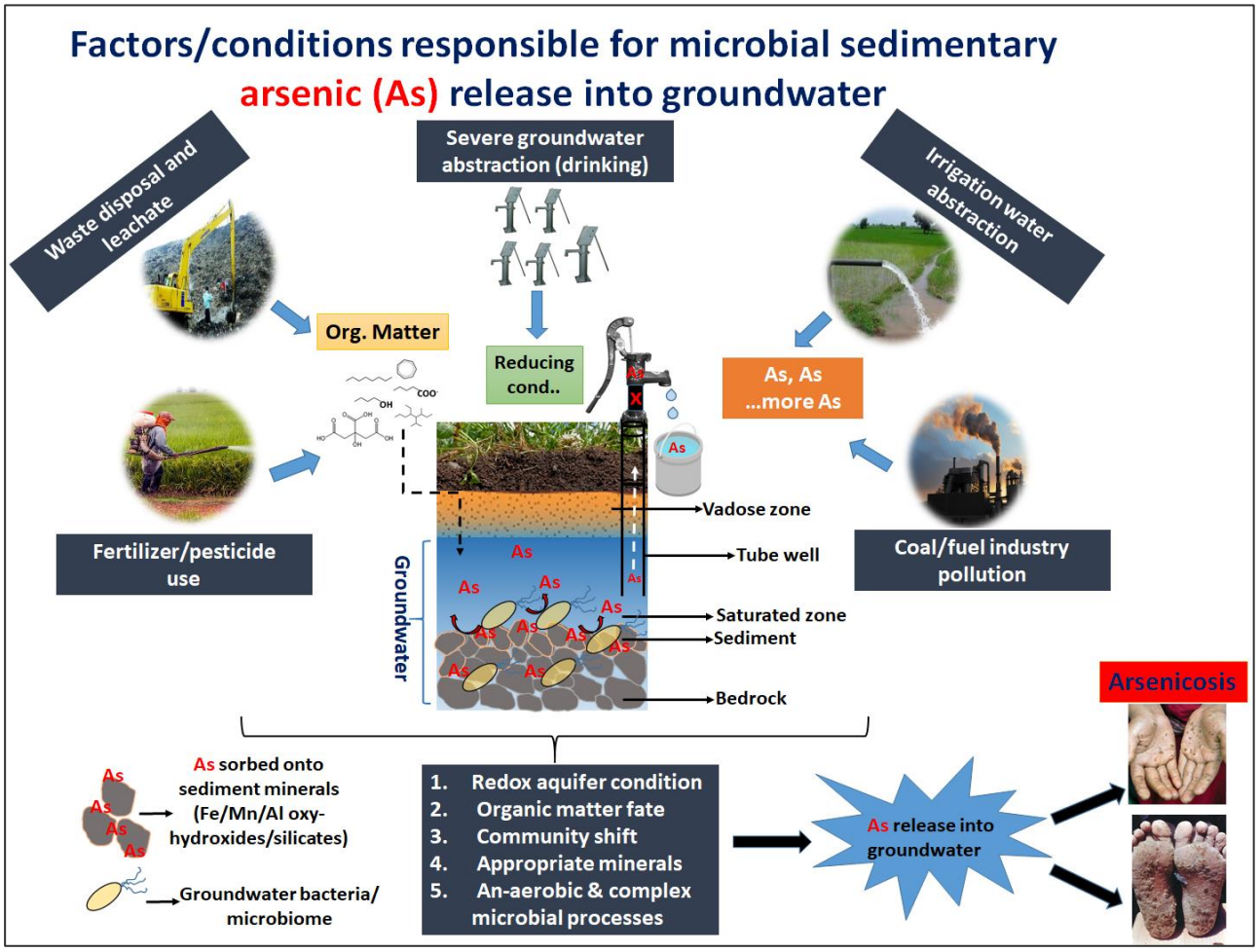

Figure 1: Schematic representation of the multipartite factors responsible for high arsenic condition in the groundwater of West Bengal in India as well as other areas and microbial members contributing in release of arsenic from sediment into the groundwater.

Bacteria-As-sediment interaction has been found to be a prominent mechanism for mobilization of sediment bound As into the groundwater of Bengal, India has been the point of greatest debate for sustainable groundwater management. Indian geo-microbiologists, especially researchers at IIT Kharagpur, India have deciphered the sediment-groundwater microbial communities and their diverse roles played underground (3-5) by isolating and characterizing more than 250 bacteria from groundwater and sediment samples of Bengal, India. Culture independent technologies involving next generation sequencing: metagenomics and Geo-chip etc. have emphasized the abundance of facultative anaerobic bacterial residents belonging to phylum *Proteobacteria* (*Rhizobium, Pseudomonas, Xanthomonas, Achromobacter), Actinobacteria (Rhodococcus, Arthrobacter*), Firmicutes (Bacillus) (images are presented) in theAs-contaminated groundwater of Bengal, India . These microbes are found to encode several genes like arsenite (As3+) oxidase (*aioAB*),

arsenate reductase (*arsC*), arsenite transporter (*arsB*), arsenite pump (acr3), As regulator (*arsR*), etc. to transform As from sediment to groundwater. For the first time, three bacteria were named and described as novel bacteria from As-contaminated groundwater of India as: *Rhizobium arsenicireducens* (published in Achieves of Microbiology), *Pseudoxanthomonas arseniciresistens* (published in Plos One), and *Achromobacter arsenitransformans* (published in Journal of Env. Science and Health Part-A), which showed versatile As transformative capacities (6-10). Next level studies like whole genome sequencing and X-ray based technologies (X-ray absorption of near edge structures, X-ray diffraction, and X-ray fluorescence) proved the multifaceted role of bacteria in metabolizing hydrocarbons, reducing Fe (dissimilatory Fe reduction), nitrate (NO3-), nitrite (NO2-) (denitrification), ammonia (NH4+) oxidation, methane production (methanogenesis), and subsequently mobilize As from sediment minerals to groundwater.

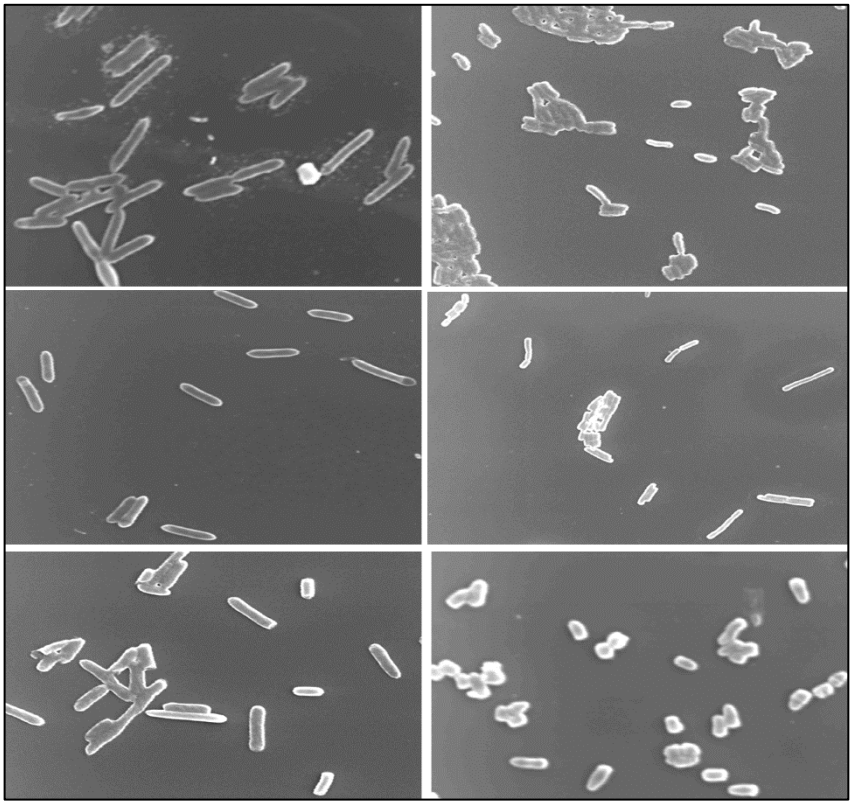

Figure 2: Electron micrographs show some of the isolated bacterial members from arsenic-contaminated groundwater of Bengal, India which show high arsenic transformation properties.

Arsenic removal technologies: The biological step and future prospects

Sub-surface ecology with changing nutrient flux, electron donors, acceptors, carbon, large surface, contrasting pH and temperature, hydrostatic pressure, and dissolved salts hosts dynamic microbial communities with vast array of metabolic pot-

ential and has been treated as “blackbox”. Since, aquifer or groundwater environment is ideal for sediment mineral-microbe interactions with metal and nutrient biotransformation abilities, more focus on groundwater-sediment microbiology and biogeochemistry is imperative to understand many geomicrobiological processes. With respect to role of microbes in As-geomicrobiology, key microbial members use the sedimentary organic matters (as hydrocarbons, sugar acids, etc.) and other energy rich inorganic nutrients for their survival or metabolism and acts upon sediment facies to remove or release As using oxidative-reductive reactions. Biological water treatment methods are considered to be a suitable approach to overcome these problems and they have attracted considerable research interest over recent years. Efforts on removal of arsenic has been performed by using bacterial consortia, pure cultures of arsenic resistant bacteria or iron- and manganese-oxidizing bacteria to transform and/or capture arsenic forms indirectly. One of the innovative technology for arsenic removal has been used biocolumn reactors consisting of immobilized bacterial cells capable of arsenic adsorption where a low cost biocomposite granules of cement coated with cysts of Azotobacter were used for arsenic removal from drinking water [93] that has claimed to remove 95 % of As. Besides bioremoval, bacterial oxidation of As (III) to As (V) is an alternative approach to treat contaminated water instead of using conventional oxidants (i.e., potassium permanganate, chlorine, ozone, hydrogen peroxide). Some recent studies have been conducted to assess the As (III) oxidation efficiency of different As(III)-oxidizing bacteria like Ensifer, Rhodococcus, Acinetobacter. Instead of pure cultures, use of consortia like CAsO1 has been attempted but pose several limitations in viability, efficiency, and effects on the treated water. Hence it is imperative to explore the indigenous groundwater microbiome or microbial strains to decipher their complete metabolic processes in terms of As biotransformation. With advent of genome sequencing many bacterial genome sequencing is undertaken to study the evolution of arsenic metabolism. In addition, next-generation sequencing based microbial community metagenomics of As-contaminated environments and gene expression patterns is providing immense insight into the microbial potential to predict their behaviour under sub-surface environmental conditions to design, develop and succeed in strategizing As removal or management options in a sustainable way.

Author’s Biography

Dr. Balaram Mohapatra is a passionate environmentalist and an enthusiastic plant lover. Dr Mohapatra is a post-doctoral fellow in the Department of Biosciences and Bioengineering at the Indian Institute of Technology (IIT) at Bombay in India. His research activities are focused on gaining insight into the genomic and metabolic ways of microbial pollutant biodegradation. He received PhD in Biotechnology from the Department of Biotechnology, IIT Kharagpur in 2019 in the area of groundwater arsenic geo-microbiology and genomics. He has published over 15 international research publications based on innovative concepts of

arsenic detection, and filtration. His research paved the way in the discovery and naming of three novel bacterial strains from arsenic-impacted groundwater in the eastern states in India. With considerable research experience in cutting edge areas including genomics, community genomics, proteomics, and X-ray based advanced analytical technologies, Dr Mohapatra has expertise and unique skills to study and understand microbial communities and metabolic pathways for hydrocarbons degradation and metal-microbe interaction. Based on his outstanding reputation and his excellent research, he received several prestigious awards such as DST-INSPIRE (2013-2018), Young scientist award at IISF, DST, and National entrepreneurship competitions for pitching idea for start-ups on developing arsenic detection kit and filtration units. Dr. Mohapatra has been associated with international association on hydrological sciences (IAHS), global microbial identifier (GMI), society for human ecology (SHE), and student member of Deep Carbon Observatory (DCO). In near future, he aims to work on microbial metal bio-geo-cycling and pollutant biodegradation at soil-root-plant interface. Dr. Mohapatra can be reached at balarammohapatra09@gmail.com.

Prof. Pinaki Sar is currently a mentor and professor nurturing a group of young microbiologists and ecologists at Environmental Microbiology and Genomics Laboratory in the Department of Biotechnology, IIT Kharagpur. He has great interests in Microbial genomics, Geomicrobiology, and Environmental Biotechnology to explore and understand the microbiomes from ecological hot-spots like deep terrestrial subsurface, arsenic contaminated groundwater, impacted sites (Acid mine Drainage, Petroleum refinery, etc.) using next generation sequencing and culturomics technologies, their biogeochemical role relevant for environmental processes and solution strategies. His current focus aims to understand landfill microbiome and its application for Bioremediation of Environmental Pollutants with Tata Consultancy Services Limited. Other projects are on Arsenic from Root to Gut and the effect Arsenic contaminated groundwater on Rice Paddy Soil and its microbiome, biogeochemical cycles, and impact on Arsenic (As) Accumulation by the Rice plants. In one of the interesting ongoing project, Prof. Sar aims to understand the microbiology of deep granitic subsurface of Koyna-Warna region, where the team found digs up life in India from 2.5 billion years ago corresponding to great oxidation event and the news that has been highlighted and covered by Times of India (https://timesofindia.indiatimes.com/city/kolkata/iit-kharagpur-digs-up-life-in-india-from-2-5-billion-yearsago/articleshow/67617949.cms). He has been recipient of several awards and honors like Competitive Seed Challenge Grant, Young Investigator award from DBT, BOYSCAST fellowship, Atomic Energy Young Scientist award, DST Fast Track award and with several research publications in journal of national and international repute and has guided 11 PhD till date and several others are still continuing. Prof. Sar can be reached at sarpinaki@yahoo.com.

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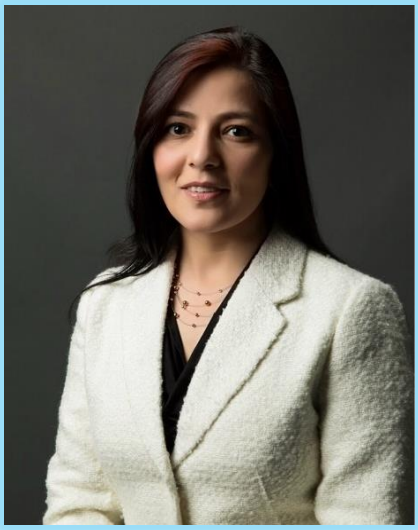
Biotechnology Advances around the World

Editor's Picks

Every issue of Biotechnology Kiosk presents select latest research news picked by the executive editors on significant research breakthroughs in different areas of biotechnology around the world. The aim is to promote further R&D in all of these cutting edge areas of biotechnology. The editors have compiled and included the following innovations and breakthroughs to highlight the recent biotechnology advances.



Dr. Megha Agrawal
Executive Editor

Dr. Shyamasri Biswas
Executive Editor

Stem Cells and Neurodegeneration

Malfunctioning brain cells can trigger young-onset Parkinson's disease

It is known that Parkinson's disease (PD) occurs as a result of impaired or dead brain neurons. Healthy brain neurons are critically important because these neurons make dopamine, which is a substance that helps coordinate muscle movement. PD symptoms can get worse over time, if left undetected and untreated. Patients suffering from PD exhibit slowness of movement, rigid muscles, tremors and loss of balance. Despite major advances that have been made in research in PD, the exact cause of the brain neuron failure is still unclear along with no known cure. An estimated overwhelming number of over 500,000 people in the U.S. alone are diagnosed with Parkinson's each year.

In a recent discovery, researchers in the United States focused on stem cells based study and found that malfunctioning brain cells can trigger PD that even may start before birth. This new study published in the journal Nature Medicine (iPSC modeling of young-onset Parkinson's disease reveals a molecular signature of disease and novel therapeutic candidates. Nature Medicine, 2020; DOI: 10.1038/s41591-019-0739-1) focused on the young-onset patients to understand the links involving dopamine neurons in case of malfunctioning brain cells and the onset of PD.

In a major breakthrough in PD research, the researchers were able to detect key abnormalities in the dopamine neurons including accumulation of a protein called alpha-synuclein. This protein is believed to occur in most forms of Parkinson's disease. In addition, researchers observed that malfunctioning lysosomes contained cell structures that triggered cell to break down and dispose of proteins. They further observed that the malfunction could cause alpha-synuclein to build up.

In their research approach, the research team generated special stem cells comprising induced pluripotent stem cells (iPSCs). These cells were derived from cells of patients with young-onset Parkinson's disease. Further, their novel process involved using adult blood cells that belonged to a primitive embryonic state that allowed iPSCs to produce any cell type of the human body that was all genetically identical to the patient's own cells.

This study paves the way for the development of novel therapeutics that potentially might provide solutions to correct these disease processes.

Antibiotics & Infectious Disease

Discovery of new antibiotics capable of treating drug-resistance infections

There is an urgent need to address the ongoing antibiotic crisis that requires the discovery of novel compounds with new mechanisms of action that can be employed for treating drug-resistant infections.

To this end, a team of researchers in Canada recently reported a new group of antibiotics

that exhibited a unique approach to attacking bacteria. This discovery makes it a promising clinical candidate to fight against antimicrobial resistance. Their research was published in the journal Nature (Evolution-guided discovery of antibiotics that inhibit peptidoglycan remodeling, Nature, 2020; DOI: 10.1038/s41586-020-1990-9). The researchers reported a new group of antibiotics equipped with a unique approach to attacking and killing bacteria, thus making it a promising clinical candidate in the fight against antimicrobial resistance.

This discovery was made from a family of antibiotics called glycopeptides that were produced by soil bacteria. Researchers demonstrated bacteria-killing actions of the newly-found corbomycin and the lesser-known complestatin. The never-before-seen actions were achieved by blocking the function of the bacterial cell wall.

The results were also demonstrated in mice to confirm the effectiveness of new antibiotics that can block infections caused by the drug resistant Staphylococcus aureus. This belongs to a group of bacteria that can cause many serious infections, and this discovery of novel antibiotic compounds offers huge promise in future therapeutics to combat infectious disease.

Marine Biotechnology

Allowing reef-building corals to respond to climate change and sustain

Studies have indicated that coral reefs worldwide are getting significantly diminished due to climate change. Corals usually take a long generation time to grow. It is a major concern that corals may not be able to genetically adapt in time to regrow after overcoming the challenge of rapid pace of climate change.

A collaborative team of marine biology and environmental genomics researchers in Abu Dhabi and Saudi Arabia has addressed this major issue in marine biology. For the first time, they recently demonstrated in their paper published in the journal Nature Climate Change (Intergenerational epigenetic inheritance in reef-building corals, Nature Climate Change, 2020; DOI: 10.1038/s41558-019-0687-2) that epigenetic modifications in reef-building corals can be transmitted from parents to their offspring. Researchers studied reef-building corals based on epigenetics that allowed the modification of the nature of the genome. This was done without altering the actual genetic code. Researchers showed that their process can be used to turn a gene on or off depending on when and to what degree the modification is carried out.

This discovery advances the fundamental biological understanding of corals. More importantly, it paves the way to new approaches that can be employed to reverse the loss of this foundation species of marine ecosystems. This also demonstrates the importance of generating pre-adapted coral colonies and larvae through epigenetic conditioning that can be leveraged for the creation of seeding populations to repopulate dying reefs.

Fisheries Science

Studying genetic diversity among world fish population

Genetic diversity in flora and fauna systems is a critically important subject for study. The reason behind this is the fact that genetic diversity can more rapidly decline in a population of animals or plants than other species diversity. Fish population and plants are affected more vigorously by various stress factors including disease, changes to habitat or change in the climate. However, there is a very insignificant research done on fish genetic diversity around the world.

To address this issue, an international team of scientists from French universities and ETH Zurich, Switzerland has studied genetic diversity among fish around the world for the first time. Their study was recently published in the journal Nature Communications (Global determinants of freshwater and marine fish genetic diversity, Nature Communications, 2020; 11 (1) DOI: 10.1038/s41467-020-14409-7). In their research, they demonstrated the first global distribution map for genetic diversity among freshwater and marine fish that can be leveraged as a tool to improve the protection of species and genetic diversity in the world.

In the process of developing the global distribution map, the researchers also identified the environmental factors that are deemed instrumental in determining the distribution of genetic diversity. They developed and analyzed a database that contained the data of over 50,000 DNA sequences and representing 3,815 species of marine fish and 1,611 species of freshwater fish. The average genetic diversity in sections of bodies of water (each section measuring 200 square kilometers) was then estimated from this sequence data.

This study revealed an uneven distribution of genetic diversity throughout marine and freshwater fish with the greatest genetic diversity found among marine fish in the western Pacific Ocean, the northern Indian Ocean and the Caribbean. Genetic diversity among freshwater fish was found greatest in South America. Whereas, a comparatively low diversity was found in Europe.

The researchers envision that their study could provide as a powerful tool to improve conservation of genetic diversity that eventually helps biodiversity.

Compiled and Edited by Dr. Megha Agrawal and Dr. Shyamasri Biswas.

Biotech and Pharma Industry Roundup

Adverum Biotechnologies Closing $150 Million of Common Stock

Adverum Biotechnologies, Inc. (Nasdaq: ADVM),a clinical-stage gene therapy company targeting unmet medical needs in ocular and rare diseases recently announced the closing of its public offering of 10,925,000 shares of its common stock at a public offering price of $13.75 per share. This included the full exercise of the underwriters' option to purchase up to an additional 1,425,000 shares of common stock [Source: https://www.biospace.com/].

Meningococcal Vaccines expected to touch US$ 9 billion by 2026

Bacteria Neisseria meningitides causes meningococcal disease. This disease occurs throughout the world especially in the developing world. Typical symptoms include inflammation in the membranes of the brain and spinal cord which is characteristic of meningitis. The meningococcal vaccines market is pretty vast with a lot of potential to make its footprints even larger in the future that is expected to reach $9 billion by 2026. This vaccine exists in the market and doing a great business due to its utility and need for preventing the incidence of this deadly disease [Source: https://www.biospace.com/].

Alvogen to acquire the product Gralise® (gabapentin) from Assertio Therapeutics

Assertio Therapeutics, Inc., ("Assertio") will transfer all responsibilities associated with the product Gralise® (gabapentin) to Alvogen expectedly in early 2020, subject to regulatory approval. This announcement was made recently. To acquire the product, Alvogen will pay Assertio a total value of $127.5 million [Source: https://www.biospace.com/].

The market of dental membrane and bone graft substitutes to reach US$ 1.1 Billion by 2027

Current dental R&D has extensively focused on the developments of quality oral health care including new dental membrane and bone graft substitutes. This is one area in dental research that has seen extensive developments and innovation in recent years. This is primarily due to increasing number of accidents and oral health issues. Initially, the global dental membrane and bone graft substitutes market was valued at ~US$ 620 Million in the year 2018. Due to the vastly improved market scenario, and an ever increasing demand for quality dental care, the dental membrane and bone graft market is projected to steadily increase and expand at a rate from 2019 to 2027 and reach US$1.1 Billion by 2027. The growth of the market can

be attributed to rise in the dental disorders, worldwide aging population, growing medical tourism for dental procedures, and increase in the number of dental implant procedures around the world [Source: https://www.biospace.com/].

SMA drug produced by Roche gets a boost with new study data

Roche recently announced that its experimental drug risdiplam helped babies with the severest form of the rare disorder spinal muscular atrophy sit unassisted one year after beginning treatment. This finding should help Roche's case for approval now before the FDA. It is expected that if this drug is finally approved by the FDA, risidiplam will enter a highly competitive field already served by two injectable drugs, Biogen's Spinraza and Novartis' gene therapy Zolgensma [Source: https://www.biopharmadive.com/).

AstraZeneca to plan China expansion in view of coronavirus outbreak

The British pharma AstraZeneca earns about one-fifth of its sales in China. While the company's expansion in the country has always aided revenue growth to its profile, uncertainty from coronavirus disease outbreak could potentially affect AstraZeneca more than some of its peers in the market. However, despite the current instability, AstraZeneca has committed to China. This commitment includes both in marketing its globally recognized brands as well as committing research spending to finding drugs with a goal to treat diseases common in the country. With the expansion of the virus, now named COVID-19, that commitment means AstraZeneca is expected to combat the virus effectively [Source: https://www.biopharmadive.com/)].

Blue Cross Blue Shield partners with Civica on generic drug mission

In a recent announcement, the Blue Cross Blue Shield Association said that together with 18 affiliate BCBS companies, it will invest $55 million to create a new subsidiary of Civica Rx. This generic drug company was created by hospital systems in 2018. [Source: https://www.biopharmadive.com/)].

Investors pouring cash to counter cancer genes

It is known for years that a family of genes that, when mutated, turn regular cells cancerous. There has been recent progress in developing drugs that can effectively silence those genes. This has fueled investor optimism in companies going after these genes that are known as RAS. The most recent example of investments comes from a California based biotech company named Revolution Medicines that has raised $238 million through an initial public offering. RAS genes are known to make special proteins that regulate how a cell grows, specializes and divides. One of these proteins, K-ras, has drawn a particularly large amount of attention for R&D. and Amgen, the country's largest biotech has released data showing an experimental drug appeared to stabilize disease in a small group of lung cancer patients with KRAS gene mutations. This has further fueled extensive R&D in this area [Source: https://www.biopharmadive.com/)].

Madrid-based RNA specialist Bioncotech Therapeutics enters into a Phase II clinical trial collaboration with a MSD subsidiary

The clinical collaboration between Bioncotech Therapeutics and Merck Sharpe & Dohme's aims at providing clincial Phase II evidence that' RNA–based cancer lead BO-112 can improve the efficacy of PD1 checkpoint inhibitor pembrolizumab in partients with tadvanced-stage solid tumors with liver metastases [Source: https://european-biotechnology.com/].

French company Stilla raises €20m in series B financing round

French biotech company Stilla Technologies SA raised €20million in a Series B funding to boost digital PCR-based genetic testing [Source: https://european-biotechnology.com/].

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