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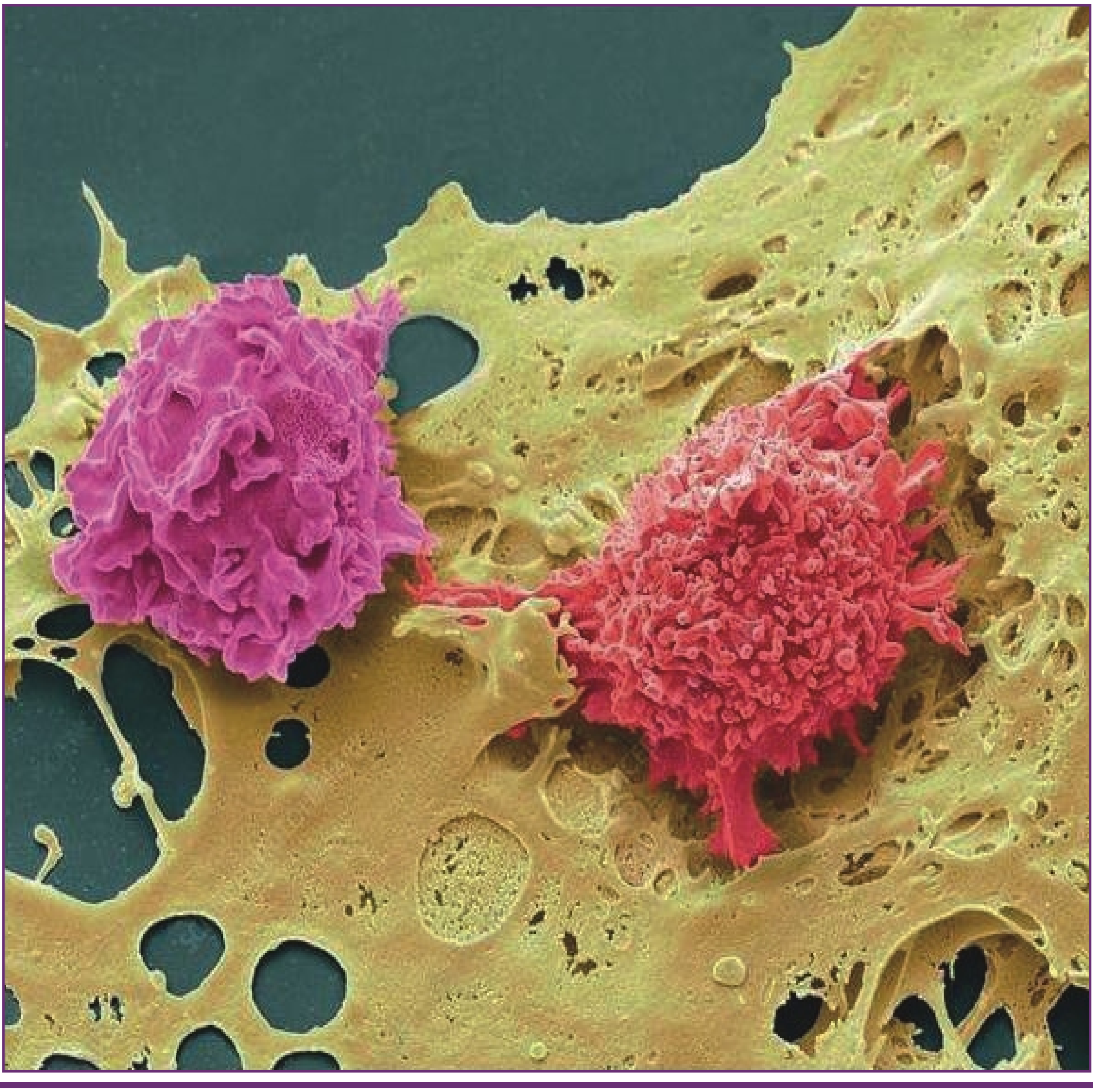

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ENVIS Newsletter on 'Microorganisms and Impact on Public Health', a quarterly publication, brings out original research articles, reviews, reports, research highlights, news-scan etc., related to the thematic area of the ENVIS Centre. In order to disseminate the cutting-edge research findings to user community, ENVIS Centre on Microorganisms and Impact on Public Health invites original research and review articles, notes, research and meeting reports, details of forthcoming conferences / seminars / symposia / trainings / workshops for publication in the newsletter.

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Cover Page : Coloured scanning electron micrograph (SEM) show natural killer cells purified from a healthy donor's blood attacking a liver cancer cell line (HepG2). NK cells (pink and red) have multiple finger-like protrusions for sensing danger and interacting with target cells and can kill their targets by punching holes in their surface. Natural killer cells are part of our body's battalion of immune soldiers, specialised at killing cancerous cells. They provide a powerful first line of defence against tumours and are being developed as immunotherapy for liver cancer, that is the second commonest cause of cancer deaths worldwide. Magnification x 7000 at 10cm wide. Specimen courtesy of the Maini Lab. UCL.

Image credit : STEVE GSCHMEISSNER / SCIENCE PHOTO LIBRARY

ENVIS NEWSLETTER
on
MICROORGANISMS AND IMPACT ON PUBLIC HEALTH

VOLUME 19 | ISSUE 1 | JAN - MAR 2021

Contents Page No.

3rd March, 2021

From the Coordinator's Desk!

Dear Readers,

Greetings!

Heavy metals contamination in the ecosystem is one of the most hazardous environmental and health challenges at present in our society. With growing need for the development of novel, efficient, eco-friendly, and cost-effective approaches for the remediation of inorganic metals (Cr, Hg, Cd, and Pb) released into the environment and to safeguard the ecosystem; recent advances in microbes-base heavy metal degradation have propelled bioremediation as a prospective alternative toward conventional techniques. Heavy metals are non-biodegradable and could be toxic to microbes. Many microorganisms have evolved with detoxification mechanisms in their arsenal to counter the toxic effects of these inorganic metals. This issue contains a review article that focuses on the microbe mediated remediation of heavy metals in soil that briefly describes effects, bioremediation and metal-microbe interaction with future prospects.

This issue also includes reports on a new method for fluorescence microscopy, microbiologist's view on soil health equally important as air and water, RNA imaging technique in live cells, biomarkers that could help determine who's at risk for severe COVID-19 symptoms and many other interesting topics for the readers. Stay safe and act with social responsibility against this COVID 19 pandemic.

Dr. C. Arulvasu

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REVIEW ARTICLE

MICROBE MEDIATED REMEDIATION OF HEAVY METALS IN SOIL

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Bacteria
Toxic heavy metals
Soil
diseases

ABSTRACT

All aspects of life on earth are directly or indirectly dependent on soil, its hydrodynamics, elemental composition and microflora. In the last few decades, as a result of extensive developmental activities a great percentage of global soil have been degraded due to heavy metals, metalloids, persistent organic pollutants etc. The necessity of soil revitalization is inevitable in ensuring biodiversity, sustainable agriculture and a healthy environment for the generations to come. Heavy metal contamination of soil is highly concerned as biggest threat to the homeostasis of soil ecology and the productivity of plants. Heavy metals are persistent and bio accumulate through food chain and possibly implicate potential health hazards in humans and organisms. Even though chemical and physical methods are widely pursued for the remediation of contaminated soil, bio-remediation techniques are clean, effective solution, with ecological and cost-associated benefits yet often out weighed due to various constrains. Several indigenous microbes from heavy metal contaminated ecosystem can withstand the effect of toxic metals, contribute to revival of tarnished soil and help other organisms to overcome many of the adverse. A better and effective understanding about possibilities of bioremediation is a bright ray of hope in recovery of our soils. The present review deals with measures for toxic heavy metals contamination on agricultural soil and other effects on this biome.

Introduction

Groundbreaking and intricate development of our civilization in this century has raised pollution as our greatest problem. The future of our planet depends on how wise we decide to redefine our relationship with the environment. The complex ecological succession whether land, water, atmosphere or any other environment, is a function of time and inevitable efforts from an assorted group of organisms, which in most cases do not include a lot of microbes as itself. But later on, they obviously display unacquitted roles in the community. Environments today are passing through an alarming situation of serious threats to existence of various ecosystems due to drastic anthropogenic actions as well as natural disasters and demands to pursue towards a sustainable and feasible solution. One of those threats, the heavy metal contamination of soil is a dire condition that evokes worldwide concern. They stance the biggest threat to the homeostasis of soil ecology as well as the productivity of plants. Also, when they are present in soil for a long time, they get accumulated and when taken up by plants, they result in potential health hazards to the consumers in food chain (Cooper *et al.*, 2010).

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Many at times, we humans have explored the microbial world for its enigmatic potential, as such as our sunlight-driven hotspot for revitalizing the life-sustaining conditions of our biome. Despite from chemical and physical methods, bioremediation using microbes has proven to be sustainable, clean and comprehensive solution for heavy metal toxicity; it has also overweighed the ecological and economical concerns of the chemical methods. Several indigenous microbes have been found naturally, that understand and help in heavy metal biodegradation which not only withstand but also help ultimately in renewal of the environment (Gupta and Arora 2016). Plants associated with these microbes have been found to accumulate and remove these extremely toxic substances from the soil, leading to the recovery of the productive farming lands (Dixit *et al.*, 2015). On a global scale, these steps are essential in the field of agriculture for ensuring sustainable agriculture and thereby ensuring productivity in term securing a healthy environment.

Effects of heavy metals on the environment

Increasing presence of heavy metals in environment has been showing many deadly effects in plants and animals. Non-threshold toxic heavy metals like arsenic (As), cadmium (Cd), chromium(Cr)(VI), mercury (Hg) and lead (Pb) etc., have received more attention than any other due to their higher concentration in environment. In plants they result in oxidative.Stress and destruct the cell structure and lead to abnormal growth and metabolism due to inhibition of cytoplasmic enzymes. Exposure to these pollutants is a major cause of deadly degenerative diseases in humans (Fig. 1).

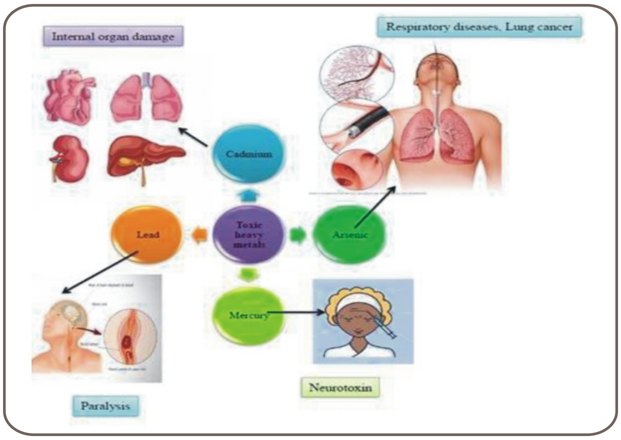

Figure 1: Schematic summarizing terms and concepts involved in various human diseases of toxic heavy metals.

Bioremediation

Bioremediation utilizes biological mechanisms of microbes to degrade hazardous environmental contaminants like heavy metals, metalloids, and persistent organic pollutants etc. (Fig. 2). It depends on the nature and degree of contamination and the metabolic potential of microorganisms. Microbes in general are capable of developing certain resistances phenotypically or genotypically; in needs of survival threats. They adopt various mechanisms to overcome threats to themselves and to the vegetative community they are associated with. Certain microorganisms inhabit in a highly heavy metal polluted soil are found capable of heavy metal degradation or detoxification and can be exploited for environmental remediation purposes (Dixit *et al.*, 2015). *Agrobacterium, Azospirillum, Pseudomonasetc.*, have shown great potential of oxidation of Arsenic (Bachate *et al.*, 2012). *Penicillium chrysogenum*is known to mediate bio-mineralization of Lead (Qian *et al.*, 2017), *Shewanella putrefaciens* can reduce Chromium (Myers *et al.*, 2000), *Klebsiella pneumoniae* and *Bacillus sp.* precipitate Mercury-Sulhate complexes in soil (Essa *et al.*,2005; Gutknecht, 1981), *Acidophilum* and *Arthrobacter* help in recovery of some heavy metals through bioleaching by producing some organic acids and chelating agents (Pathak *et al.*, 2009). These are only a few microbes to mention while there are even many more, although conventional chemical and physiochemical methods for remediation is already available, it is always better to focus on a cost effective and sustainable solution while possible.

Phytoremediation is another segment of microbe-mediated bioremediation, which includes plants and associated rhizospheric microorganisms. Metal tolerant-hyper accumulator plants growing in highly contaminated areas bind, extract and remediate pollutants from the soil.

Bioaugmentation is an application-level technique of bioremediation by inoculating the microbes into a polluted environment, like agriculture lands. Different aspects of bioremediation can be considered as a cost effective and sustainable solution for our present situation.

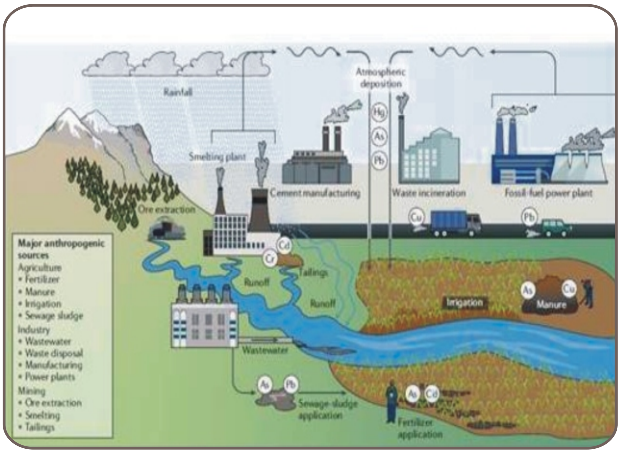

Figure 2: Sources of heavy metals pollution in agricultural soil (Hou *et al.*, 2020).

Major anthropogenic sources can be classified into three categories: agricultural, industrial and mining. Heavy metals can enter agricultural soil through atmospheric deposition, following release into the atmosphere from fossil-fuel burning, waste incineration or cement manufacture. Heavy-metals-contaminated runoff from mining and industry can enter waterways and reach agricultural land. The use of manure or sewage contaminated with heavy metals to fertilize crops can also contaminate agricultural land.

Pollutant- microbe interactions

Even though most of the microbes such as protozoa, bacteria, fungi and algae have some trivial level of heavy metal remediation capacity, metal scan prove to be hostile when in higher values than threshold. This causes toxic effects on cells by manipulating essential element availability, inhibiting metabolic reactions, and destabilizing DNA, RNA and thereby proteins (Yin *et al.*, 2019). Bioremediation of heavy metals with help of micro-organisms is influenced by heavy metal resistant microorganisms with different phenotypic expressions, which is a more effective interaction (Ojuederie and Babalola, 2017). These microorganisms are capable of degrading toxic heavy metals by binding them to the functional groups of proteins/lipids or polysaccharides present in their cell wall and altering the chemistry to block their uptake by plants, or converting them to a less toxic state (Jan *et al.*, 2014). Bacteria and plants, in association stimulate different signal molecules as a specific receptor between their interactions to react with various metals from the environment (Arul Kumar Murugesan, 2020). Their chemical coordination relies on an array of some fundamental chemical reactions such as redox reactions, transformation, mineralization, leaching, precipitation, volatilization, biosorption, accumulation etc. These interactions depend upon various physical and chemical factors such as pH, motility, bio-availability and possess a great environmental significance in the circulation of heavy metals in the biogeochemical cycles (Hashem *et al.*, 2017). Phytoremediation deals with the cleanup of organic pollutants and heavy metal contaminants using plants and rhizospheric microorganisms (Fig. 3). It is inexpensive, eco-friendly and an efficient means of restoration of polluted environments especially those that of heavy metals (Ali *et al.*, 2013; Jan and Parray, 2016).

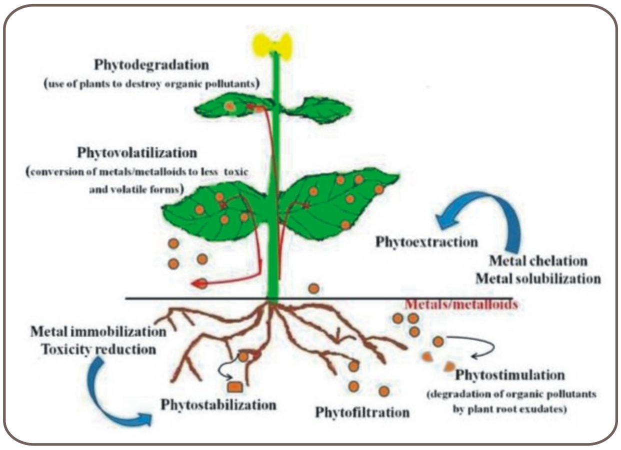

Figure 3: Processes used in phytoremediation of heavy metals.

Future of microbe mediated heavy metal bioremediation

While microbe mediated bioremediation is still at developing stage on its own and in combination with plant assisted bioremediation (phytoremediation), we cannot stop exploring every single aspect we can. In the era of emerging transgenics and systems biology, environmental biotechnologists are surfing around new possibilities for better results. Genetically modified microorganisms can be considered as a more effective possibility in this subject (Wu *et al.*, 2010). But we need more detailed understanding about the metabolic activities and capacities of transgenic microbes on their effects and side-effects in the environment.

Conclusion

Global soil pollution by toxic heavy metals represents one of the biggest challenges for sustainable development and developing countries are particularly vulnerable to this threat for their food, health and livelihoods. The accumulation of toxic heavy metals in agricultural soils is an obstacle in achieving global food safety and security. Bioremediation is a promising nature-based solution for treating heavy metals contamination; however, several issues must be addressed before it can be widely implemented.

References

Ali, H., Khan, E and Sajad, M. A. (2013). Phytoremediation of heavy metals-concepts and applications. *Chemosphere*, **91** (7): 869 - 881.

Arul Kumar, M. (2020). Plant interaction with microbial pathogens – an overview. ENVIS Newsletter, **18** (4): 3 - 5.

Bachate, S. P., Cavalca, L and Andreoni, V. (2009). Arsenic-resistant bacteria isolated from agricultural soils of Bangladesh and characterization of arsenate-reducing strains. *Journal of applied microbiology*, **107** (1): 145 - 156.

Cooper, T. G., Noonan, E., Von Eckardstein, S., Auger, J., Baker, H. W., Behre, H. M and Vogelsong, K. M. (2010). World Health Organization reference values for human semen characteristics. Human reproduction update, **16** (3): 231 - 245.

Dixit, R., Malaviya, D., Pandiyan, K., Singh, U. B., Sahu, A., Shukla, R and Paul, D. (2015). Bioremediation of heavy metals from soil and aquatic environment: an overview of principles and criteria of fundamental processes. *Sustainability*, **7** (2): 2189 - 2212.

Essa, A. M., Macaskie, L. E and Brown, N. L. (2005). A new method for mercury removal. *Biotechnology letters*, **27** (21): 1649 - 1655.

Gupta, R. D and Arora, S. (2016). Ecology, soil and crop management for livelihoods in Ladakh region: An Overview. *Journal of Soil and Water Conservation*, **15** (2): 178 - 185.

Gutknecht, J. (1981). Inorganic mercury (Hg 2+) transport through lipid bilayer membranes. The *Journal of Membrane Biology*, **61**(1): 61-66.

Hashem, M. A., Nur-A-Tomal, M. S., Mondal, N. R and Rahman, M. A. (2017). Hair burning and liming in tanneries is a source of pollution by arsenic, lead, zinc, manganese and iron. *Environmental Chemistry Letters*, **5** (3): 501 – 506.

Hou, D., O'Connor, D., Igalavithana, A. D., Alessi, D. S., Luo, J., Tsang, D. C and Ok, Y. S. (2020). Metal contamination and bioremediation of agricultural soils for food safety and sustainability. *Nature Reviews Earth & Environment*, **1** (7): 366 - 381.

Jan, A. T., Azam, M., Ali, A and Haq, Q. M. R. (2014). Prospects for exploiting bacteria for bioremediation of metal pollution. Critical Reviews in *Environmental Science and Technology*, **44** (5): 519 - 560.

Jan, S and Parray, J. A. (2016). Approaches to heavy metal tolerance in plants (pp. 1-18). Singapore: Springer.

Myers, N., Mittermeier, R. A., Mittermeier, C. G., Da Fonseca, G. A and Kent, J. (2000). Biodiversity hotspots for conservation priorities. *Nature*, **403** (6772): 853 - 858.

Ojuederie, O. B and Babalola, O. O. (2017). Microbial and plant-assisted bioremediation of heavy metal polluted environments: a review. *International journal of environmental research and public health*, **14** (12): 1504.

Pathak, H., Jain, N., Bhatia, A., Mohanty, S and Gupta, N. (2009). Global warming mitigation potential of biogas plants in India. *Environmental monitoring and assessment*, **157** (1): 407 - 418.

Qian, H., Field, R., Zhang, J and Zhang, Y. (2017). Does daily climate variation have an effect on species' elevational range size?. *Journal of Biogeography*, **44** (10): 2432 - 2436.

Wu, G., Kang, H., Zhang, X., Shao, H., Chu, L and Ruan, C. (2010). A critical review on the bio-removal of progress, eco-environmental concerns and opportunities. *Journal of Hazardous Materials*, **174** (1-3): 1 - 8.

Yin, W., Wang, Y., Liu, L and He, J. (2019). Biofilms: The Microbial Protective Clothing. Extreme Environments. *International Journal of Molecular Science*, **20** (14): 3423.

RESEARCH REPORTS

Comb of a lifetime: A new method for fluorescence microscopy

Fluorescence microscopy is widely used in biochemistry and life sciences because it allows scientists to directly observe cells and certain compounds in and around them. Fluorescent molecules absorb light within a specific wavelength range and then re-emit it at the longer wavelength range. However, the major limitation of conventional fluorescence microscopy techniques is that the results are very difficult to evaluate quantitatively; fluorescence intensity is significantly affected by both experimental conditions and the concentration of the fluorescent substance. A new study by scientists from Japan is set to revolutionize the field of fluorescence lifetime microscopy.

A way around the conventional problem is to focus on fluorescence lifetime instead of intensity. When a fluorescent substance is irradiated with a short burst of light, the resulting fluorescence does not disappear immediately but actually decays over time in a way that is specific to that substance. The fluorescence lifetime microscopy technique leverages this phenomenon, which is independent of experimental conditions, to quantify fluorescent molecules and changes in their environment. However, fluorescence decay is extremely fast, and ordinary cameras cannot capture it. While a single-point photodetector can be used instead, it has to be scanned throughout the sample's area to be able to reconstruct a complete 2-D picture from each measured point. This process involves movement of mechanical pieces, which greatly limits the speed of image capture.

In a study, published in *Science Advances*, the team of scientists developed a novel approach to acquire fluorescence lifetime images without the need for mechanical scanning. Professor Takeshi Yasui, from Institute of Post-LED Photonics (pLED), Tokushima University, Japan, who led the study, said their method can be interpreted as simultaneously mapping 44,400 light-based stopwatches over a 2-D space to measure fluorescence lifetimes, all in a single shot and without scanning.

One of the main pillars of their method is the use of an optical frequency comb as the excitation light for the sample. An optical frequency comb is essentially a light signal composed of the sum of many discrete optical frequencies with a constant spacing in between them. The word comb, in this context, refers to how the signal looks when plotted against optical frequency: a dense cluster of equidistant spikes rising from the optical frequency axis and resembling a hair comb. Using special optical equipment, a pair of excitation frequency comb signals is decomposed into individual optical beat signals (dual-comb optical beats) with different intensity-modulation frequencies, each carrying a single modulation frequency and irradiated on the target sample. The key here is that each light beam hits the sample on a spatially distinct location, creating a one-to-one correspondence between each point on the 2-D surface of the sample (pixel) and each modulation frequency of the dual-comb optical beats.

Because of its fluorescence properties, the sample re-emits part of the captured radiation while preserving the frequency-position correspondence. The fluorescence emitted from the sample is then simply focused using a lens onto a high-speed single-point photodetector. Finally, the measured signal is mathematically transformed into the frequency domain, and the fluorescence lifetime at each pixel is easily calculated from the relative phase delay that exists between the excitation signal at that modulation frequency versus the one measured.

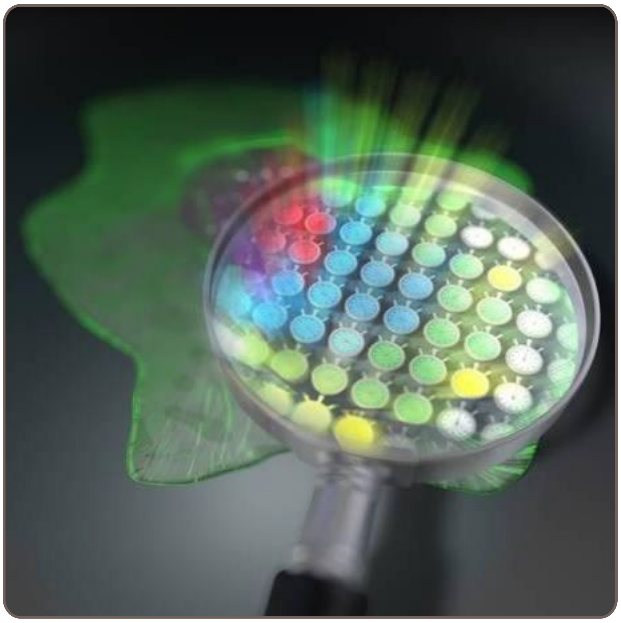

Image: 2-D arrangement of 44,400 light stopwatches enables scan-less fluorescence lifetime imaging.

Image Credit: Tokushima University

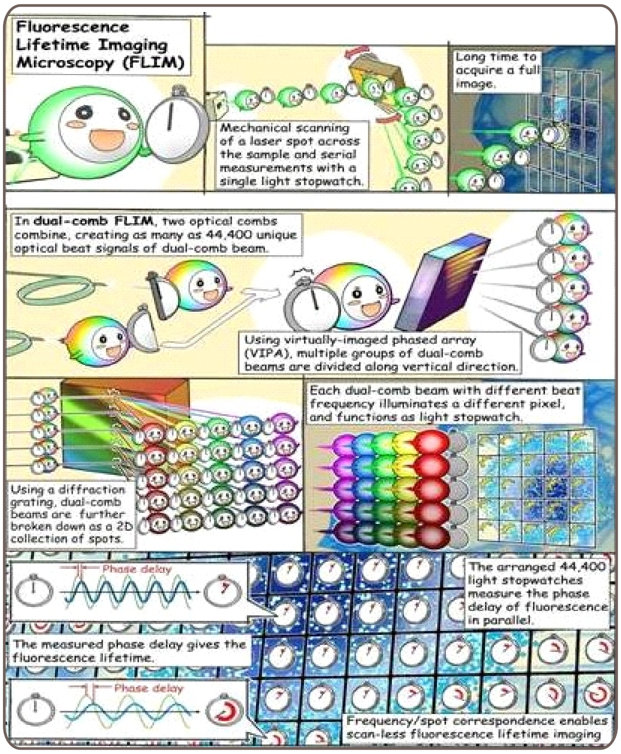

Image: This new fluorescence microscopy technique will measure both fluorescence intensity and lifetime and it will not require mechanical scanning of a focal point; instead, it will produce images from all points in the sample simultaneously, enabling a more quantitative study of dynamic biological and chemical processes.

Image Credit: Suana Science YMY.

Source: www.phys.org

Soil health is as environmentally important as air and water quality, say microbiologists

There are an estimated 40,000 to 50,000 species of microorganism per gram of soil. Addition of certain microbes can tailor soil characteristics: removing contaminants, improving fertility and even making barren land available for farming.

The Microbiology Society's report calls for increased access to research into soil health, promoting outreach activities in agricultural colleges and schools and showcasing work in non-academic outlets. This, say microbiologists, is the best way to collaborate with farmers to improve soil health and agricultural productivity.

Tilling and excessive use of fertilizers have major effects on soil health. Microbiology can be used to help understand the impact of intensive farming and design feasible mitigation practices.

The report highlights collaboration with farmers as key for improving soil health, and sustainable soil management practices should be designed with agricultural requirements and practices in mind. Sustainable soil management should be in centivised, the report says, and research outcomes should be affordable and ready for use on farms.

The UK is estimated to be 30 to 40 years away from fundamental eradication of soil fertility, and the UN have warned that if current degradation rates are not reversed there may be less than 60 harvests left in the world's soil.

The EU has raised soil health as one its top five priorities and many global initiatives are emerging in the area of soil protection. The UK should take advantage of this increased profile to consolidate active communities working together to improve the uptake and development of new sustainable land management practices.

Source: www.phys.org

Super-resolution RNA imaging in live cells

Ribonucleic acid (RNA) is key to various fundamental biological processes. It transfers genetic information, translates it into proteins or supports gene regulation. To achieve a more detailed understanding of the precise functions it performs, researchers based at Heidelberg University and at the Karlsruhe Institute of Technology (KIT) have devised a new fluorescence imaging method which enables live-cell RNA imaging with unprecedented resolution.

The method is based on a novel molecular marker called Rhodamine-Binding Aptamer for Super-Resolution Imaging Techniques (RhoBAST). This RNA-based fluorescence marker is used in combination with the dye rhodamine. Due to their distinctive properties, marker and dye interact in a very specific way, which makes individual RNA molecules glow. They can then be made visible using single-molecule localisation microscopy (SMLM), a super-resolution imaging technique. Due to a lack of suitable fluorescence markers, direct observation of RNA via optical fluorescence microscopy has been severely limited to date.

RhoBAST was developed by researchers from the Institute of Pharmacy and Molecular Biotechnology (IPMB) at Heidelberg University and the Institute of Applied Physics (APH) at KIT. The marker created by them is genetically encodable, which means that it can be fused to the gene of any RNA produced by a cell. RhoBAST itself is non-fluorescence achieved by the RhoBAST-dye complex, which is a key requirement for obtaining excellent fluorescence images. However, for super-resolution RNA imaging the marker needs additional properties.

The researchers discovered that each rhodamine dye molecule remains bound to RhoBAST for approximately one second only before becoming detached again. Within seconds, this procedure repeats itself with a new dye molecule. “It is quite rare to find strong interactions as between RhoBAST and rhodaminecombined with exceptionally fast exchange kinetics", says Prof. Dr.Gerd Ulrich Nienhaus from the APH. Prof. Nienhaus said that rhodamine only lights up after binding to RhoBAST, the constant string of newly emerging interactions between marker and dye results in incessant blinking. This on-off switching is exactly what they need for SMLM imaging.

Prof. Dr. Andres Jäschke, a scientist at the IPMB, explained that the RhoBAST system solves yet another important problem. Fluorescence images are collected under laser light irradiation, which destroys the dye molecules over time. The fast dye exchange ensures that

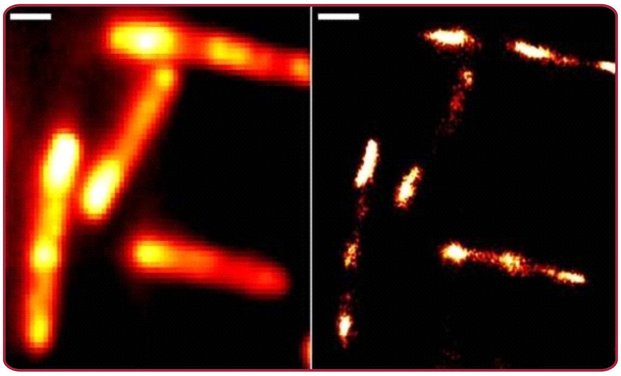

Image: Conventional epifluorescence (left) and super-resolved localisation microscopy images (right) of gut bacteria (*Escherichia coli*), using the new RhoBAST-dye marker complex for fluorescence labelling. Scale bar: 1 μm.

Image Credit: Heidelberg University/Karlsruhe Institute of Technology.

photobleached dyes are replaced by fresh ones. This means that individual RNA molecules can be observed for longer periods of time, which can greatly improve image resolution.

The researchers from Heidelberg and Karlsruhe were able to demonstrate the superb properties of RhoBAST as an RNA marker by visualizing RNA structures inside gut bacteria (*Escherichia coli*) and cultured human cells with excellent localisation precision. "We can reveal details of previously invisible subcellular structures and molecular interactions involving RNA using super-resolution fluorescence microscopy. This will enable a fundamentally new understanding of biological processes," says Prof. Jäschke.

Source: www.phys.org.

ONLINE REPORTS

Biomarkers that could help determine who's at risk for severe COVID-19 symptoms

One of the many mysteries still surrounding COVID-19 is why some people experience only mild, flu-like symptoms, whereas others suffer life-threatening respiratory problems, vascular dysfunction and tissue damage. Interestingly, in an article in the journal ACS *Analytical Chemistry*, reports that researchers have used a combination of metabolomics and machine learning to identify possible biomarkers that could both help diagnose COVID-19 and assess the risk of developing severe illness.

Although some pre-existing conditions, such as diabetes or obesity, can increase the risk of hospitalization and death from COVID-19, some otherwise healthy people have also experienced severe symptoms. As most of the world's population awaits vaccination, the ability to simultaneously diagnose a patient and estimate their risk level could allow better medical decision-making, such as how closely to monitor a particular patient or where to allocate resources. Therefore, Anderson Rocha, Rodrigo Ramos Catharino and colleagues wanted to use mass spectrometry combined with an artificial intelligence technique called machine learning to identify a panel of metabolites that could do just that.

The cross-sectional study included 442 patients who had different severities of COVID-19 symptoms and tested positive by a reverse transcriptase-polymerase chain reaction (RT-PCR) test, 350 controls who tested negative for COVID-19 and 23 people who were suspected of having the virus despite a negative RT-PCR test. The researchers analyzed blood plasma samples from the participants with mass spectrometry and machine learning algorithms, identifying 19 potential biomarkers for COVID-19 diagnosis and 26 biomarkers that differed between mild and severe illnesses.

Of the COVID-19-suspected patients, 78.3% tested positive with the new approach, possibly indicating these were RT-PCR false negatives. Although the identified biomarkers, which included metabolites involved in viral recognition, inflammation, lipid remodeling and cholesterol homeostasis, need to be further verified, they could reveal new clues to how SARS-CoV-2 affects the body and causes severe illness, the researchers say.

Source: www.phys.org.

Electric cable bacteria breathe oxygen with unheard efficiency

Ten years ago, researchers at Aarhus University, Denmark, reported the discovery of centimeter-long cable bacteria, that live by conducting an electric current from one end to the other. Now the researchers document that a few cells operate with extremely high oxygen consumption while the rest of the cells process food and grow without oxygen. An outstanding way of life.

We humans need food and oxygen to live. Now, imagine if oxygen was to be found only at the mountain top and food only in the valley. That's what the world looks like for cable bacteria, which live in the bottom of seas and lakes. For them, oxygen is available only at the very surface of the bottom, whereas the food is buried centimeters down.

Biowires

Lars Peter Nielsen, head of Center for Electromicrobiology, Aarhus University, Denmark said "While other organisms try to solve the problem by moving oxygen and food up and down, cable bacteria have developed electric wires. When consuming food they produce electrons and send them through the biowires to the surface for reduction of oxygen from the overlying water".

A cable bacterium consists of many cells in line. It can grow centimeters long, the cells encased in a common coat wherein the wires stretch.

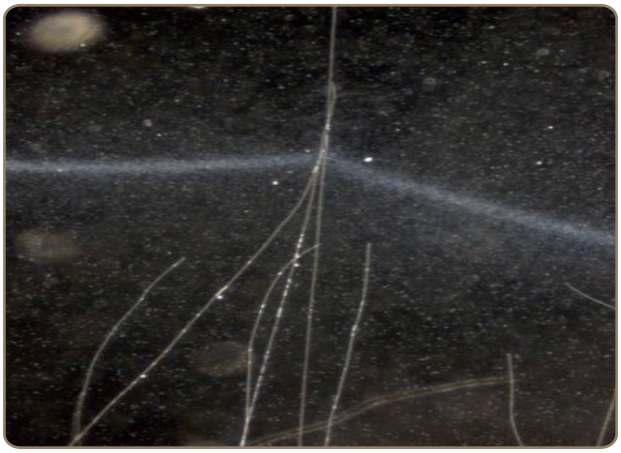

Image: Microscope image of cable bacteria reaching one end out for oxygen. The deformed oxygen front is seen as a milky line consisting of smaller bacteria attracted to the interface with the lower oxygen free layer. **Image Credit:** Stefano Scilipoti.

The researchers placed cable bacteria in a small, transparent chamber. In the middle, the bacteria had access to oxygen-free mud stuffed with food, while oxygen diffused in from the edges. Right where the intruding oxygen was depleted, numerous unicellular bacteria formed a distinct front. In that specific position they fought to capture food and oxygen from either side simultaneously.

Less than 10% of the cells are breathing

Stefano Scilipoti, Ph.D. student at Center for Electromicrobiology, Aarhus University and the primary discoverer has watched how single cable bacteria placed themselves across the front with one end into the zone with oxygen under the microscope. He watched how one single cable bacterium could distort the front made by unicellular, swimming bacteria. The cable bacterium respired so much oxygen that the unicellular bacteria had to move closer to the edge of the chamber to sustain the oxygen supply needed for their respiration. The cable bacterium could just dip a few cells in oxygen, and the magnitude of the distortion in laboratory jargon called bump allowed them to calculate how much oxygen was being consumed.

The cable bacterial machinery

The ancestors of cable bacteria lived without any oxygen. Anaerobic bacteria, as you call them. For these bacteria, oxygen is toxic and prolonged exposures

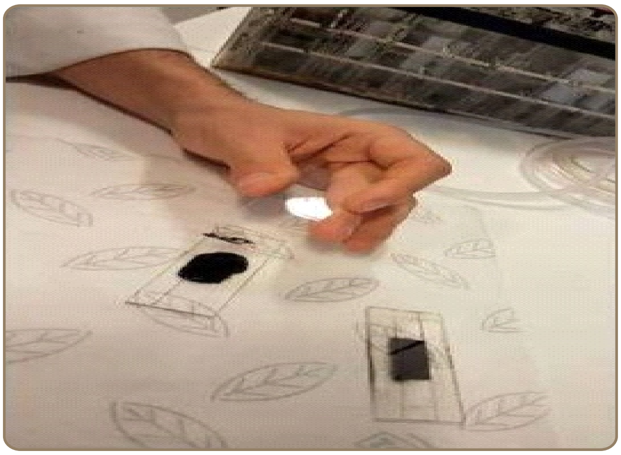

Image: In the laboratory, cable bacteria were placed in a little, transparent chamber. In the middle, the bacteria had access to oxygen-free mud stuffed with food, while oxygen diffused in from the edges.
Image Credit: Maria Blach Nielsen

eventually lead them to death. With the evolution of electric connection to oxygen however, cable bacteria can explore the strength of breathing with oxygen without exposing many cells to oxygen stress, thus getting the best of oxygen (more energy) and avoiding the rest (damage to the cells).

At Center for Electromicrobiology, the pursuit to unravel the special mechanisms that enable this unique electric form of life continues. The study is published in *Science Advances*.

The battle against hard-to-treat fungal infections

Systemic fungal infections are much rarer than other illnesses, but they are potentially deadly, with limited options for treatment. In fact, fungi are becoming increasingly resistant to the few drugs that are available, and infections are growing more common. A cover story in Chemical & Engineering News, the weekly newsmagazine of the *American Chemical Society*, details how scientists are working to improve our antifungal arsenal.

At present, there are only four types of antifungal drugs approved by the U.S. Food and Drug Administration (FDA), and some infections are resistant to those drugs, making surgery the only option for treatment, writes Senior Correspondent Bethany Halford. Fungi can be found almost everywhere, but only a few hundred species are able to infect humans, and most people's immune systems can fight them off. However, people with compromised immune systems (for instance, cancer patients being treated with certain chemotherapies) are at a higher risk for developing fungal infections. The FDA has not approved a drug from a new antifungal class in 20 years, and the ones available all have downsides, including drug resistance and kidney toxicity. This dearth of treatments has doctors concerned that the problem will only get worse as time goes on.

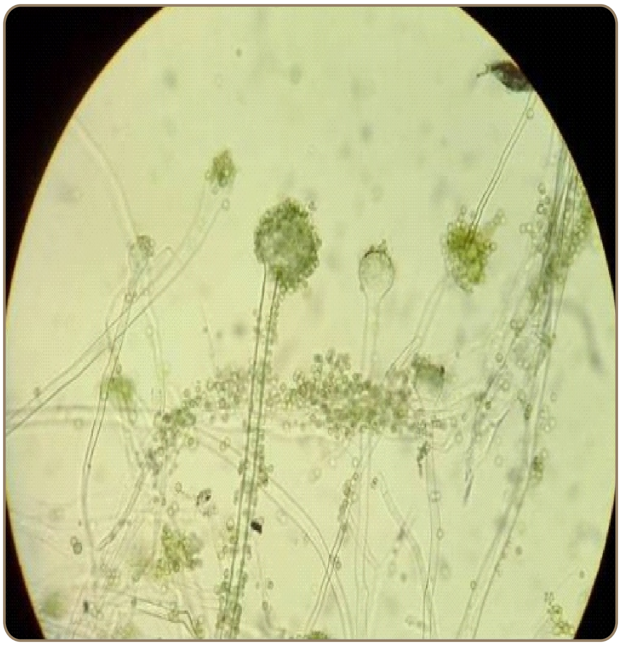

Image: Conidiophores with conidia of the microscopic fungi *Aspergillus oryzae* under light microscope.

Image Credit: Yulianna.x / Wikimedia / CC BY-SA 4.0

Creating a new antifungal drug is challenging because of the biological similarities between humans and fungi. Many molecules that are harmful to fungi are also harmful to people. Experts say that exploiting the differences between humans and fungi is key to developing new treatments; for example, fungal cells have walls, but human cells do not. In addition to developing new treatments, pharmaceutical researchers are working to improve established antifungal drugs to make them more potent and have fewer side effects. Although scientists and doctors are hopeful that new antifungals will be approved, establishing clinical trials has proven challenging because most of the people who get fungal infections are already very sick. However, the COVID-19 pandemic could change how pharmaceutical companies think about therapies for infectious diseases, prioritizing them in the future.

Source: www.phys.org

Color blindness-correcting contact lenses

Imagine seeing the world in muted shades gray sky, gray grass. Some people with color blindness see everything this way, though most can't see specific colors. Tinted glasses can help, but they can't be used to correct blurry vision. And dyed contact lenses currently in development for the condition are potentially harmful and unstable. Now, in *ACS Nano*, researchers report infusing contact lenses with gold nanoparticles to create a safer way to see colors.

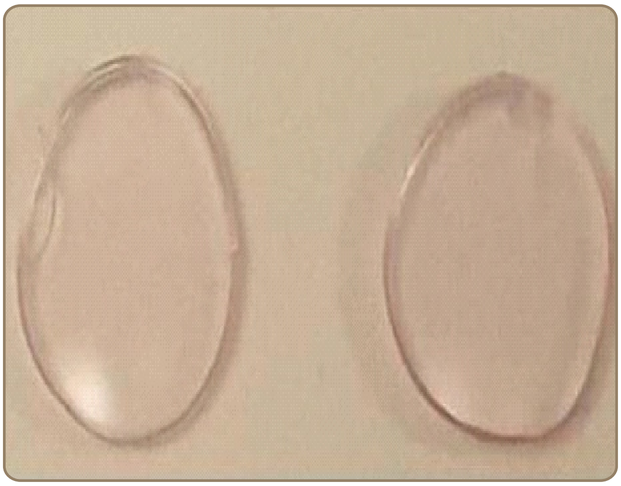

Image: Rose-tinted contact lenses (about 10 mm in diameter) containing gold nanoparticles filter out problematic colors for people with red-green color blindness.

Image Credit: Adapted from ACS Nano 2021, DOI: 10.1021/acsnano.0c09657

Some daily activities, such as determining if a banana is ripe, selecting matching clothes or stopping at a red light, can be difficult for those with color blindness. Most people with this genetic disorder have trouble in discriminating red and green shades, and red-tinted glasses can make those colors more prominent and easier to see. However, these lenses are bulky and the lens material cannot be made to fix vision problems. Thus, researchers have shifted to the development of special tinted contact lenses. Although the prototype hot-pink dyed lenses improved red-green color perception in clinical trials, they leached dye, which led to concerns about their safety. Gold nanocomposites are nontoxic and have been used for centuries to produce "cranberry glass" because of the way they scatter light. So, Ahmed Salih, Haider Butt and colleagues wanted to see whether incorporating gold nanoparticles into contact lens material instead of dye could improve red-green contrast safely and effectively.

To make the contact lenses, the researchers evenly mixed gold nanoparticles into a hydrogel polymer, producing rose-tinted gels that filtered light within 520-580 nm, the wavelengths where red and green overlap. The most effective contact lenses were those with 40 nm-wide gold nanoparticles, because in tests, these particles did not clump or filter more color than necessary. In addition, these lenses had water-retention properties similar to those of commercial ones and were not toxic to cells growing in petri dishes in the lab. Finally, the researchers directly compared their new material to two commercially available pairs of tinted glasses, and their previously developed hot-pink dyed contact lens. The gold nanocomposite lenses were more selective in the wavelengths they blocked than the glasses. The new lenses matched the wavelength range of the dyed contact lenses, suggesting the gold nanocomposite ones would be suitable for people with red-green color issues without the potential safety concerns. The researchers say that the next step is to conduct clinical trials with human patients to assess comfort.

Source: www.phys.org

NEWS

Study provides first evidence of DNA collection from air

Researchers from Queen Mary University of London have shown for the first time that animal DNA shed within the environment can be collected from the air.

The proof-of-concept study, published in the journal PeerJ, opens up potential for new ecological, health and forensic applications of environmental DNA (eDNA), which to-date has mainly been used to survey aquatic environments.

Living organisms such as plants and animals shed DNA into their surrounding environments as they interact with them. In recent years, eDNA has become an important tool to help scientists identify species found within different environments. However, whilst a range of environmental samples, including soil and air, have been proposed as sources of eDNA until now most studies have focused on the collection of eDNA from water.

In this study, the researchers explored whether eDNA could be collected from air samples and used to identify animal species. They first took air samples from a room which had housed naked mole-rats, a social rodent species that live in underground colonies, and then used existing techniques to check for DNA sequences within the sampled air.

Using this approach, the research team showed that air DNA sampling could successfully detect mole-rat DNA within the animal's housing and from the room itself. The scientists also found human DNA in the air samples suggesting a potential use of this sampling technique for forensic applications.

Dr. Elizabeth Clare, Senior Lecturer at Queen Mary University of London and first author of the study, said: "The use of eDNA has become a topic of increasing interest within the scientific community particularly for ecologists or conservationists looking for efficient and non-invasive ways to monitor biological environments. Here we provide the first published evidence to show that animal eDNA can be collected from air, opening up further opportunities for investigating animal communities in hard to reach environments such as caves and burrows."

Research impact

The project was supported by Queen Mary's Impact Acceleration Accounts, strategic awards provided to institutions by UK Research and Innovation (UKRI) that support knowledge exchange and help researchers generate impact from their research. The research team are now working with partners in industry and the third sector, including the company Nature Metrics, to bring some of the potential applications of this technology to life.

Dr. Clare added: "What started off as an attempt to see if this approach could be used for ecological assessments has now become much more, with potential applications in forensics, anthropology and even medicine. For example, this technique could help us to better understand the transmission of airborne diseases such as COVID-19. At the moment social distancing guidelines are based on physics and estimates of how far away virus particles can move, but with this technique we could actually sample the air and collect real-world evidence to support such guidelines".

Source: www.phys.org

Abstracts of Recent Publications

01. Marine Pollution Bulletin, 2021, Vol. 169, 2021, 112553.

Bioremediation of polycyclic aromatic hydrocarbons in contaminated mangroves: Understanding the historical and key parameter profiles.

Felipe Filgueiras de Almeida, Danúbia Freitas, Fabrício Motteran, Bruna Soares, Fernandes Sávia Gavazza.

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Sensitive biomes, such as coastal ecosystems, have become increasingly susceptible to environmental impacts caused by oil logistics and storing, which, although more efficient nowadays, still cause spills. Thus, bioremediation techniques attract attention owing to their low impact on the environment. Among petroleum-based compounds, polycyclic aromatic hydrocarbons (PAHs) are known for their potential impact and persistence in the environment. Therefore, PAH bioremediation is notably a technique capable of reducing these polluting compounds in the environment. However, there is a lack of understanding of microbial growth process conditions, leading to a less efficient choice of bioremediation methods. This article provides a review of the bioremediation processes in mangroves contaminated with oils and PAHs and an overview of some physicochemical and biological factors. Special attention was given to the lack of approach regarding experiments that have been conducted in situ and that considered the predominance of the anaerobic condition of mangroves.

Keywords: Coastal ecosystem, Polycyclic aromatic hydrocarbons, Mangroves, Oil products, Microorganisms, Biological degradation.

02. Journal of Hazardous Materials, 2021, Vol. 419, 126516.

Synthetically engineered microbial scavengers for enhanced bioremediation.

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Microbial bioremediation has gained attention as a cheap, efficient, and sustainable technology to manage the increasing environmental pollution. Since microorganisms in nature are not evolved to degrade pollutants, there is an increasing demand for developing safer and more efficient pollutant-scavengers for enhanced bioremediation. In this review, we introduce the strategies and technologies developed in the field of synthetic biology and their applications to the construction of microbial scavengers with improved efficiency of biodegradation while minimizing the impact of genetically engineered microbial scavengers on ecosystems. In addition, we discuss recent achievements in the biodegradation of fastidious pollutants, greenhouse gases, and microplastics using engineered microbial scavengers. Using synthetic microbial scavengers and multidisciplinary technologies, toxic pollutants could be more easily eliminated, and the environment could be more efficiently recovered.

Keywords: Microbial scavengers, Synthetic biology, Biodegradation, Metabolic engineering, Toxic pollutants.

E-Resources

NATIONAL

Central Food Technological Research Institute (CFTRI)
https://cftri.res.in/

CSIR - National Institute of Oceanography (NIO)
https://www.nio.org/

ICMR - National Institute of Virology (NIV)
https://www.niv.co.in/

Indian Institute of Remote Sensing (IIRS)
https://www.iirs.gov.in/

INTERNATIONAL

National Research Council Canada
https://nrc.canada.ca/en

Center for Microbial Ecology
https://www.canr.msu.edu/cme/

Society for General Microbiology
https://socgenmicrobiol.org.uk/

Soil Science Society of America (SSSA)
https://www.soils.org/

EVENTS

Conferences / Seminars / Meetings 2021

4th International Conference on Clinical Microbiology and Infectious Diseases. August 23 - 24, 2021. **Venue:** Berlin, Germany. **Website:** https://clinicalmicrobiology.annualcongress.com/

16th International Conference on Microbial Interactions & Microbial Ecology. October 06 - 07, 2021. **Venue:** Barcelona, Spain. **Website:** https://microbialinteractions.expertconferences.org/

9th World Congress and Expo on Applied Microbiology. October 25 - 26, 2021. **Venue:** Zurich, Switzerland. **Website:** https://microbiology.conferenceseries.com/

9th World Congress on Microbiology & Infectious Diseases. November 08 - 09, 2021. **Venue:** Vienna, Austria. **Website:** https://microbiology.infectiousconferences.com/

2nd World Plant and Soil Science Congress. November 15 - 16, 2021. **Venue:** Tokyo, Japan. **Website:** https://plantscience-biology.agriconferences.com/

Daily rhythms of our genes are disrupted when sleep times shift

A study from the University of Surrey, published in the journal PNAS (Proceedings of the National Academy of Sciences), found that the daily rhythms of our genes are disrupted when sleep times shift.

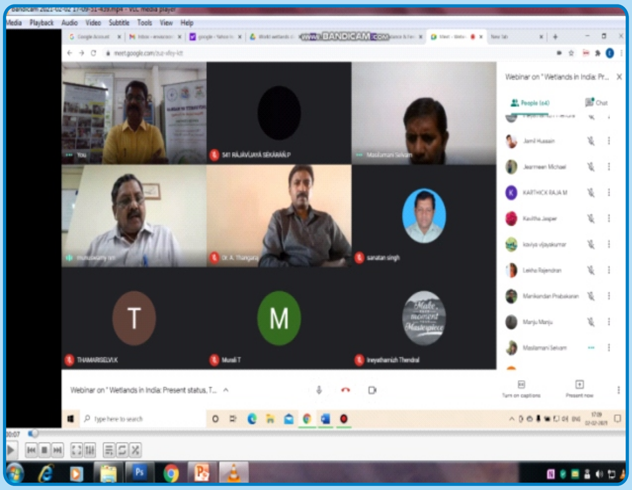
Researchers placed twenty-two participants on a 28-hour day in a controlled environment without a natural light-dark cycle. As a result, their sleep-wake cycle was delayed by four hours each day, until sleep occurred 12 hours out of sync with their brain clock and in the middle of what would have been their normal 'daytime'. The team then collected blood samples to measure the participants' rhythms of gene expression.

During this disruption of sleep timing, there was a six-fold reduction in the number of genes that displayed a circadian rhythm (a rhythm with an approximately 24 hour period). This included many regulators associated with transcription and translation, indicating widespread disruption to many biological processes.

The study also revealed which genes may be regulated by sleep-wake cycles and which are regulated by central body clocks. This finding provides new clues about sleep's function as separate from the circadian clock.

Source: www.sciencedaily.com

World Wetlands Day – 2nd February, 2021



Pamphlets