THE INDIAN SCIENCE CONGRESS ASSOCIATION
14, Dr. Birendra Guha Street, Kolkata - 700017

ISC A YOUNG SCIENTIST’S AWARD PROGRAMME : 2019-2020

To encourage Young Scientists, The Indian Science Congress Association has instituted a number of awards in different disciplines. These awards carry a sum of Rs.25,000/- besides a Certificate of Merit.

1. Applications are invited from members (Life & Annual) of the Association who have paid their subscription on or before July 15, 2019. The upper age limit of the candidates for the award is 32 years as reckoned on December 31, 2019 (born on and after January 01, 1988).

2. Four copies of the abstract (not exceeding 100 words) along with four copies of full length paper must reach the office of the General Secretary (Membership Affairs) not later than August 16, 2019. At the top of each copy of the paper and its abstract, the name of the Section under which the paper is to be considered should be indicated. For details of Sections see http://www.sciencecongress.nic.in/html/paper/presentations.php.

3. Along with the four copies of paper, four copies of the Application Form (to be downloaded from ISCA website http://www.sciencecongress.nic.in/html/young_sc_programme.php) with brief bio-data of the candidate (not exceeding 2 pages), list of publications, with copies of reprints of already published papers if any, and a soft copy of the duly filled application form with scanned copies of enclosures (excluding reprints), full length paper and abstract in MSWord (.pdf/pdf) along with bio data in the form of a CD must also be sent simultaneously along with the hard copies.

4. The Paper submitted must be a single author paper and the research work should have been carried out in India and this has to be certified by the Head of the Institution from where the candidate is applying.

5. The candidate should give an undertaking that the paper being submitted has not been published in any journal or presented in any other Conference / Seminar / Symposium or submitted for consideration of any award.

6. A Young Scientist can present only one paper in any one Section (and not a second paper on the same or any other topic in any other Section).

7. A person who has already received Young Scientist Award in any section once will not be eligible to apply for the above Award in the same or any other section.

8. Incomplete Applications will not be considered.

9. The papers submitted will be subjected to verification for authenticity.

10. Full length paper will be evaluated by experts and the selected Young Scientists (maximum of six) in each section will be invited to make oral presentation of their paper during 107th Indian Science Congress. The selected candidates will be provided admissible travelling allowances by ISCA.

11. The final selection for the Awards will be made by a duly constituted committee and the awards will be given during the Valedictory Session of 107th Indian Science Congress to be held on January 7, 2020.

12. Applications submitted for the above award will not be returned.

13. The last date for receiving papers at ISCA Headquarters is August 16, 2019.

All correspondences should be made to: The General Secretary (Membership Affairs) The Indian Science Congress Association, 14, Dr. Birendra Guha Street, Kolkata-700017. Tel.Nos: (033) 2287-4530/2281-5323, Fax.No.: 91-33-2287-2551/2287-2551 E-mail: iscacal@vsnl.net
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S & T ACROSS THE WORLD
IS THE HIGHER EDUCATION IN INDIA IN RIGHT PROSPECTIVE TO MEET THE FUTURE CHALLENGES?

India stands for the third largest networks of higher education institutions, next to the United States and China the world. Here is still a lot of potential for further development in the education system in India. We claim that India must rank 3rd among all countries by 2020 in education. If we observe overall ranking of relevant institutions it is observed in the year 2000, out of 500 there were two Indian Universities / Institutes were ranked in the list, and one institution from China. In due course of time, in 2010, only one institution from India whereas 32 institutions were ranked from China. With over 750 universities and more than 38,000 colleges today—compared to roughly 650 universities and 25,000 colleges in 2012—the country looks unsurprisingly unlikely to meet that objective. We need to think and act for its reforms to meet the future objectives of education over a large number of students.

The aim of the government to raise its current Gross Enrolment Ratio (GER) to 30 per cent by 2020 will also boost the growth of the distance education in India. Number of colleges and universities in India reached 39,050 and 903, respectively in 2017-18. India had 36.64 million students enrolled in higher education in 2017-18. GER in higher education reached 25.8 per cent in 2017-18. Gross Enrolment Ratio (GER) is a ratio of enrolment in higher education to population in the eligible age group (18-23) years. Tamilnadu had the highest GER in the country at 46.9%. Bihar is at the bottom with 14.9 per cent of its youth. Higher Education System in India compare to developing / developed countries needs substantial improvement. The percentage of students taking higher education is hardly about 13 % whereas the same is varying between 28 to 90 %, across the world. The lowest % being 28 % and the same is as high as 90 % in developed countries.

The main regulatory body in Indian Education System is the University Grant Commission (UGC), which enforces its standards, advises the government, and helps coordinate between the Central and the Regional Accreditation for higher learning. The UGC has been criticised as it is preoccupied with disbursing funds, whereas, hardly concentrate on monitoring the institutes, focusing on research to be undertaken etc. Unfortunately, the UGC had no such powers and can only releases a list of bogus institutions and not recognise their degrees.

Indian higher education is in need of thorough reforms in the Education Policy. Government of India may increase the budget allocation, as the existing one which is not adequate, and therefore allocation must be made appropriately, i.e. minimum 6 % in order to improve the scenario. Basic education must reach to maximum number of children from different strata of the society so that they are eligible to pursue higher education.

Institutions must also concentrate on giving quality inputs to the students and must look into constantly updating the syllabus in order to help students considering the changing market scenario. Education should be made liberal as
well as introduce new practices & applied research work. Medium of teaching in English in India provides additional opportunities to students as Mr Amit Phadnis, Cisco (India) Highlighted the availability of English speaking tech-educated talent, democratic governance and a strong legal and intellectual property protection framework are enablers for world class product development.

Concerted and collaborative efforts are needed in broaden student choices through liberal arts education. A focus is to be made on higher standards of transparency, strengthening of the vocational and doctoral education, and professionalization of the sector through stronger institutional responsibility. It would help in reprioritizing efforts and working around the complexities. If such developments take place in its true sense in our country students would be attracted to pursue higher education which will in turn fulfil corporate expectations. Efforts should also be taken to guide, mentor students and parents to develop and retain interest amongst students.

In addition to above, curriculum should also include sports, hobby classes, vocational skills development program, employability enhancement & soft skills development programs, entrepreneurship development modules, specialization wise clubs and committees of students, practical assignments related to their field, industry interface related modules such as internships, industry visits, guest lectures, workshops, seminars, participation in summits, management quiz etc. with evaluation and monitoring system so as to ensure continual improvement in the same. Institutions should also inculcate multitasking abilities amongst students, foreign languages, advanced IT knowledge so that they can perform better in the chosen field. Student exchange, cultural exchange should be encouraged and various ways and means should be found to enhance student’s interest level & participation. Special emphasis must be given to communication and presentation skills, especially for students coming from rural background / remote locations and that for student’s studies in local dialect, so that they can perform well in the corporate world, across the world.

The Government of India is quite serious for reforming the Education Policy in India. In this regard, The T.S.R. Subramanian committee, entrusted with preparing a new education policy for India submitted the report to the Government in May suggesting measures that the country must take to improve the sector that caters to over 300 million students in the country. The recent draft of the Higher Education Commission Bill 2018 aims to dramatically alter the way higher learning is governed in the country. There are some apprehensions that the proposed Bill could result in the concentration of power in the hands of the Centre instead of existing experts from academia.

Prof. Arun Kumar
Department of Earth Sciences,
Manipur University, Imphal

“One of the first conditions of happiness is that the link between man and nature shall not be broken”
— Leo Tolstoy
STINGING INSECTS
Surjeet Kumar and Saurbh Soni

Stinging insects such as various types of wasps, yellow jackets, hornets and bees, are common summertime pests and their stings can be more than just a painful nuisance. Those with allergies to stings are most at risk, although anyone can be affected if a large number of stinging insects swarm and sting at once.

INTRODUCTION

Stinging insects are members of the order Hymenoptera of the class Insecta. The medically important groups of Hymenoptera are the Apoidea (bees), Vespoidea (wasps, hornets, and yellow jackets), and Formicidae (ants). The family Apidae includes the social honeybees, the solitary bees, and bumblebees. Honeybees are herbivorous and live on nectar and pollen. The family Vespidae includes wasps, hornets, and yellow jackets which are predacious carnivores and live on other insects and sweet substances, such as sap and nectar. These venomous insects possess the capability to sting using a modified ovipositor found on the terminal end of their abdomen. These insects deliver their venom by stinging their victims. There is often a great deal of misidentification between bees and their vespid cousins. Honeybees are social insects and build their nests in hollow trees or other cavities. Yellow jackets are usually ground dwellers, whereas the hornets and wasps live in shrubs and trees, and are not ground nesting. The stinger of these insects is another method of identification.

Honeybees can only sting once; they possess a barbed stinger that stays behind in the victim’s skin after they sting. The stinger and the venom sac are pulled out of the bee’s abdomen and soon after the insect dies. Wasp, hornet, and yellow jacket stingers are not barbed and each insect is capable of delivering multiple venom-injecting stings without dying. Typically, people and animals are stung accidentally when they step on or otherwise disturb these insects.

WHY THEY STING?

Stinging insects such as bees, wasps, yellow jackets and hornets use their stings to subdue prey (primarily insects and spiders) and to defend themselves or their colony.

CATEGORIES OF REACTIONS AND SYMPTOMS

i. Localized reactions- These are the most common types of reaction to a bee or wasp sting. Symptoms include pain, swelling, warmth, redness at the site of the sting and itching. Symptoms show up almost immediately after stings and may last several hours. Large local reactions may result in excessive swelling that may last as long as a
week as well as feelings of nausea and fatigue. These symptoms do not cause major medical problems.

ii. Secondary bacterial infections— This type of skin infection develops if the sting site is frequently scratched and bacteria are given a suitable condition in which to develop. Failure to adequately clean, disinfect and medicate sting sites enable infections to occur.

iii. Systemic (affecting the whole body) allergic reactions— Symptoms of systemic allergic reactions include swollen red bumps on the skin, flushing of the skin and difficulty in breathing. The reactions may vary in severity from mild skin to life-threatening. In severe reactions, hypotension (low blood pressure, circulatory disturbances, and breathing difficulty) can progress to fatal cardiorespiratory arrest.

iv. Toxic reactions: result directly from wasp or bee venom rather than the immune system’s response. These reactions occur when an unusual amount of venom is introduced to the body. Individuals usually experience toxic reactions after being stung multiple times. Symptoms can include fever, nausea, vomiting, diarrhea, headache, fainting and convulsions. Swollen red bumps, rash and other skin-related symptoms are less common in toxic reactions than in systemic allergic reactions.

v. Delayed reactions: are uncommon and may show up days to weeks after the sting. These reactions constitute less than one per cent of all reactions to insect stings. Delayed reaction symptoms can vary a great deal and may include inflammation of the brain, the nerves, blood vessels and kidneys as well as blood clotting disturbances.

MORE INFORMATION ABOUT STINGING INSECTS
A. BEES

There are more than 20,000 recorded bee species.

1. Honey Bees

Honey bees, although one of the most popular bees are known for producing and storing honey as well as building impressively large nests using wax secreted by workers in a particular colony.

Species of Honey bees:
- Giant honey bee (Apis dorsata Fab.): It is called as rock bee. These bees are present all over the plains, sub mountains or lower regions of India up to 4000 feet height i.e. 1200 m amsl. They make their nests on rocks or tall trees. This bee keeps migrating between hills and adjoining plains and has got ferocious temperament due to which it cannot be domesticated.
- Little honey bee (A. florea Fab.): This is small bee which is present all over India, but is rarely present in places which are higher than 1500 m amsl. This bee makes a single comb which remains suspended from branches of small trees, bushes, and piles of dried sticks.
- Indian honey bee (A. cerana Fab.): commonly known as Drohla and Mahun. These bees are present all over the state and they live in cavities of the tree trunk, hollow rocks, hollowed out logs, wooden boxes, packing cases, empty tins, wall recesses, unused almirahs etc. This bee makes parallel combs.
- European honey bee (A. mellifera L.): commonly called as Italian honey bee. The colony builds its nest with several parallel combs mostly in hollow trees and caves. It also builds up its nest in shady open places.
Honey Bee Sting: Honey bees usually sting as a form of defense of themselves or their colony. But when they sting, an attractant pheromone marks the victim and this pheromone attracts more bees to attack and sting. The stinger is barbed and located at the end the abdomen. When a honey bee stings, its stinger, the venom sac and other parts of the honey bee’s body are pulled out and left behind, killing the bee. Although the bee dies, its sting takes effect quickly, and, if the stinger is not removed quickly, the symptoms gradually increase as the venom sac continues to pump venom into the wound.

Behaviour and Habits: While some bees are solitary, species such as honey bees and bumble bees are tremendously social. Bee colonies are comprised of three castes: the queen bee, infertile female worker bees and male drones. The queen mates and lays eggs for the span of her life. Male drones exist solely to fertilize the queen and die soon after having fulfilled their task. Female worker bees perform a multitude of tasks necessary to the survival of the hive.

2. Carpenter bees

Carpenter bees are not social insects. They construct their nests in trees or in frame buildings. Most of the top of the abdomen of carpenter bees is without hairs and is shiny black in colour.

Feeding habits and behavior: Carpenter bees do not eat wood but do feed on plant pollen and nectar. The female is capable of stinging but seldom does so unless she is provoked or handled. The males do not sting. A carpenter bee begins her nest by drilling a nearly perfectly round entrance hole (about 1/2 inch diameter) into the wood. Bees prefer to attack wood that is greater than two inches thick. Large carpenter bees excavate dry, unpainted and weathered wooden objects such as doors, windowsills, roof eaves, railings, decks, untreated poles, fences, wooden lawn furniture.


Bumblebees are large, fuzzy, very hairy insects that are black and yellow colored or in some species orange or red.

Behaviour and Habits: They usually build their nest in dry, protected and hidden cavities either below ground, on the ground or close to the ground level. Typical places for bumblebee nests are abandoned rodent tunnels, behind structure siding where gaps and cracks allow entrance, under piles of wood on the ground, under piles of dead leaves and compost piles or even abandoned birds’ nests. The bumblebee queen that has overwintered in a protected location constructs the nest in the early spring and begins the new bumblebee colony.
Do Bumblebees Sting?

Like most other stinging wasps and bees, bumblebees sting to defend themselves and their nest. Female bumblebees have a stinger and a pointed abdomen, while males do not have a stinger and have a rounded abdomen.

B. WASPS

Wasps have 4 distinct stages – egg, larva, pupae and adult. Adults are extremely variable in appearance and color, depending on the wasp species. Most have two pair of wings and a pinched waist.

Reproduction: Late in the summer, the queen of some species produces unfertilized eggs. These develop into males. The males fertilize the wasps that become the queens of the following year. These fertilized females overwinter in a sheltered location. In most cases, the rest of the colony perishes when winter comes.

Next spring, the queen starts laying eggs. The fertilized eggs that they produce become workers, building the nest and feeding the larvae produced by the queen.

Types of Wasps

i. Solitary Wasps: usually build their nests underground. Only one female wasp cares for the nest. The female wasp constructs the nest; goes hunting to collect prey; captures and paralyzes the prey; then returns to the nest where she lays an egg on the prey; finally sealing the prey in a nest cell. Since these wasps are not socialized like honey bees, yellow jackets and hornets, they are not aggressive and rarely sting.

ii. Social Wasps: Social wasp colonies are established annually, but die off in the late-fall leaving behind only some fertilized queens. These queens will survive the winter and begin a new colony the next spring. Nests are constructed of “paper” the wasp makes from chewed up wood mixed with the wasp’s saliva. Social wasp nests can be either above or below ground level. The most common social wasps are the yellow jackets, the group of wasps most likely to sting, and the hornets.

iii. Parasitic Wasps: lay their eggs in or on other insects and the wasp larvae consume and kill the host. They are non-aggressive, stinging only when handled. Their sting produces very little pain. Parasitic wasps are beneficial as they help control a wide variety of insect-pests of crops, gardens and landscape plants.

1. Hornets

Behaviour and nest building: Hornet nests are constructed with paper-like material produced by the hornets mixing their saliva together with the wood fibers they gather. Hornet nests are located within or atop trees, in attic rafters and in other covered areas. They can sometimes be found near the eaves of houses. While hornets are known for their ability to inflict a painful sting, they are very beneficial predators and help to control a variety of insects that could otherwise become pests.

Queen hornets begin the construction of nests in order to house their eggs. The female workers then assume the responsibilities of nest building and brood tending, while the queen’s sole duty is to lay the eggs from which future generations are born in late summer. The size of a hornet nest grows in proportion to the size of the colony. However, nests are only used once; worker populations perish in winter, leaving only the fertilized females to begin new colonies in the coming warm seasons.
What do hornets eat?

Worker hornets often feed on sugary liquids such as nectar or juices. They can be found on fallen fruit or even open containers of soda.


Paper wasps gather fibers from dead wood and plant stems, which they mix with saliva, and use to construct water-resistant nests made of gray or brown papery material. Some types of paper wasps are also sometimes called umbrella wasps, due to the distinctive design of their nests. There are many different species of paper wasps, but the most commonly seen are brown, reddish with yellow or red markings. Paper wasps have very long legs and, even when in flight, their legs will extend below their body. Nests are usually made of a paper-like material with a circular comb of cells that open toward the bottom of the nest. Paper wasp nests are commonly found under building overhangs and decks, behind shutters and inside gas grills, children’s play sets, mailboxes, light fixtures and abandoned vehicles. Most paper wasps are not as aggressive as yellow jackets and baldfaced hornets, but will readily sting to protect their nest. Since their territoriality can lead to attacks on people, and because their stings are quite painful and can produce a potentially fatal anaphylactic reaction in some individuals.

3. Yellow jackets, *Dolichovespula* spp. and *Vespula* spp.

Yellow jackets are sometimes mistakenly called “bees”, given that they are similar in size and sting, but yellow jackets are actually wasps. They may be confused with other wasps, such as hornets and paper wasps. A typical yellow jacket worker has alternating bands on the abdomen. Queen is larger having different patterns on their abdomens help separate various species. Yellow jackets, in contrast to honey bees, have yellow or white markings, are not covered with tan-brown dense hair on their bodies, do not carry pollen, and do not have the flattened hairy hind legs used to carry it.

Feeding habits: Yellow jackets are pollinators and may also be considered beneficial because they eat beetle grubs, flies and other harmful pests. However, they are also known scavengers who eat meat, fish and sugary substances, making them a nuisance near trash receptacles and picnics.

Stinging habits: They are known to be aggressive defenders of their colonies. Yellow
jackets are otherwise not quick to sting. All species have yellow or white on their faces. However, the sting of a yellow jacket is painful, and each insect is capable of delivering multiple stings. Because they are equipped with lance like stingers with small barbs, yellow jackets are capable of stinging repeatedly.

**Nests:** Many yellow jackets are ground-nesters. Their colonies can be found under porches or steps, in sidewalk cracks, around railroad ties or at the base of trees. Some yellow jackets build aerial nests in bushes or low-hanging branches or in the corners of buildings and other manmade structures.

**REFERENCES**

'GRAPHENE’—WORLD’S THINNEST MATERIAL FOR REVOLUTIONIZING APPLICATIONS

Krishna Kumar Jaiswal, S. Sudhakar and Arun Prasath Ramaswamy*

The 2-D atomic-scale super-material graphene is a polycyclic hydrocarbon with incredible strength, light-weight, and flexibility. It is the most efficient conductor of heat and electricity with remarkable future technological potential. The substantial applications of eco-friendly graphene focus in the field of energy conversion and storage, electronics, sensors, catalysts, biomedical, membranes, etc.

INTRODUCTION

Graphene (“super-material”) is an atomic scale two-dimensional honeycomb hexagonal lattice created entirely out of carbon atoms. It can be deliberated as indefinite massive aromatic structured molecules with the flat and uniform structure of polycyclic aromatic hydrocarbons. Carbon atoms are the fundamental structural element of other allotropes including graphite, charcoal, diamond, lonsdaleite (hexagonal diamond), fullerenes (C₆₀, C₅₄₀, C₇₀) and carbon nanotubes (CNTs). The incredible properties of graphene are amazing which includes nearly transparent sheets of crystal, strongest material than steel, yet incredibly light-weight and flexible with diameter 1,000,000 times smaller than a single human hair¹. Graphene stands as the grand daddy for the recent boom in materials science. This revolutionary characteristics of this material will pool the science, art, and history to reveal the inspiring story of thinnest, strongest, lightest and utmost conductive materials in the world.

HISTORY OF THE WONDER MATERIAL ‘GRAPHENE’ AND THE GLOBAL EXPLOSION

Graphene, the millions of ultra-thin layers stack along to make graphite usually found in pencils, were initially deliberate in the past of 1947. Electric current conduction in graphene carried out effectively by mass-less charge carriers have been shown theoretically in 1984, and the ‘graphene’ term was introduced first in 1987 to explain the graphitic layers. The rediscovery, isolation and characterization of graphene in 2004 by playful approach of two researchers, Prof. Andre Geim and his Ph.D. student Kostya Novoselov at the University of Manchester began a flurry of studies in the field of 2-D materials and led the generation of the stunning scientific feat to won Noble Prize in 2010 in Physics employing a piece of graphite and a few scotch tape¹. Andre and Kostya usually conduct the ‘Friday night experiments’ to try out experimental science not essentially related to their routine research. One Friday ‘Graphene Fridays’ they removed few flakes from the graphite piece sticky
tape and observed some thinner flakes than others. By repeatedly fragment splitting they succeeded to create only one atom thick isolated graphene for the first time. The original article describing the initial isolation of graphene and well-versed by existing theoretical description of the structure, composition, and properties was printed in the journal ‘Science’ on 22nd October 2004 which sparked a global explosion in graphene research.

UNDERSTANDING PROPERTIES OF GRAPHENE

Graphene is the structure of an $sp^2$ plane with bond length 0.142 nm and the stacked layers with interplanar spacing 0.335 nm form graphite. Single-atom thick graphene is lightest at ~ 0.77 mg/m² and strongest (100-300 times stronger than steel with the tensile stiffness of 150,000,000 psi) material with incredible flexibility known to man at present. It is the best known conductor of heat [(4.48±0.44) x 10⁴ to (5.30±0.48) x 10³Wm⁻¹K⁻¹ at room temperature] and electricity (electron mobility at values of >15,000 cm²V⁻¹s⁻¹). The other notable property is the unique level of light absorption at $\delta\chi H'' 2.3\%$ of white light transport spin-dependent current². The 2nd most abundant element within the human body ‘carbon’ is the chemical basis for entire living being on earth and might be eco-friendly, sustainable elucidation for a countless range of applications.

APPLICATION PROSPECTIVE

World’s thinnest material is set to be revolutionizing nearly every aspect of daily life. The exceptional physical properties and potential applications fascinate this material stems from the advancement of future technologies. Graphene is realized to open up new markets through improvement in existing materials and transformational ability.

SOLAR POWER SYSTEMS

The truly flexible, inexpensive and transparent solar cells are convincible due to graphene material in-turn of the electric power source from the surface, virtually. Recent advances in graphene-based solar cells, altered number of graphene layers and doping parameters witnessed the reduction in the reflectance of solar rays ~ 20%. Optical transparency of a single layer graphene appears 97.7% and for 3-layered graphene stacks around 90.8% whereas addition of each layer corresponds to a 2.3% reduction of optical transparency³. Graphene-based materials can play an important role in solar energy conversion systems.

BATTERIES AND SUPERCAPACITORS

Graphene dramatically increases the lifecycle of a traditional Lithium-ion battery to incite quick charging of devices and greater power storage. Highly flexible and light-weight graphene batteries can be stitched into the clothing or into the body. The impact of this might be immense for soldiers to carry lesser weight batteries instead of heavier, with rechargeability by body heat or solar radiation to stay out for longer in the field. Graphene-based supercapacitors are supposed to store energy almost as Li-ion batteries, charging-discharging in seconds and to uphold all this over tens of thousands charging cycles³. It might be achieved by using a highly porous form of graphene with the enormous internal surface area. Graphene supercapacitors might offer a large amount of power while draining lesser energy than conventional devices.

GRAPHENE-BASED WIND TURBINE

Graphene and its composite implanted in polymer or resin for improving interfacial load transfer to achieve anti-static and lightning strike protection for wind turbines. Increasing tensile
strength and modulus opens the possibility to design longer, stiffer and lighter wind turbine blades. The 2-D structure of graphene sheets is superior in deflecting cracks and promises to develop stronger, long-life turbine blades for wind energy.

**GRAPHENE-BASED FUEL CELL**

Graphene has been proved theoretically and experimentally for higher electro-catalytic activity due to high charge carrier mobility on the surface of an electrode and an electrolyte. Dopant with high electronegativity species within the graphene sheets promotes anchoring points to adsorb reactive species. The substitution of platinum with low-cost highly efficient graphene-based catalyst promises fuel cells with widely accessible renewable energy production.

**PHOTO-CATALYTIC WATER SPLITTING**

Graphene oxide or heteroatom-doped graphene for photo-driven water splitting emerges for clean energy H₂ generation. The valence and conduction band of graphene consist of bonding and antibonding orbitals, respectively which make a single sheet of graphene a zero-band-gap semiconductor. The large surface area and the conjugated basal plane of graphene oxide serve as an electron sink to facilitate exciton separation and subsequent electron transport and/or storage for water splitting to H₂. Tuning the electronic properties of graphene by introducing heteroatoms/dopants extends the applications of graphene to photo-catalysis processes.

**BIOFUEL PRODUCTION**

Graphene oxide nanosheets and its composites highlight the latest advancement in biofuel sectors due to numerous key factors to confirm biocatalyst efficiencies such as a high surface area for greater enzyme immobilization, lower mass transfer resistance, reduced fouling impact and non-chemical separation from the reaction mixture. Latest findings recommend the enhancement of activity and stability of immobilized enzymes/biocatalysts in hydrolysis/esterification reactions by using nano-materials/sheets, as a result of protection from denaturation and improved activation of enzymes that they afford for biofuel production.

**GRAPHENE IN MEMBRANE AND FILTRATION**

Membranes derived from graphene are having the potential to develop a perfect barrier to deal with liquids/gases. It can separate organic solvent efficiently from water and water from gaseous mixtures at an exceptional level. New research progresses of graphene sieve in water purification technologies establishes the real-world perspective to avail clean drinking water for the people who struggle to access adequate clean water resources. Graphene might even be used to create ultrafine, antibiotic water filter for quick and simple filtration of potentially hazardous drinking water.

**GRAPHENE-BASED COMPOSITES AND COATINGS**

The simple and efficient approach to harnessing the potential of graphene is to combine with existing products. It can be applied to brick and stone for waterproof home or in food wrapping to resist the transmission of O₂-H₂O molecules, the cause of food deterioration. Graphene oxide can be applied to create ‘smart packaging tools’ for food and pharmaceuticals with the ability to detect the atmospheric fluctuations.
BIOMEDICAL AND BIO-ENGINEERING APPLICATIONS

A Graphene-based nanomaterial along with pristine sheets of graphene, few-layered graphene and graphene oxide offers a wide range of versatile, distinctive, and tunable properties to revolutionize for biomedical applications into numerous extents of transport systems, improved brain penetration, health-testing kits, and 'smart' implants, tissue engineering and biological agents. Bioengineering scientists encourage graphene nanosheets to penetrate the cell walls for insertion of molecules of researcher’s interests. The flat surface enables easy modification for desired surface functionalization to offer enormous design platforms for drug delivery and ultrasensitive biosensor.

GRAPHENE SENSORS

Graphene is an ideal material for the sensor as each atom of graphene can be exposed to sense the fluctuations in its environments. Ultrasensitive micrometer size sensor enables molecular level detection of a potentially hazardous substance in the unsafe environment. A graphene-based sensor boosts the monitoring efficiency for the existence of harmful gases which could impact on field crops. Graphene sensors enable to emphasize the best areas for cultivating specific crops as per atmospheric condition. The acute sensitiveness might be tuned to chemical warfare and explosive agents to ensure early warning detection system for soldiers in the field.

GRAPHENE ELECTRONICS AND WEARABLE TECHNOLOGY

Next-generation electronics can be sparked by graphene to enhance the technology of today’s devices. Graphene coating has been used to improve the existing touch screens for phones and tablets. The flexible, conductive and wearable mechanical properties of graphene insight a smartphone to wear on the wrist or a tablet could be rolled up like newspapers.

GRAPHENE TRANSISTORS AND SEMICONDUCTORS

The upcoming challenges for electronic industry concern the further miniaturization of technology. Researchers have been developed the world’s smallest transistors using graphene for better performance within circuits. Graphene chips recognized as much faster performance than silicon chips, due to the ability of electric conduction at room temperature by one atom thick graphene semiconductors.

FUTURE TECHNOLOGIES

This is just the beginning and initial steps for future technologies. The amazing potential of graphene is limited only by imagination in science.

Graphene eye: The bionic technology of graphene is under the development of smart and sensible contact lenses to miniaturize biocompatible electronic devices. Graphene-coated contact lenses might facilitate to establish an era of wearable eye electronics that monitor health while providing protection from electromagnetic radiation and moistness loss.

Graphene paints: Graphene is a highly inert material and acts as a corrosion barrier for O₂-H₂O diffusion. The unique coating of graphene paint can indicate the end of deterioration of ships and cars through rust and can be applied to vehicles to be corrosion resistant for rust-free future.

Graphene isotope sieve: Graphene membranes might facilitate to shrink the energy cost of manufacturing heavy water and decontamination in atomic energy plants.
**Graphene dress:** The future technology dress ‘CuteCircuit’s Graphene Dress’ has a stretch sensor to capture breathing pattern of the wearer and change the color of the dress’ LED ornament depending on the depth of breath.

**Graphene Computers:** The logic circuits based on graphene transistor upgrades microprocessors clock speed by 1000 times and consume power $1/100$th of silicon-based computers and also smaller logic circuits encourage the transformative generation of energy-efficient computing.

**RM 50-03 graphene watch:** World’s ultra-light high-performance mechanical watch developed with graphene is unveiled on 16 January 2017 in Geneva.

**Nano-calligraphy on graphene:** Chemical patterns can be written thousand times finer than human-hair on graphene ‘paper’. Consequently, graphene concludes for smart future.

**REFERENCES**

1. [http://www.graphene.manchester.ac.uk/](http://www.graphene.manchester.ac.uk/)
MICROBIAL BIOSURFACTANTS AND ITS INDUSTRIAL APPLICATIONS

Kamaldeep Kaur* and Ashish Vyas

Research on microbial biosurfactants is explored less as compared to other applied aspects of microorganisms. Biosurfactants are surface active and classified into low molecular and high molecular weight compounds. Biosurfactants are produced by different types of microorganisms. Applications of biosurfactants are in trade of pharmacy, beauty products, petroleum, and also in eatable manufacturing industries. Biosurfactants are very helpful in field of agriculture by way of remediation of hydrocarbon, inorganic compounds and remediation of inorganic compound such as heavy metals. They have capability to increase the stabilization of oil or water emulsions, effective for removal of bulk arsenic from slime pits. Biosurfactants increases the constitution of soil by removing the heavy metals from contaminated soil.

INTRODUCTION

Biosurfactants are morphologically unmatched molecules which are surface stimulated compounds generated by variety of microorganisms. They are divided on the basis of chemical skeleton and their microbial origin. The chemical skeleton comprises of a hydrophilic portion, an acid, anions, peptides, cations, monosaccharides, disaccharides or polysaccharides and a hydrophobic part of unsaturated or saturated hydrocarbon series or fatty acids. These molecules have tendency to reduce surface as well as interfacial tension of liquids and micelles formation. Microbial biosurfactants can be classified in two major categories that are low-molecular-weight compounds known as biosurfactants, comprising lipopeptide, glycolipids, proteins and polymers of high-molecular-weight called polysaccharides, lipopolysaccharides proteins or lipoproteins. These two constituents are combinatorially known as bioemulsions or bioemulsifiers. Amphilic polymers are composed of hydrophilic and hydrophobic parts. They are very important throughout industry in many applications such as emulsifiers. This type of polymer is also called biosurfactants. Because of their amphiphilic structure, they enhance the surface area of hydrophobic particles. In counterpart to chemically manufactured equivalents they have lots of benefits. They are not harmful to environment, biologically degradable and less toxic. Amphilic biosurfactants have superior foaming properties and higher level of selectivity. They show its activity at extreme temperatures, pH and salinity.

Biosurfactants have polar groups present in these compounds and they are categorized into
chemically-synthesized surfactants. Biosurfactants are generally categorized by microbial origin and their chemical composition. Biosurfactants are mostly glycolipids in nature. Glycolipids are carbohydrates attached to long chain aliphatic acids or hydroxylaliphatic acids through an ester group. Among these glycolipids, well known glycolipids are rhamnolipids, trehalolipids and sophorolipids. Lipopeptides or lipoproteins consist of a lipid linked to polypeptide chain. Most of the lipopeptides show antimicrobial activity against different types of bacteria, fungi, algae and viruses. Most common lipopeptide iturin shows antibacterial activities at pH 5-11. Polymeric biosurfactants are high molecular weight biosurfactants and formed by different components. A well known polymeric biosurfactant is emulsan. It contains heteropolysaccharide backbone by which fatty acids are covalently attached. Particulate biosurfactants are of two types: whole microbial cells and extracellular vesicles. Extracellular vesicles produce micro emulsions that play a significant role in uptake of hydrocarbons through microbial cells.

**BIOCHEMISTRY BEHIND MICROBIAL BIOSURFACTANTS**

Biosurfactants are classified according to their microbial origin, hydrophobic and hydrophilic moieties. Hydrophilic moieties contain amino

### Table-1. Microorganism Producing Microbial Biosurfactants

<table>
<thead>
<tr>
<th>Name of Microorganisms</th>
<th>Group of biosurfactants</th>
<th>Class of biosurfactants</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Pseudomonas sp.</em></td>
<td>Glycolipids</td>
<td>Rhamnolipids</td>
</tr>
<tr>
<td><em>Pseudomonas aeruginosa</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Burkholderia glumae</em></td>
<td>Glycolipids</td>
<td>Trehalose lipids</td>
</tr>
<tr>
<td><em>Burkholderia thailandensis</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Burkholderia plantarii</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Rhodococcus erythropolis</em></td>
<td>Glycolipids</td>
<td>Sophorolipids</td>
</tr>
<tr>
<td><em>Nocardia erythropolis</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Mycobacterium sp.</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Arthrobacter sp</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Torulopsis apicola</em></td>
<td>Glycolipids</td>
<td>Celllobiolipids</td>
</tr>
<tr>
<td><em>Torulopsis bombicola</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Torulopsis petrophilum</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Ustilago maydis</em></td>
<td>Glycolipids</td>
<td></td>
</tr>
<tr>
<td><em>Ustilago zeae</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Bacillus subtilis</em></td>
<td>Lipopeptides and lipoproteins</td>
<td>Surfactin/iturin/fengycin</td>
</tr>
<tr>
<td><em>Bacillus licheniformis</em></td>
<td>Lipopeptides and lipoproteins</td>
<td>Lichenysin</td>
</tr>
<tr>
<td><em>Pseudomonas fluorescens</em></td>
<td>Lipopeptides and lipoproteins</td>
<td>Viscosin</td>
</tr>
</tbody>
</table>
### Name of Microorganisms | Group of biosurfactants | Class of biosurfactants
--- | --- | ---
*Serratia marcescens* | Lipopeptides and lipoproteins | Serrawettin
*Bacillus subtilis* | Lipopeptides and lipoproteins | Subtilism
*Bacillus polymyxa* | Lipopeptides and lipoproteins | Polymixin
*Acinetobacter sp.*  
*Rhodococcus erythropolis*  
*Mycococcus sp.* | Fatty acida/neutral lipids/Phospholipids | Phosphatidyl ethanolamine
*Penicillium spiculisporum* | Fatty acida/neutral lipids/Phospholipids | Spiculisporic acid
*Acinetobacter calcoaceticus* | Polymeric surfactants | Emulsan
*Acinetobacter radioresistens* | Polymeric surfactants | Alasan
*Acinetobacter calcoaceticus A2* | Polymeric surfactants | Biodispersan
*Acinebacter calcoaceticus* | Polymeric surfactants | Polysaccharide protein Complex
*Candida lipolytica* | Polymeric surfactants | Liposan
*Saccharomyces cerevisiae* | Polymeric surfactants | Mannoprotein
*Pseudomonas aeruginosa* | Polymeric surfactants | Protein PA
*Acinetobacter calcoaceticus*  
*Pseudomonas marginalis* | Particulate Biosurfactants | Vesicles
*Cyanobacteria* | Polymeric surfactants | Whole microbial cells

 acids, peptides, monosaccharide or polysaccharides. The hydrophobic moiety contains saturated or unsaturated fatty acids. Biosurfactants are generally glycolipids, lipopeptides or lipoproteins, fatty acids, neutral lipids, phospholipids, polymeric and particulate. Different types of biosurfactants have different biochemistry.

### PRODUCTION AND BIOSURFAC-TANTS OPTIMIZATION OF MICROBIAL

Microbial biosurfactants comprises those characteristics that are environmentally favourable viz. high level of biodegradability, less amount of toxicity and also superior foaming qualities as comparison with synthetic chemical pesticides. Due to cost of biosurfactants production, marketing of microbial surfactants is not appropriate as expected. At a present time, the cost of production of many biosurfactants is not as of chemical surfactants. Different strategies have been proposed to minimize the expenses of processing such as:

1. More effective bioprocesses have been developed that includes optimization of contrivances of fermentation and downward recovery processes
### Table-2. Chemical nature of biosurfactants is given below:

<table>
<thead>
<tr>
<th>Group of microbial biosurfactants</th>
<th>Class of microbial biosurfactants</th>
<th>Chemical nature of microbial biosurfactants</th>
<th>Structure of microbial biosurfactants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glycolipids</td>
<td>Rhamnolipids</td>
<td>1 or 2 molecules of rhamnose is attached with 1 or 2 molecules of β-hydroxydecanoic acid and -OH group of 1 of the acids take part in glycosidic attachment to reducing end of -OH group of rhamnose disaccharide.</td>
<td><img src="image1" alt="Rhamnolipid Structure" /></td>
</tr>
<tr>
<td>Glycolipids</td>
<td>Trehalose lipids</td>
<td>Attachment of disaccharide trehalose at Carbon-6 and Carbon-6' to mycolic acid is linked to many species of <em>Mycobacterium</em> and <em>Corinebacterium</em>. Long chain mycolic acids are α-branched-β-hydroxy fatty acids.</td>
<td><img src="image2" alt="Trehalose Lipid Structure" /></td>
</tr>
<tr>
<td>Glycolipids</td>
<td>Sophorolipids</td>
<td>It possesses a dimeric carbohydrate sophorose linked with long-chain of hydroxyl fattyacid with the help of glycosidic linkage.</td>
<td><img src="image3" alt="Sophorolipid Structure" /></td>
</tr>
<tr>
<td>Lipopeptides and lipoproteins</td>
<td>Surfactin/iturin/fengycin</td>
<td>Surfactin possesses beta-hydroxyl fatty acids and D-/L-amino acid remnants according to Haddad”. It is formed by 7 amino-acid ring structure linked with a chain of fatty-acid chain through lactone linkage.</td>
<td><img src="image4" alt="Surfactin Structure" /></td>
</tr>
<tr>
<td>Lipopeptides and lipoproteins</td>
<td>Lichenycin</td>
<td>These are identical in shape and physio-chemical features with surfactin.</td>
<td><img src="image5" alt="Lichenycin Structure" /></td>
</tr>
<tr>
<td>Fatty acids/neutral lipids</td>
<td>Corynomycolic acid</td>
<td>Corynomycolic acids, ( R_1-CH(OH) \ \text{CH}(R_2)\text{COOH} ) is a cluster of surface active compounds having different count of carbon atoms.</td>
<td><img src="image6" alt="Corynomycolic Structure" /></td>
</tr>
<tr>
<td>Polymeric surfactants</td>
<td>Emulsan</td>
<td>Emulsan is made by a branchless polysaccharide with back side attachment to O-acyl and N-acyl bound fatty acid side chains. Polysaccharide back chain made by 3 aminosugers, D-galactosamine, D-galactosaminouronic acid and a dideoxydiaminohehexose in proportion as 1:1:1.</td>
<td><img src="image7" alt="Emulsan Structure" /></td>
</tr>
</tbody>
</table>
(2) Use of less expensive and unwanted material

(3) Manufacturing of extra production strains

*Pseudomonas, Bacillus* and *Candida* are used for the large-scale economic production of most biosurfactants.

To optimize microbial biosurfactant production experimental design techniques have been applied. The use of surface response techniques enhances the production of biosurfactants very effectively through *Rhodococcus sp.* MTCC 2574 growing on n-hexadecane with yields of biosurfactants enhances from 3.2 to 10.9 g/L. BS29 enhances the formation of cell-bound glycolipids through 5-fold using surface responding techniques. When an artificial neural network attached with genetic algorithm; it gives a 3.5-fold enhancement in yield of biosurfactants. Same techniques were used aimed at optimizing biosurfactants formation by *B. circulans* MTCC 8281.

**APPLICATIONS OF MICROBIAL BIOSURFACTANTS**

Different strategies have been found for the manufacturing of microbial biosurfactants. They are easily degraded with biological agents and releases very less toxic compounds than synthetic surfactants. Biosurfactants can be used for reducing microorganisms causing diseases in plants or crops in growing areas and increases the amount of beneficial nutrients in soil. Biosurfactants are widely used for improvement in quality of soil in crop growing fields through process known as soil remediation. Microbial biosurfactants are used more widely than synthetic pesticides. Applications of biosurfactants are:

**ENVIRONMENTAL APPLICATIONS**

Production or development of bacteria on hydrocarbons is done with the help of microbial biosurfactants through expand the surface area among water and oil by the process of emulsification and pseudosolubilisation of hydrocarbons through distinction into micelles. Microbial biosurfactants helps in remediation of hydrocarbon, inorganic compounds. It helps in remediation of inorganic compound such as heavy metals. Rhamnolipids stimulates the deterioration of n-hexadecane by the producing strain of *P. aeruginosa*. Concentration of rhamnolipids contrived the surface of cell hydrophobicity and also physiological state of cell. In a washing treatment removal and mobilization of contaminants was done with the help of pseudosolubilisation and emulsification. Stabilization of emulsions among water–liquid hydrocarbons was done through high-molecular-weight biosurfactants (bioemulsifiers) that helps to expand the surface area for decaying bacteria by biological agents. According to the idea proposed by Das, *Bacillus circulans* was used to enhance the bio accessibility of anthracene through a process known as Polycyclic Aromatic Hydrocarbons (PAH) biodegradation. In hydrocarbon uptake mechanism, cell-surface hydrophobicity was changed by managing the linkage of cell with hydrophilic-hydrophobic surfaces by revealing various parts of cell destined microbial biosurfactants.

**APPLICATIONS IN INDUSTRIES**

Most commonly used rhamnolipids, lipopeptides, such as surfactin, lichenysin and emulsan have ability to increase oil recovery. Removal of oil is done with *B. subtilis*. *B. subtilis* PT2 and *P. aeruginosa* SP4 biosurfactants which have tendency to recover oil than synthetic biosurfactants. Microbial surfactants reduce
surface tension and also help in detaching oil from sludge present at bottom of tank. Microbial biosurfactants helps to reduce surface-tension properties, wetting and dispersing as well as low toxic level and high level of biodegradability. Microbial biosurfactants are also used to decrease salting, solubilization of essence oils and better sensorial characters in formulations of bakery and ice cream like outrigger of fat while cooking of fats. Microbial biosurfactants are widely used in food industries to form stable emulsions, which improve the texture and creaminess of dairy products. Rhamnolipids are suggested to improve dough characteristics of bakery products; use as food ingredients of compounds obtained from pathogen P. aeruginosa is not practically feasible. Where biosurfactants evolved from yeasts or Lactobacilli, are recognized as safe and are already involved in many food-processing technologies.

APPLICATIONS IN BIOMEDICAL

Surfactin formed by B. subtilis, is a leading lipopeptide that shows antimicrobial activity. Another microbial biosurfactants having antimicrobial activities are lipopeptides viz. iturin, fengycin formed by B. subtilis. A cyclic lipopeptide derived from Streptomyces roseosporus known as daptomycin act as an antimicrobial agent. Mannosylerythritol lipids (MEL-A and MEL-B) also obtained from Candida antarctica strains shows antagonistic activity for Gram-positive bacteria. In the gastrointestinal tract, inhibition in growth of pathogenic microorganisms was carried through construction of antimicrobial lipopeptides by Bacillus probiotic compounds according to Hong. Soybean oil waste have been used for the production of rhamnolipid, ability to act as antimicrobial agent against many microorganisms such as Mucor miehei Bacillus cereus, Micrococcus luteus, Neurospora crassa S. aureus, Pseudomonas sp. strain produced rhamnolipid with alginate, showed beneficial antiviral activity against herpes simplex virus types 1 and 2. Microbial biosurfactants are appropriate alternative to manmade drugs and antimicrobial agents so biosurfactants are adequate and intact curing agents. Sophorolipids are another microbial biosurfactants that are antagonistic to human immunodeficiency virus according to Shah. A yeast-like fungus Pseudozyma flocculosa is used to produce a cellbiose lipid called Flocculosin that was tested against isolation of clinical microorganism (bacteria) and disease causing yeast Candida albicans. Study of reveals that C. albicans cells were damaged by flocculosin (cellbiose lipid) instantly.

APPLICATIONS IN AGRICULTURE

Microbial biosurfactants have capability to increase the stabilization of oil or water emulsions and extraction of hydrocarbons from soil as per the study of Franzetti. Degradation of contamination in soil through Cd and Zn, ejection of polyaromatic hydrocarbons and removal of heavy metals from soil is carried by rhamnolipid through a recent process called foaming-surfactant technology. Microbial biosurfactants produced by microorganisms are effective for withdrawing hydrocarbons and heavy metals present in soil viz. Cd, Zn and Pb etc. Degradation of certain chemical insecticides is increased with microbial biosurfactants that are present in soil of crop growing areas in excess amount. Microbial biosurfactants are very effective for removal of bulk arsenic from slime pits or contamination of soils under alkaline situations. Surfactin helps to remove pesticides from soil and also degrade chlorinated hydrocarbon through glycolipids. Biosurfactants increases the constitution of soil by removing the heavy metals from impure soil.
with the help of *Acinetobacter sp.*, *Bacillus sp.*, and *Pseudomonas sp.* Microbial biosurfactants improves vigor of agricultural soil through soil remediation. Biosurfactants are very helpful for decomposition of pesticides\(^1_4\). Study of Wattanaphon\(^19\) revealed that oil-contaminated soil is used to isolate Burkholderia which have potential to bioremediate different types of contamination with pesticides. *Pseudomonas* and *Bacillus* are the isolates of rhizosphere produced by biosurfactants. They show their biological activity to control soft rot disease caused by *Pectobacterium* and *Dickeya sp.* Rhamnolipids inhibits zoospore formation of disease causing microorganisms in plants and helps to become plant resistant from different economically used pesticides\(^8_16\). *Pseudomonas* is antagonistic to aphid of green peach (Myzus persicae). *Pseudomonas putida* is a plant growth-promoter which produces microbial biosurfactants. Such biosurfactants helps in breakdown of zoospores of the *Phytophthora capsid*, causing disease damping-off in cucumber plants. *Bacillus* strain produced biosurfactants that retards the growth of disease causing fungi such as *Fusarium sp.*, and, *Aspergillus sp.* Isoform of surfactin produced by Brevibacillus brevis strain HOB1. It is antagonistic to bacterial and fungal disease causing pathogens\(^16\). Fluorescent pseudomonad's produces biosurfactant and they are helpful to minimize fungal pathogens growth viz. *Phytophthorn ultimum* causes diseases such as damping off and root rot of plants, *Fusarium oxysporum* causative agent for wilting in crops and *Phytophthora cryptogea* is a causative agent of rotting of flowers and fruits. *Pseudomonas sp.* plays a crucial role in biological control of Verticillium wilt of potatoes. Mature microsclerotia are enough to cause disease in potatoes\(^3\). *Pseudomonas sp.* retards the growth of *Rhizoctonia solani* a causative agent of plant diseases and *Phytophthorn ultimum* a causative agent of root rot and damping off the plants with the help of double function performing compounds such as tensin, viscosin and viscosinamid. *Bacillus subtilis* strain is isolated from soil produces biosurfactants helps to control anthracnose on papaya leaves\(^8\). *Pseudomonas aeruginosa* inhibited by production of biosurfactants through *Staphylococcus sp.*, derived from fossil oil-impure soil\(^4\).

**CONCLUSION**

From the above discussion it can be summarized that microbial biosurfactants produced by different microorganism plays an important role in food processing industries, medicine, industries, agricultural and phytoremediation. Thus it can also be thought of as a measure to act as a fungicide thereby helping in increasing subsequent crop yield.

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COMMERCIAL ZEBRA FISH FARMING: A NEW CONCEPT OF GENETIC MANIPULATION FOR ORNAMENTAL FISH TRADE

Naima Parveen, Ayesha S. Ali and Sharique A. Ali*

Globally, ornamental fish trade is a multibillion dollar industry. Everyone loves vibrant color and unique pattern in fishes. This innate attraction to color and a growing interest in pet fishes has forced scientists to develop beautiful colourful fish from an ordinary fish. Glofish is thus the results of the effort of those scientists working in this field. It has been produced from zebra fish injected with fluorescent gene of other fluorescent organisms. Although zebra fish is the native of India, but its commercialization in the form of glofish is done by Yorktown Technologies, a company in United States and it acquires high profit.

INTRODUCTION

Zebra fish, Danio rerio, is a tropical fresh water fish belonging to the Minnow family (Cyprinidae) of the order Cypriniformes. Zebra fish is native of rivers of India, Pakistan, Bangladesh and Nepal. It measures four to five centimetres long and is named for the five uniform, pigmented, horizontal stripes on the side of the body which resemble a zebra’s stripes. Its shape is fusiform and laterally compressed with its mouth directed upward. It is used as a model organism for various scientific studies as its size is small, easy and cheap to maintain compared to laboratory mice coupled with having great physiological and genetic resemblance with human systems.

Many creatures of the universe glow naturally, a phenomenon called bioluminescence. The underwater world has so many fishes which are able to glow but zebra fish has never been one of them. Scientists from National University of Singapore inserted a zebra fish’s egg with a gene of sea anemone that makes anemone coloured and then inserted Green Fluorescent Protein (GFP) gene from jelly fish. Hence zebra fish with injected fluorescent gene started glowing and sold as squarium fish with more interest and with the trade name Glofish. It has been noticed that creating a novelty pets as per the public demand with low environment risk by using techniques of genetic engineering becomes prominent among commercial markets. Accordingly, introduction of glofish in the market improves the ornamental fish trade and marked a significant change in the status quo.

DEVELOPMENT OF GLOFISH

Green Fluorescent Protein (GFP) is a fluorescent market gene initially isolated from jelly fish (Aequorea victoria). Gene encodes for the GFP allows the jellyfish to glow in the dark. Glofish is produced by injecting zebra fish with
GFP gene. Fertilized eggs of the zebra fish in the period of blastodisc formation and up to the fourth division of cleavage are injected with plasmids expressing the GFP through microinjection. The foreign gene later on becomes the part of genetic makeup of the injected zebra fish and the fluorescence color so obtained gets transferred to the next generations through traditional breeding.

People sometimes wrongly believe that glofish are dyed or injected with certain colors, while they are actually bred to glow with transferred genes. Furthermore, genetic mutant of GFP including Yellow Fluorescent Protein (YFP), red or orange Red Fluorescent Protein (RFP) and non-fluorescent purple-blue chromoproteins (CP) from other glowing organisms have also been used to be injected into zebra fish to develop multicolour glofish3.

**GLOFISH ENHANCES ORNAMENTAL FISH TRADE**

Ornamental fish keeping was considered as one of the most attractive hobbies practised by the people of developed countries but recently it is gaining interest of developing countries also. They contribute for about two third of the total export value. Overall it is the increasing interest in ornamental fishes that has resulted in firm boost in ornamental fish trade globally. Major exporters of ornamental fish are Singapore, Malaysia, Japan, USA, Spain and Germany. Yet India possesses rich resources such as Andaman and Nicobar, Coast of Kerela, Gulf of Mannar, Lakshwadeep and Minicoy Island etc of highly attractive and varied species of ornamental fish but its position in an emerging international market of ornamental fishes is not so good.

Since, there is a big demand of ornamental fish in many countries of the world. Therefore,
in order to endorse ornamental fish trade there is a need to encourage ornamental fish production at low cost, which can be attained by the implementation of improved technologies, better management practices, increased quality assurance with more investment in the sector. Glofish is one of the fish produced by the implementation of recent technology of biological sciences and is among the most scrutinized fishes to be ever sold in ornamental fish market. The economic attraction of these modified fishes is obvious.

The right to glofish is owned by Yorktown technologies, and it was commercialized in 2003 for the first time in the markets of United States. Commercialization of glofish has gone forward in the markets of several other countries including parts of Asia and Latin America. Fluorescent green zebra fish have also been developed by Taiwan and exported in Malaysia and Hong Kong. Glofish is available in different striking colors including red, green, orange, blue and purple with the trade name Starfire Red Electric Green®, Sunburst Orange®, Cosmic Blue®, and Galactic Purple® respectively. Cost of each glofish is estimated as 6.5 to 10.5 US Dollars that is approximately 417 to 673 Indian Rupees. The company also provide glofish deluxe collection, cost of which is 99 US dollars that is 6400 Indian Rupees (approx.). Hence, glofish market seems to be profitable one and the company looking forward to produce safe and enjoyable product for many years to come. Along with zebra fish many other fishes like tetra and barb species are also used for the production of glofish.

OTHER PRACTICAL APPLICATIONS

1. As pollution indicator

Scientists have developed transgenic zebra fish which gets fluorescence in the presence of pollutant hence used as pollution indicators. It is now better option than complicated pollution testing system. Glowing zebra fish can be used to detect pollution in drinking water. The fish light up when exposed to polychlorinated biphenyls (PCBs). It can detect low level of PCBs in the water. Polychlorinated biphenyls are known to cause cancer in human beings. Testing water with fluorescent zebra fish is time saving and cheap as compared to conventional testing equipments.

The fluorescence in fish is under the control of genes. To enable the fishes used as bioindicator for pollution, inducible gene promoters are used to act as control switches to activate different tissues of the fish in the presence of certain triggers. These promoters drive the fluorescent colour gene in zebra fish. Such fluorescent transgenic fish will be able to respond in the presence of pollutant. Examples of such types of promoters’ are- oestrogen inducible promoter and stress responsive promoter. These promoters will respond to the presence of damaging chemicals like heavy metals which can contaminate water.

2. As experimental organism

Zebra fish are used as model organism because physiology of it resembles with that of human. It can be used as an alternative to laboratory mice for testing new drugs and medicines. Disease implantation in mice takes much time as compared to modified zebra fish. Zebra fish can lay hundreds of eggs at a time which is much more than the mice which reproduce two, three or a dozen mice. Thus produces a larger test sample in a short span of time. Fluorescent gene from jelly fish was implanted in zebra fish that are further implanted with a disease for testing.
different drugs against it. This enables the scientist to easily monitor the disease development in zebrafish with special microscope and to evaluate the impact of a particular drug.

Fluorescent zebrafish can test the specific drug against cancer and other disease in less time and at low cost as compared to the conventional laboratory mice. It is used to study how the disease developed in a cell and to appraise the effect of drug on that particular disease. So, it has been helpful to study the development of life threatening disease like cancer, to find out the effective drug against the disease and to the discovery of targeted drug\textsuperscript{6,7}. Fundamental characters of glofishes are represented in Table 1.

### Table 1. Fundamental characters of glofishes and suggested requirements in an aquarium.

<table>
<thead>
<tr>
<th>Property</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Scientific name</strong></td>
<td><em>Danio rerio</em></td>
</tr>
<tr>
<td><strong>Commercial names</strong></td>
<td>Glofish-Starfire Red\textsuperscript{®}, Electric Green\textsuperscript{®}, Sunburst Orange\textsuperscript{®}, Cosmic Blue\textsuperscript{®}, Galactic Purple\textsuperscript{®}, Red Danio, Green Danio, Orange Danio, Blue Danio, Purple Danio etc</td>
</tr>
<tr>
<td><strong>Size</strong></td>
<td>4-5 cms long</td>
</tr>
<tr>
<td><strong>Life span</strong></td>
<td>2-4 years</td>
</tr>
<tr>
<td><strong>Required aquarium size</strong></td>
<td>10 gallon or larger. They looks very nice when kept in large tanks with dark gravels</td>
</tr>
<tr>
<td><strong>Tank mates</strong></td>
<td>Can be kept with other danios, barbs, tetra, angelfish, and other fresh water fish but not big enough to eat glofish</td>
</tr>
<tr>
<td><strong>Glofish diseases</strong></td>
<td>It is susceptible to velvet disease, mycobacteriosis, and intestinal capillariosis and some other diseases that are often found in fresh water fishes</td>
</tr>
<tr>
<td><strong>Food</strong></td>
<td>Eats insect larvae, worms, and small crustaceans and a good tropical flake fish food</td>
</tr>
<tr>
<td><strong>Optimum temperature</strong></td>
<td>18°C-24°C</td>
</tr>
<tr>
<td><strong>Optimum pH</strong></td>
<td>6.5-8</td>
</tr>
</tbody>
</table>

**TRANSGENIC FLUORESCENT ZEBRA FISH AND ENVIRONMENTAL RISK**

US Food and Drug Administration (FDA) made a government environmental risk assessment, which has a command over all genetically modified animals including fluorescent zebrafish, as they consider the inserted gene as drug. There are no facts or data available which shows that these genetically engineered zebrafish have any threat to environment as they are aquarium fish. The FDA once stated that “there is no evidence that these genetically modified fish pose any more threat to the environment than their counterparts which have long been widely sold in the United States”. So there is no reason to regulate these fishes.
Some people are still bothered about the toxicity and allergens issues associated with genetically engineered fluorescent zebra fish. But fluorescent protein is found naturally and has been widely distributed in marine ecosystem with no adverse effect on any other creature reported till date. Fluorescent protein also does not share any relationship or similarity with the amino acid sequence of the identified allergens known to cause allergy in human and other animals. Hence, glofish may not cause any environmental problems and it is not worth ignoring these beautiful fishes at the aquarium fish market.

PRECAUTIONS TO BE TAKEN TO AVOID BIODIVERSITY CONTAMINATION

Although glofish do not harm the environment but precautions have to be taken care to avoid biodiversity contamination. As glofishes are aquarium fishes, case to be taken not to release them in natural water resources. They should be limited to aquariums only. Fluorescence takes energy and is a burden that makes the fish less fit. So, if the glofish breed with ordinary tetra fish, fluorescent gene transfer into them and the resulting altered fishes will no longer be fit for their natural habitat as compared to the original one. Hence, for the safety purpose, domestic fishes have not been bred with glofishes.

REFERENCES
5. https://www.glofish.com/
WHY SCIENCE?

K. Sampath

Science enriches our life. Without science, we would be missing out different inventions and areas of knowledge that have helped to progress in life and learn about the world.

THERE IS NOTHING GREATER OR HOLIER THAN KNOWLEDGE

Science is knowledge or state of knowing. Science is the endless frontier; therefore opportunities for discoveries (new knowledge), invention and development are boundless. Some examples of endless frontiers are numbers, space, time, sea waves, birth and death.

The following statement of Henri Poincare may be recalled here.

“The scientist does not study nature because it is useful; he studies it because he delights in it, and he delights in it because it is beautiful. If nature were not beautiful, it would not be worth knowing, and if nature were not worth knowing, life would not be worth living.”

Science generates power. What sort of power? The power of new knowledge! It is well known that Knowledge dispels ignorance. With knowledge one raises above others; one becomes happy. It shapes one, not only as a man of success but also as a man of values.

Science is the greatest tool to generate new ideas, make new discoveries, and fabricate new instruments and to lower the degree of empiricism. It is a rich source for technology and invention that helps us to understand the universe and also of ourselves as a part of the world in which we live. It is an integral part of our everyday life. Without science, we would be missing out on several different inventions and areas of knowledge that have helped us to progress in life and learn about the world. It also helps to achieve economic growth and prosperity.

Science can cover a variety of different questions and fields. It opens up the possibilities of imagination and exploration. Our modern electronic world would not have been possible were it not for our understanding of the quantum world. Everything around us concerns science. Simple cooking involves processes like boiling, evaporation and condensation. Transportation, navigation and many other everyday activities involve calculations, concepts of physics as also logical and critical thinking.

Geologists studying about the ages of our planet Earth, fossils, continental shifting, causes of natural calamities such as earthquake and tsunami, finding oil fields, natural resources, end up with theories, prediction, or something which improves our daily lives. Science enriches our lives deeply at personal and emotional level as well. Without science we wouldn’t enjoy all the great inventions that we have and utilize every day.

We are living in the environment of animate and inanimate things. We should have the knowledge of everything around us to adapt to the surroundings for survival. Biology is a fundamental science which has also helped advances in medicine. Understanding our own physiology and the causes for our discomforts, we can launch a battle on invading organisms and degenerative diseases and, save lives by
medical intervention. Chemistry too has application in several fields, for example, Pharmaceutical Chemistry develops new drugs for treatment of diseases and keeps on improving upon them.

The whole edifice of science is based on evidence; the scientific facts are evidences. An exact and impartial analysis of facts is possible in the field of science alone. Science seeks the truth and truth alone supported by evidence, where exact and impartial analysis is paramount. Exposure to such a discipline will produce a state of mind that makes way for impartial analysis in all matters of life.

Science inculcates discipline in a few other areas too. If we observe dancers we can always see them in a dancing posture while walking or standing; even while speaking, their facial expression is always different from those of an ordinary person. Likewise, a military trained person will always walk and stand in an erect posture; we can witness alertness in his dealings.

All these people attained such habits by training. A kind of discipline is imposed in such training. Their mind is tuned and sharpened. Science also imposes such a kind of discipline for impartial analysis and logical reasoning, in all dealings of life in those engaged in scientific pursuits.

THE PROCESS OF SCIENCE

The process of science is iterative. Science goes back on itself so that useful ideas are built and collected and used to learn more about nature; and successive investigations of a topic may lead back to the same question at deeper levels.

The process of science is very exciting, complex, and somewhat unpredictable. To make progress, it requires many different types of scientist, engaged in a variety of field activities.

It challenges one’s understanding until a discovery /invention/development is made. The development of modern chemistry is an example. Many scientists had to work and toil hard to understand the structure of such molecules like chlorophyll and insulin. A generation of chemists and physicists had to work hard to unravel the complexities of gaseous state; a mass of strong evidence in which Kinetic theory of gases and atomic theory that are domains of physics helped in the development of modern chemistry as well. The different branches of science are indeed inter-linked.

History of sciences speaks in volumes, about the complicated situation and pressure undergone by the scientists over the centuries. A number of scientific investigations were stillborn even at the concepts level and many investigations were not reported even afterwards. The successes are known to the world; sorrows were borne by the investigators; but, even recording failures is important in science, to guide future investigations. And no concept in science is or can be declared to be absolutely final; there is always a scope for revision or improvement.

WONDERS OF SCIENCE

Wonder is the mother of all sciences. The first wonder - it is unlimited and endless. It has changed many things and our perception about them (almost everything) around. What was once thought impossible, now may be a reality and possible. The mode of thinking of the total human race has changed. Fear and anxiety about the nature has vanished. Science has revolutionized the human civilization. It has made man’s life happier and more comfortable. Distance is no more a hurdle at all. It has made inroads into the secrets of the nature. It is possible to probe the space in all possible directions and so on.
Electricity is one of the greatest wonders of modern science. Electricity can run any type of machinery in factory; light our rooms, run buses and trains, and lift and pump water, for irrigation. The rise/surge in the fast modes of transport and communication has changed the world into a global village. In the field of agriculture, science has helped in increasing the crop production and improving quality. Science has enabled man to diagnose and treat many dangerous diseases. Information technology and computers have revolutionized our life-styles. Space technology has encouraged men to travel to probe into space and explore the other planets.

We have become scientifically more advanced compared to our ancestors. Now, one can build castles inside an ocean and even in space. Television brings the whole world into our rooms and even in our hand as well. The internet connectivity has shrunk the world for communicating and exchanging vast amounts of knowledge in an instant. We have a permanent space station from where astronauts watch the weather, solar flares and other cosmic events. We are now able to grow even new human organs. The world has undergone a tremendous change because of the rapid strides made by science and technology. There is hardly a place left where science has not made its mark.

More than 40,000 journals are published in science alone world-wide. No other discipline, other than science, can reach even one hundredth of this figure. Arif Jinha at the University of Ottawa estimated that the number of scholarly articles published since 1965 is about 50 millions. The growth rate is 1.4 million of articles per year; and the rate is estimated to be 1 to 1.29 articles per minute. But 150,608 scientists dominate the research journals, having their names on 41% of all papers. These data speak volumes about the surge/wave of scientific activities around the world.

**THE BEAUTY OF SCIENCE**

The beauty of science lies in its capacity to define unit to measure and counting, very small and very large quantities. Quantifying the concepts such as time, distance, volume, temperature, energy, mass and so on is very essential and is useful in scientific calculations and daily use as well. A few examples are as under:

Planck time is the time light takes to travel one Planck length. According to Max Planck the smallest possible measurable units of length and time is $10^{-43}$ seconds. Theoretically, this is the smallest time measurement that will ever be possible; no smaller division of time than this has any meaning. The largest time unit is the supereon, composed of eons. Eons are divided into eras, which are in turn divided into periods, epochs and ages.

Astronomical unit (AU) represents the mean distance between the Earth and our Sun. An AU is approximately 93 million miles (150 million km) or approximately 8 light-minutes.

The Light year is the distance light travels in a year, a unit of astronomical distance equivalent to the distance that light travels in one year, which is $9.4607 \times 10^{12}$ km (nearly 6 trillion miles).

The smallest distance measure so far, is roughly equal to $1.6 \times 10^{-35}$ m or about $10^{20}$ times
the size of a proton while the largest is One gigaparsec which is about 3.26 billion light-years,

1 T M C is the abbreviation of one thousand million cubic feet = 28.3 Billion Liters.

Within the known, observable universe, it is believed that between 120 to 300 sextillions (that’s 1.2 x 10²³ to 3.0 x 10²³) stars exist³; and the estimated atoms are, between 10⁷⁸ to 10⁸².

It is estimated that the number of atoms in a minute mark or dot is about 10¹³, with an uncertainty of at least a factor of 10 in both directions. Atoms, however, go on practically forever, yet according to ⁴ Martin Rees, it has probably life period of about 10³⁵ years.

According to ‘quora ‘at sea level, at 15 degree C, the total number of molecules in a cubic meter of air is 2.53 x 10²⁵ molecules of air per cubic meter or 2.53 x 10¹⁹ cubic centimeter

It hides and seeks; scientists do play with it and enjoy it too!

Science is a system used to convey the rationality embedded in nature. It is in fact, amazing to think that the world indeed, is rational. That is to say, that there is a real meeting point, a real convergence between the natural world and the intellectual world and the rationality of man; man is a part of nature which is the height of the beauty.

There is orderliness in a rainbow, in the form of celestial bodies; endlessly tracing elliptical paths in cosmos without collision, in the periodical occurrences of eclipses, in the birth and death of stars, in symmetry found in almost in all aspects of nature, in definite proportion in which chemical compounds are formed and in almost everything.

Observe a crystal say common salt, a solid material. Its constituent atoms, molecules, or ions are arranged in an orderly and continual manner extending in all three dimensions. And a chemist also, revealed by X-ray diffraction, enjoys the beauty of the formation of crystals; it is indeed a live dazzling show. Geologists while mining do admire different types of crystals, naturally formed.

Chemical Abstracts Service (CAS) is a division of the American Chemical Society (ACS). It currently identifies more than 129 million organic and inorganic substances and 67 million protein and DNA sequences, plus additional information about each substance. It is updated with around 15,000 additional new substances daily

Chemistry focuses on the structure and properties of particular kinds of substances and especially on the changes that they undergo. The analysis part, helps to understand structure and synthesis part to produce them in the laboratory and industry, to understand the structures of existing molecules and in making new ones as well.

Flame Aura quartz crystal cluster (titanium treated)

Physics is one branch of science which deals with matter and its motion through space and time as also with related concepts such as energy and force, heat and radiations and so on. Nothing comes proximate to the precision with which physics enables us to understand the
world around. The goals of physics are directed towards explaining and predicting, how the universe works; for example, the phenomenon of mass energy conversion. The laws of physics are applicable also in chemistry, biology and astrophysics/cosmos.

Biology is the science of life; it covers the study of all the living beings and their interactions with the biosphere. It has to do with the origin, structure, function, development, and distribution of organism, animals and plants. There are suggestions that living beings cannot be originated from inert matter and therefore the life proceeds only from life. This is a biological axiom called Biogenesis. The continuity of life lies on the transmission of the hereditary characteristics, which is based on the DNA molecules.

Living beings interact with their environment. As the environmental conditions change, the organisms have to adapt themselves to those changes. Evolution refers to the changes that occur in the organisms so that they adapt to the changes of the environment.

Those changes in the organism can be considered in the context of the evolutionary adaptation that should occur in the DNA, such changes are inherited by the progeny.

The human brain which is responsible for all these developments is biological matter, sustaining itself for a limited duration, utilizing energy; it works and understands the complexities of matter and energy. Does it mean matter understands matter?! May be! But we are also trying to understand how the human brain thinks, innovates, works and understands everything around and those not yet known!

According to ancient Indian scriptures everything originated from the space!

SOME VITAL POINTS TO PONDER

Science could also be like a razor which can be used for surgical operations or to kill a person. A few atom bombs can destroy the entire earth. No life would be possible on the earth when such a catastrophe befalls. On the other hand nuclear energy has been tamed and is being used for constructive purposes.

The production and application of synthetic fertilizers and pesticides, improved the production of food and agricultural output enormously. It is called green revolution, but, what about its grey side? Today, we are very much concerned about toxic effects noticed in utilizing these chemicals. The discovery of polythene and related synthetic materials was applauded, exploited tremendously. But alas! Mountains of such waste materials pose a huge threat to humanity, because they are non-biodegradable and it is extremely difficult to wipe them out!

Any implementation of the applications of scientific discoveries needs an extremely careful and time taking evaluation. Of course, as stated earlier, we do learn from our mistakes in science; but at what cost? Similarly man’s adverse contributions to the composition of our atmospheres, if left unchecked, may lead to greater catastrophes’ than anticipated. It not only has altered our climatic conditions, but has caused drastic ecological imbalance as well.
There are areas of scientific development which are indeed very praiseworthy as well. For example, in an era of fast depletion of fossil fuels, the exploitations of the Solar energy is a landmark achievement of science. Discoveries in medical and biotechnology are also really great boons to humanity.

Science is a boon and a bane as well. If it is bane it is because of some hasty conclusions and the presence of animal instincts in human beings. We cannot blame science for our erroneous decision. Nature perfectly obeys its own beautiful and systematic laws. It directs us tacitly to obey its law for our happiness and harmony in the animate and inanimate world as well. Problem erupts only when men exploit nature with selfish motives. While teaching science and training people in science, we have to emphasize all these aspects.

The present and future scientists have to continue to toil and enhance human welfare and will live in the minds of those even yet to be born!

**CONCLUSION**

Science does pose challenges! Let us accept them, as there is a thrill in facing the challenges. Moreover, future belongs to new ideas, inventions, innovations and new knowledge. Science is the time proven source and resource for everything. All potential benefits to mankind will come, if they are to come at all, only through science. Therefore, like science, think science, do science and propagate science.

**REFERENCES**

ON THEORY OF CONNECTIVE PATTERNS

D. S. Hooda

The word ‘pattern’ is frequently used in written and spoken discourses. In order to understand the universe better, it is imperative to first find out the ‘distinguished patterns’ and ‘unified pattern’ governing the whole universe. More specifically, with this procurement the unification of different types of patterns may be adequately interrelated and described in the language of particle physics, molecular biology or whether it requires description, in mathematical language, of the dynamics of interactions between them. It is very interesting to know how such processes of patterns formation originate naturally and those are culturally graven as well; and how their interactions, disconnectedness, disintegration and transmutation keep the processes alive.

Definition of Patterns

The word ‘pattern’ originates from the Middle English word patron which means ‘something serving as a model,’ from the Old French word patron, which in turn comes from the Latin words patronus (protector) and from pater (father) refer to 11. The arrangement of words in syntactical patterns to impart its meaning through semantic patterns under codified structures is symmetrical patterns. Pattern is unified ‘laws of everything’. It is a perceptual structure; a customary way of operation or behavior.

The word pattern more or less prescribes its functionality mainly as processes. Furthermore, the variety of definitions of ‘pattern’ used in different fields of mathematics, the sciences, the arts, and the humanities yearn for the composite mass of them as ‘meta-pattern’. Meta-patterns embrace both nature and culture, seeking out the grand-scale patterns that help to explain the functioning of our universe. Meta-patterns offer an enlightening view of the functional, universal form in space, processes in time, and concepts in mind. The pattern which connects is a meta-pattern. It is a pattern of patterns 3.

When carbon, oxygen, and hydrogen atoms bond in a certain way to form sugar, the resulting compound has a sweet taste. The sweetness resides neither in the C, nor in the O, nor in the H; does it reside in the pattern that emerges from their interaction. It is an emergent property. Moreover, strictly speaking, the sweetness is not a property of the chemical bonds. It is a sensory experience that arises when the sugar molecules interact with the chemistry of our taste buds, which in turn causes a set of neurons to fire in a certain way. The experience of sweetness emerges from that neural activity 6.

It may be noted that there is ‘connective patterns’ in between the sugar, our taste buds,
our neural activity and also our modes of expression. Without this ‘connective pattern’ among them the possibility to know the ‘sweetness’ is problematic, and for sure, the ‘sweetness’ may turn out to be something else if the taste buds are simply missing or it has no connection to our neural activity. But what is this ‘connective pattern’? The connective pattern may be the sought mathematical equation to set or fit everything into a single pattern called ‘unified pattern’; furthermore, this may also explain the central point of interconnections and interdependencies between everything.

Actually one “could not exist in a universe in which there was no pattern or order of any sort”. It relies on the complexity of our minds and the reach of our technologies, being sufficient to understand and find these ultimate patterns“4. As the scientific method has matured, so we have become aware of more sophisticated types of pattern, new forms of symmetry and new types of algorithm that can miraculously condense vast arrays of observational data into compact formulae4. It is worth mentioning “symmetry has become the dominant theme in fundamental physics. Elementary-particle physics is singularly Platonic in this respect. Mathematicians of the past have catalogued all the distinct patterns of change that exist and have diligently encoded their essential ingredients into that branch of mathematics now known as group theory”4. Group theory gives us a mathematical way to deal with symmetry. But the actual earth has no exact symmetries: No rotation (except the neutral, do-nothing rotation) takes it into a position where it exactly coincides with itself.

The idealized sphere, on the other hand, is very symmetrical2. But what is group theory? It is just a pattern that certain things can exhibit when you have a composition law for always getting a third thing by combining any two others. Then the same group-pattern can show up in pure mathematics, particle physics, crystallography, and so on2.

Every pattern would be ever so slightly (or more!) different from every other. We could never see the regularities to abstract from the welter of reality. Mathematics would never be born. Even in mundane affairs, you cannot ignore patterns, such as those in your checkbook or the number patterns in the bus schedule; the arrangement of the rooms and furniture in your apartment (spatial patterns); the knotting of DNA (topological patterns) if you are a molecular biologist, etc.,2. Thus, one definition of mathematics might be ‘the logical study of patterns’. So, sometimes, even to show that a certain pattern is very simple (e.g. empty), you have to know about what other sorts of patterns can exist.

**PROPERTIES AND CLASSIFICATIONS OF PATTERNS**

Two basic types of problems in mathematics can be phrased as follows2:

- Can a pattern with certain given properties exist or not?
- Classify all patterns with the given properties.

The first statement can be called ‘the existence question’ and the second statement the ‘classification problem’. The reason mathematics has so many applications to other fields, such as physics, chemistry, biology, economics, and so on, is that perhaps only a mathematician would think of the empty set as a pattern—the ‘null pattern.’ In the broadest possible sense, pattern to mean any arrangement of things that follows some orderly rule, allowing for prediction or contemplation2.
On searching through its kaleidoscope of all possible patterns, the particle physicist can extract candidate symmetries to impose upon the world. The structure and behavior of molecules and crystals depends on their different symmetries. In this symmetry of each and every particle either at micro level or macro level molecules has certain properties of chemical and structural that dignifies its interconnectedness in the sense of pattern.

As the above mentioned principle is a general one, it should also apply in the organism level of biological systems. Biological systems are inherently hierarchically structured and modular. Modularity allows redundancy because the flow of information is quickly and evenly distributed within the module and also resilience since any disruption of the system is buffered by this redundancy. This has major consequences for the cellular and developmental machinery of organisms and for the stability of ecological systems also.

One view of the emergence of complexity in biology involves autocatalytic chemical reactions with molecules that are both substrates and catalysts. The resulting compartmentalization of forms and functions appears to be one of the most universal features of life, hinting to the fact that common features of symmetry breaking lead to increasing complexity of life. Seeking for analogies between modularity in the networks of cellular biology and that of ecology goes some way towards exploring the commonalities of pattern formation across scales.

One illustration is analysis of metabolic networks showing that these display scale-free features: most of the enzymes within the network have only few connections, while a few enzymes, so-called hubs, are highly connected. There is more than a point of analogy to make between metabolic networks and ecological interaction networks: modular cell biology. Ecologists have traditionally studied the patterns created by the tangled web of ecological interactions among species. The analysis of species-level interaction networks shows that they are typically modular and this has important implications for scenarios of biotic extinctions.

However, food web theory based on species graphs bears little empirical significance. Ecological interaction networks should be quantified based on what individuals do, rather than just who eats whom among species. Intra specific variation leads to a modulation of the strength of interactions through time and to a dynamic and individual-based view of ecological networks. Individual-based interaction networks build on a long-standing tradition in population ecology. Each individual differs from its neighbors, in part because its genetic makeup is unique, as well as its history is unique.

Population biology and life-history theory both strive to make sense of individual variation, and explore whether regularities exist across individuals and what causes them. Even more importantly, each individual typically interacts with a small number of its nonspecific’s during its lifetime, and these opportunities are the means by which experience is acquired. In humans, the study of networks of social interactions has become a large part of modern sociology.

The fact that individuals in nonspecific assemblages are modularly related is of great importance for the parasites that thrive on us, because they may find it easier to spread within than across modules. For instance, the rate of spread of an epidemic depends on the precise structure of this individual interaction network.
The problem of how to empirically measure individual-based networks is a serious one. In food webs, both stable isotopic signatures and environmental DNA techniques may be used. In more generalized networks, interactions can be measured directly via the real-time monitoring of individual movement; or the measurement of chemical cues, such as signaling across plants or quorum sensing in bacteria.

In some cases of great relevance to ecology and evolution, individual interactions can lead to the emergence of altogether new behavior at the macroscopic scale. But does this well-known macroscopic phenomenon also exist on the microscopic molecular level? ‘Yes!’ Back to the real world’s molecular level: the basic building blocks of life are mostly found in exclusively one of two principally possible mirror image forms, designated as D or L. Natural amino acids, the components of proteins (enzymes), are found in the L-form such as L-alanine, L-valine, L-leucine, L-aspartic acid, and others.

Sugar molecules are—in contrast to this—biosynthesized in the right-form for implementation into nucleic acids. D-ribose and D-deoxyribose are used in ribonucleic acid RNA and deoxyribonucleic acid DNA respectively, and D-glucose in glycogen, starch, and cellulose. The mirror image structures of amino acids (called D-enantiomers) are not tolerated for the molecular architecture of proteins; in a similar selective way, mirror image sugars (L-carbohydrates) do not contribute to the molecular construction of the nucleic acids RNA and DNA.

In natural sciences, this widely distributed phenomenon is called biomolecular asymmetry. In other words, living organisms are based on biopolymers that are strongly selective towards the chirality of their monomer subunits. Monomers of biopolymers are almost exclusively homochiral. Homochirality is a property of matter, which is made up of only one “hand” (that is what is literally meant by “cheir” in the ancient Greek language) out of the potentially two “hands” available within confined boundaries of abundance. The boundary thus defined by this homochirality versus symmetry could even be interpreted as the borderline between living organisms here and non-living matter there.

**Non-symmetric Patterns**

Life is not symmetric; the phenomenon of asymmetry can well be observed in living organisms commencing with microorganisms, to plants, animals, and even human beings. Just to give two examples from everyday life: soccer players prefer to use their right or left foot to shoot, and people favor to write distinguishingly either with their right or left hand. In scientific terms, biochirality describes the phenomenon that organisms display laterality. Here, symmetry is obviously broken. If we imagine living beings in a mirror-world their mirror-world properties would be non-identical to their real world properties.

After the symmetry is broken, for example, the structural changes (deletion, insertions, and inversions) between human and chimpanzee genomes have likely had a significant impact on evolution. If we fill the gap of missing link or borderline in between the human and the chimpanzee with ‘Karabo’ (a direct ancestor of Homo erectus), then it may raise a serious issue – that if there is no missing link or no ‘symmetry breaking’ between objects then there will be no diversifications in the nature. To make it more clear now suppose that everything is only made up of only one chemical element e.g. Hydrogen (H); and nothing is available in the entire universe
except the distributed pattern of Hydrogen. The difference in the atomic number of elements decides their pattern of properties and behaviors, and it causes the formation of infinitely diverse matter.

The metallic and non-metallic characters of an element vary due to their electronic configuration and ionic capacity. For example, Hydrogen has the simplest (and lightest) atom with just one proton and one electron. When two atoms of hydrogen combine together, or fuse, to form an atom of helium, in this process some mass of the hydrogen is converted into energy. It has been observe that all hydrogen atoms produce the same ‘pattern of lines’ everywhere in the universe. In fact the same pattern of lines for a given element (or structure of an atom) in the universe tells us that the same laws of physics is working everywhere in the universe. But could the laws have been different in the past? Could the laws change in the future?

Recent studies have found that the laws of physics are different depending on where you are in the universe. Research carried out at “the University of New South Wales (UNSW), Swinburne University of Technology and the University of Cambridge found that one of the four known fundamental forces, electromagnetism – measured by so called fine-structure constant and denoted by the symbol ‘alpha’ – seems to vary across the universe. In one direction – from our location in the universe – alpha gets gradually weaker, yet in the opposite direction it gets gradually stronger. The experiment found that the atoms in space behaved differently from ones on earth “31. However, quantum entities are so small that even contact with one photon changes their position, energy and momentum and this causes measurement problem.

One of the mysteries in quantum physics is the wave-particle duality: which states that every quantum object has properties of both a wave and a particle. Matter particles, such as electron, photon, etc., produce interference patterns due to their wave like nature, and this characteristic either of photons or electrons is visible. This has been tested using instruments through ‘double-slit experiment’, since the quantum world cannot be observed directly. Like the wave-particle duality, so far, it has been found that throughout the known universe there are only two types of particles; the first type of particles that make up the matter, and the second type of particles that carry force. Further these particles are filled with numerous different subgroups and types21.

We also see the large-scale structure of the known universe is made up of mainly two components. There are the “threadlike structures known as filaments that are made up of isolated galaxies, groups, clusters and super clusters. And then there are vast empty bubbles of empty space called ‘voids’. As we begin to “comprehend, we feel as though we are experiencing a new and complex universe, with unfolding patterns upon patterns, a universe defined by underlying principles of logic and symmetry”15.

Also we find that there are two competing forces in the atom. Firstly, the electrons are bound to the nucleus by electric forces (in two varieties: positive and negative charges) and secondly, the electrons will swarm around the nucleus with two rules describing electric force:

- Opposite charges attract; like charges repel.
- The force gets weaker as the two charges get farther apart.

As we know that “an atom is the basic building block of chemistry. Most of the atom is empty
space and the rest consists of a positively charged nucleus of protons and neutrons surrounded by a cloud of negatively charged electron. In some respects, the electrons behave like wave patterns called orbital around the nucleus. In other respects, the electrons in an atom behave like particles orbiting the nucleus.

In the orbits, the electron waves have to be arranged in such a way that ‘their ends meet’, i.e. that they form patterns known as ‘standing waves’. These patterns appear whenever waves are confined to a finite region, like the waves in a vibrating guitar string, or in the air inside a flute. Alike the wave pattern of the atom to more understand the functioning of the world depending on only one key force (fundamental symmetry) that keeps everything into order or disorder we have to first look at their patterns of connectivity as well as disconnectedness among them.

REFERENCES


ABC (ASIAN BROWN CLOUD): WAFTURE OF INTENSIVE AIR POLLUTION

Sushil Kumar Upadhyay

The ABC (Asian Brown Cloud) is a stratum of air pollution that periodically envelops parts of south Asia, like northern Indian Ocean, India, and Pakistan. In satellite snapshots, ABC appears as a colossal brown floating continent in air over much of south Asia and India possibly during earlier and later months of every year. The ABC was stated as Indian Ocean Experiment (INDOEX) in reports of the UNEP (United Nations Environment Program) firstly in 2002. The phrase ABC may also be used as “Atmospheric Brown Cloud” in a more generic context not specific to Asian region only. The direct impact of ABC might be reduction of photosynthetically active fraction of solar spectrum (leads to dwindled productivity), settling of aerosol particles (fly ash, black carbon and dust) on the flora and fauna (leads to increased acidity and organ damage). However, ABC indirectly might be influenced the changes in surface temperature, seasonality, rate of surface evaporation and precipitation (rainfall) and ultimately climate change. All the aforesaid growing environmental issues are somewhere interlinked either in causative factors or in the ways of preventing them. In the early and late months (January, February and November, December respectively) of the yesteryears, it was the igneous issues in daily news papers, media, televisions and social sites in NCR (Near capital region) of the country. After the comprehensive and critical study of ABC perspective to health and climate change, author suppose to propose that the huge wafting brown haze may be persistent throughout the year in coming days if not taken serious action by the government against anthropogenic activities responsible for the air pollution. Therefore, it is an urgent need to sensitize the general population about such growing environmental issues.

INTRODUCTION

ABC (Asian Brown Cloud) is soup of industrial pollutants, carbon monoxide from vehicle exhausts and particles of soot from burning of forests, municipal wastes, post-harvested agricultural residues and millions of rural cooking fires. Because the cloud is capable of being dispersed rapidly around the world, therefore, may affect a much wider area than just Asia. The term ABC seems to have been around for a couple of years in scientific circles, but came to prominence in August, 2002 in a report prepared by climatologists at the United Nations Environment Program (UNEP) for the World Summit on Sustainable Development in Johannesburg (well-known as 2nd Earth Summit) in the month of September, 2002. The good news, broadcasted by the climatologist was that, unlike other causes of pollution and climate change, this one is curable if Asians can shift to...
more efficient ways of burning fuels. The most visible impact of air pollution is the brownish haze (a layer of floating pollutants and particles from biomass burning, vehicle and industrial emissions), a common feature of NCR and industrial regions around the world called as atmospheric brown cloud (Fig. 1). It is now becoming clear that the brown cloud can have huge impacts on agriculture, health, climate and water budget of the planet.1

The ABC (Asian Brown Cloud) is a layer of air pollution that covers parts of the Asia-Pacific continents, northern Indian ocean, India, parts of south Asia, southeast Asia and China.2 This floating pollution layer was observed during the Indian Ocean Experiment (INOEX), a project under umbrella of the United Nations Environment Program (UNEP).3 “The ABC is also responsible for rapid melting of Himalayan glaciers and may precipitate an environmental disaster that could affect billions of people”. The effects have been linked to the retreat and supply water to major rivers including the Ganges, Yamuna and Indus. These rivers in turn comprise the chief water supply for billions of people in India. The consequences for India whose rivers flow from this source are incalculable, with the melting already being blamed for downstream flooding in late summer. The more frequent downstream flooding, seasonal oscillations and climate change has been noticed in past and present year are supposed to be due to ABC, could not be ignored. Chiefly, domestic wood and dung fires plus smoke burning of forests, fields for agriculture and municipal wastes caused the formation of floating continent of brown cloud on major part of the country. In addition, vehicle exhausts, power plants and factory chimneys added to the mix.4 The INDOEX has revealed that this haze is transported far beyond the source region, particularly during early and late months of year. Scientists in India are claiming that the “Asian Brown cloud” is not something specific to Asia and does not have a knock-on effect on pollution-related mortality.5

There is little awareness about Asian Brown Cloud in the general population. As global warming has emerged as matter of environmental concern for entire world, similarly the ABC is also one essential environmental issue globally and especially for Asian countries. Since the broadcast of INDOEX-UNEP about ABC, it became a matter of gossip in daily news, television and social media during early and late
ABC: DIRECT AND INDIRECT IMPACT

The available literature and INDOEX-UNEP reports reflected that the haze, ABC has primary impact on regional temperature, precipitation, agriculture, climate, productivity and health. Haze can produce an impact on agriculture productivity in a variety of ways directly and indirectly.\(^6\)\(^7\)

The direct effects are: (i) Reduction of total solar radiation in the photosynthetically active part of spectrum, that in turn leads to a declining productivity, (ii) Settling of aerosol particles (fly ash and black carbon) on the plants can shield leaves from solar radiation and may damage plants by increased acidity. The deposition of aerosol can increase acidity and may cause plant damage. However, the indirect effects are: (i) Changes in surface temperature can directly affect growing season, (ii) Surface cooling in tropics can extend growing season, (iii) Frequent changes in green house gases and particulate matters in the environment, (iv) Changes in surface evaporation and rate of precipitation, rainfall (Fig. 3).

ABC: PERSPECTIVE TO HEALTH AND CLIMATE CHANGE

The joint study of World Health Organization (WHO), World Resources Institute (WRI) and the United States Environmental Protection Agency (USEPA) estimated that nearly each of the 23 cities with a population of over a million in India, air pollution levels exceed the standards. A study of year 2005 study indicated nearly two million people die each year, in Asia alone, from conditions related to the brown cloud.\(^8\) The wide publicity given to the release of an UNEP report on the so-called Asian Brown Cloud and its multifarious impacts on health, agriculture and climate, on both regional and global scales, has led to considerable concern. It occurs every year, extends from about November to March and possibly might be longer.\(^9\) The black carbon and other species in haze reduce the average irradiative heating of ocean by as much as 10% and enhance the atmospheric solar irradiative
heating by 50-100%. The prolonged duration of the haze, black carbon content, large perturbation to the irradiative energy budget and simulated impact on the rainfall distribution, if proved correct, have significant implications to regional water budget, agriculture, climate and health. The link between anthropogenic aerosols and reduction of monsoonal rainfall in south Asia has also been established using over 15 model studies preceding the UNEP report.10

The report of year 2007 also addressed the global concern of warming and concluded that the brown clouds have masked 20 to 80% of greenhouse gases in the past century. The report suggested that air pollution regulations can have large amplifying effects on global warming.11 In a study of 2011 found that pollution is making Arabian sea cyclones more intense as the atmospheric brown clouds has been producing weakening wind patterns which prevent wind shear patterns that historically have prohibited cyclones in the Arabian sea from becoming major storms. This phenomenon was found responsible for the formation of stronger storms in yeasteyears.12

**ABC: AN IGNOMINIOUS WAFTING TOXIC CLOUD**

When the researchers first began noticing this smoggy haze, they thought it might be confined to major cities. As it turned out, it became an enormous blanket covering much of the area around the northern Indian Ocean. This part of the world is home to nearly 3 billion people, or about half the world’s population, and it is industrializing rapidly. Most of the new industries here are using old-fashioned, highly polluting engines and fuels. The Asian Brown Cloud, the thick haze caused by pollution that hangs over southern Asia, is rapidly melting Himalayan glaciers and could precipitate an environmental disaster that could affect billions of people, scientists have warned.13 Therefore, the Asian Brown Cloud was added to the ignominious list.
A study published in British journal claimed the thick plume floating over the region is as much to blame as green house gases for warming of glaciers on the 3rd largest ice mass on planet, Tibetan plateau. However, the analysis of pollution-filled clouds also offers hope that the region may be able to arrest alarming retreat of such glaciers and ensure the security of water supplies by reducing pollution, for instance by cutting the dependence on wood burning stoves. The brown haze was believed to cool the land and sea beneath them by filtering out sunlight, known as global dimming, and not contribute much to global warming. But black soot particles in cloud absorbed the sunlight and therefore, warmed the atmosphere around them more than believed.

The conventional thinking is that brown clouds have masked as much as 50% of the global warming by green house gases through the so-called global dimming, said Dr Ramanathan. While this is true globally, this study reveals that over southern and eastern Asia, the soot particles in brown clouds are intensifying the atmospheric warming trend caused by green house gases significantly. The combined heating effect of green house gases and brown clouds, which contain soot, trace metals and other particles from a growing cadre of urban, industrial and agricultural sources, is enough to account for the retreat of Himalayan glaciers observed in the past half century.

The rapid melting of these glaciers if becomes widespread and continues for several more decades, will have unprecedented downstream effects on southern and eastern Asia. The main cause of climate change is the build up of green house gases from the burning of fossil fuels, said Achim Steiner, United Nations under-secretary General and Executive Director, UNEP. But brown clouds, whose environmental and economic impacts are beginning to be unraveled by scientists, are complicating and in some cases aggravating their effects.

CONCLUSION

By the comprehensive, meticulous and wide-ranging study, it is clear that the UNEP broadcasting about Asian Brown Cloud has created awareness about pollution and their consequences. This should give an impetus to the ongoing program for reduction of harmful emissions in our cities. People living in Asia must be concerned about this haze because it has immediate and long-term impacts on their health, seasonality, climate change and water budget. Additionally, there is also a sudden rise in pollution during the festivals due to excessive fireworks was also the stuff of tittle-tattle in yesteryear and supposed to be the source of ABC in the mega-metro cities including capital city of India. In India, so far work done related to ABC and global warming is mainly confined to research, conferences, seminars and workshops, while the general population having very little knowledge about these burning issues. Thus general population is usually unaware about the recent environmental trends as a result of which the pollution is rising on a daily basis. These environmental issues may be due to increasing number of automobile vehicles, various industries disposal, indoor pollution, burning of municipal wastes, forests and post harvested agricultural residues, etc. All these growing environmental concerns are somewhere interlinked either in causative factors or in the ways of preventing them. Hence, it is an urgent need to sensitize the general population about such growing environmental issues. Therefore, year after the
UNEP came out with a statement concerning the existence of a 3.0km immense coating of wafting pollutants admitted “Asian Brown Cloud” over south Asia and India, the Government of India has decided to launch a steady study to determine how far India is responsible for it and what are the consequences on population and environment?

REFERENCES

The Coconut Research Station at Kasaragod in Kerala was initially established in 1916 by the then Government of Madras and subsequently it was taken over by the Indian Central Coconut Committee in 1948. Central Plantation Crops Research Institute (CPCRI) was established in 1970 as one of the agricultural research institutes in the National Agricultural Research System (NARS) under the Indian Council of Agricultural Research (ICAR). The Institute had the mandate to undertake research on coconut, arecanut, cocoa, cashew, oil palm and spices at the time of establishment. The research on cashew, oil palm and spices were later delinked from CPCRI to form separate institutes. The present mandate of the institute is to conduct research on coconut, arecanut and cocoa.

**Organizational set up**

The present organizational set up of the Institute with headquarter at Kasaragod, Kerala, Regional Stations at Kayamkulam (Kerala), Vittal (Karnataka) and Minicoy (Lakshadweep islands) and Research Centres at Kahikuchi (Assam), Mohitnagar (West Bengal) and Kidu (Karnataka) cater to the research needs of the mandate crops.
at the National level. The research programmes of the institute is organized under five divisions viz. Crop Improvement, Crop Production, Crop Protection, Physiology, Biochemistry and Post Harvest Technology and Social Sciences. The Institute also holds the International Coconut Gene Bank for South Asia at Kidu in Karnataka. The Institute also serves as the headquarter of All India Co-ordinated Research Project (AICRP) on Palms with 13 centres on coconut, 7 centres on oil palm and 2 centres on palmyrah.

**Mandate**

- Basic, strategic and applied research to enhance sustainable productivity, quality and utilization of coconut, arecanut and cocoa,
- Repository of plantation crops genetic resources and scientific information,
- Transfer of technology, capacity building and impact assessment of technologies,
- Coordinate research and validation of technologies on plantation crops through AICRP on Palms.

**Vision**

To make India a world leader in the production and productivity of coconut, arecanut and cocoa.

**Mission**

Harness science and technology to enhance competitiveness in coconut, arecanut and cocoa through generation of appropriate technologies.

**Focus**

- Strengthening the biodiversity and biosecurity of mandate crops and their utilization for improving the productivity and income security of coconut, arecanut and cocoa growers.
- Protecting and improving the land, water, microbial and climate resources essential for sustained advances in the productivity, profitability and stability of palm based farming systems.
- Development of appropriate technologies which can help to attract entrepreneurs and can confer the empowerment of small and marginal farmers both in the production and post-harvest technologies, thereby enhancing their income and competitiveness.
- Promote adaptation and mitigation strategies for climate change and to evolve mechanisms for crop and water management.
- Enhancing the income, livelihood, nutrition and health security of farm families through mutually reinforcing package of technologies.
- Promote innovations and improve human resource capacity involving all stakeholders in plantation crops.
- Foster linkages and collaborations with public and private, national and international organizations.

**Divisions**

**Crop Improvement**

**Sections:**

- Genetics and Plant Breeding
- Biotechnology

The major thrust of the division is to manage the genetic resources in coconut, arecanut and
cocoa for breeding high yielding varieties/hybrids with resistance to biotic and abiotic stresses through conventional and biotechnological approaches, development of in vitro mass multiplication protocols and large scale production of planting material including nucleus and breeder seed for establishment of seed gardens.

Major Research Activities:

- Prospection, conservation and utilization of genetic resources targeting desirable novel traits
- Enriching the gene pool of mandate crops with gene resources for specific traits.
- Complementary conservation strategy via cryopreservation.
- Multiplication of germplasm, pre breeding and conservation.
- Germplasm characterization including molecular characterization, developing repository of donor parents and registration of trait specific lines.
- Evolving new varieties and hybrids for higher productivity, resistance to biotic and abiotic stresses, quality and diversified products.
- Identification and utilization of superior accessions using molecular markers for plant habit, hybridity, biotic/abiotic stress tolerance.
- Evaluation of promising lines and development of varieties.
- Establishment of mother blocks of promising varieties.
- Production of quality planting material in mandate crops.
- Application of bioinformatics tools for accelerating research on genomics, diagnostics and microbial resources.
- Bioinformatics tools for coconut whole genome sequencing.
- Transcriptomic and proteomic studies.
- Development of computational tools for crop improvement.

Crop Production

Sections:

- Agronomy
- Soil Science
- Microbiology

The major thrust of the Division is to sustain the production of coconut, arecanut and cocoa through the development of improved production technologies such as cropping/farming system/organic farming and precision farming in accordance with the climate change and soil biotic and abiotic environment. This include cultivation of compatible crops in the inter spaces and integration with other enterprises like dairy, goat, poultry etc. to offer considerable scope for increased production and productivity per unit area, time and inputs by more efficient utilization of resources like sunlight, soil, water and labour.

Major Research Activities:

- Developing eco-friendly, cost effective production systems for higher resource use efficiency and increased productivity.
• Precision farming- Developing site specific Management practices
• Developing tailor made nutrient packages for specific cultivation scenarios of palms and cocoa
• Developing low cost water harvesting structures to augment the surface and ground water resources along with proper management for judicial utilization of the harvested water in conjunction with ground water.
• Developing cropping Farming system models with high carbon sequestration through waste biomass recycling and utilizing beneficial microbial resources.
• Developing self sustainable cropping/farming system models.
• Developing microbial products for enhanced nutrient use efficiency, biotic and abiotic stress tolerance.
• Developing low input/conservation agricultural practices.

**Crop Protection**

**Sections:**

- Plant Pathology
- Entomology
- Nematology

Crop Protection division mainly focus on occurrence and distribution of pests and diseases and surveillance of emerging pests and diseases, diagnosis of pests and diseases, etiology, pathogen diversity, epidemiology, pest and disease forecasting and IPM and IDM with special emphasis on biological control.

**Major Research Activities:**

- Integrated biocontrol of major pests of coconut like eriophyrid mite, red palm weevil, leaf eating caterpillar, white grub and rhinoceros beetle.
- Collection and cataloging of natural enemies of the pests.
- Field evaluation of EPN against coconut white grub.
- Refinement of IPM for major pests of coconut.
- Surveillance and monitoring of possible invasive and emerging pests of palms and cocoa.
- Exploring the potential of pheromone and kairomone blend for red palm weevil management and nanotechnological approach for pheromone delivery.
- Integrated management of arecanut white grub.
- Integrated approaches for the management of tea mosquito bug in cocoa.
- Development of diagnostics for coconut root (wilt) disease (RWD) and arecanut yellow leaf disease (YLD) using molecular techniques.
- Studies on induced systemic resistance against RWD and YLD.
- Diversity analysis of Phytophthora sp. causing disease of coconut and cocoa.
- Epidemiology of Phytophthora disease of coconut and cocoa.
- Integrated biocontrol of major diseases.
- Developing IDM Modules for Phytophthora diseases.
• Demonstration of new IPM and IDM technologies developed by CPCRI in farmers gardens.

Physiology Biochemistry and Post Harvest Technology

Sections:
• Plant Physiology & Biochemistry
• Pre and Post Harvest Technology

The major thrust of the division is to understand the physiological and biochemical basis of coconut, arecanut and cocoa to growth and yield under normal and abiotic stress (drought, flooding and high temperature) conditions, to phenotype the crops for various abiotic stresses, impact assessment and adaptation studies to climate change, biochemical and qualitative studies during fruit development and shelf life of the produce, process optimisation and commercialisation of value added products and mechanisation of farm operation.

Major Research Activities :
• Understanding the physiological and biochemical basis of growth and development under different agro climatic conditions with reference to present and future climates-
• Impact assessment- Development and validation of simulation models
• Model simulation for the prediction of coconut production for the present and future climates
• Adaptation strategies: Identification of phenotypic and genotypic traits tolerant to drought, high temperature, flooding etc.

• Development of management strategies to mitigate the effect of climate change on plantation crops
• Value addition, product diversification and up scaling technology for commercial dimensions.
• Development of new value added products
• Pharmacological studies in arecanut and studies on flavour components and quality of cocoa
• Physiological and biochemical studies to improve the shelf life of products from mandate crops
• Developing labour saving and drudgery reducing farm machineries.
• Development of tools and machineries for processing and drudgery reduction
• Refinement of machineries for processing
• Commercialization of processing equipments

Social Science

Sections:
• Agricultural extension
• Agricultural economics
• Agricultural statistics

Social Sciences Division formulate and undertake research projects pertaining to various aspects of technology generation, transfer, utilization and impact in mandate crops; policy interventions in agriculture, and refinement of statistical methods in plantation crops research.
Major Research Activities

- Up-scaling technology transfer through ICT tools, participatory/community based approaches and refinement of technology delivery mechanisms.
- Validation and refinement of technology delivery mechanisms.
- Cyber extension programmes.
- Policy research and Impact assessment.
- Statistical investigations for improving research methodology in plantation crops.

Contact:

Director
ICAR-Central Plantation Crops Research Institute
Kudlu.P.O,
Kasaragod,Kerala, 671124
Phone : 04994-232894
Fax : 04994-232322
E-mail :director.cpcri@icar.gov.in,
directorecpcri@gmail.com,
cpcri@gov.in
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Contact:
Dr. A. Ranganadha Reddy Email rangaaluri@gmail.com ph: 8019963972
Dr. Abraham Peele K, Email karlapudiabraham@gmail.com, ph: 8297164147
Organizing Secretary, International Conference (ICESHHD-2019), Dept. of Biotech, Vignan’s Foundation for Science, Technology and Research (VFSTR, Deemed to be University), Vadlamudi-522213, A.P.

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LIFE-LIKE AIRWAY CAN BE PRINTED ON A CHIP

Researchers at Pohang University of Science and Technology (POSTECH) and Seoul National University (SNU) have fabricated a biomimetic airway-on-a-chip using a 3D printing technique that exploits bioinks laden with cells taken from human trachea. The device, which contains a network of blood vessels connecting with epithelial cells, could be used as a model to study respiratory diseases, such as asthma, rhinosinusitis, and chronic lung disease.

Rising air pollution in many counties is both increasing the number of people who suffer from respiratory diseases, and making their symptoms more severe. Researchers have therefore attempted to create life-like models that could be used to characterize these inflammatory diseases.

In this new research, a team led by Dong-Woo Cho made a biomimetic airway structure by 3D printing the various different types of cells that are found in natural mucous membranes. The bioink was composed of a decellularized extracellular matrix (dECM) isolated from pig trachea, which was laden with mucosal isolated from human trachea (Biofabrication 11 015002).

“We reproduced an in-vivo-like 3D vascular network by assembling endothelial cells and fibroblasts using the dECM bioink in a one-step printing process,” explains lead author of the study, Ju Young Park. “The structure we produced has the same physiological functions as the biological airway epithelium and so can be used to model diseases like asthma. The presence of blood vessels, for example, leads to an excessive production of proinflammatory cytokines in our airway model. This process (also known as the ‘cytokine storm’) occurs during asthmatic airway inflammation and allergen-induced asthma exacerbation in the physiological context.”

The researchers also confirmed that their model epithelium airway becomes sensitized by house dust mites, which are well-known respiratory allergens. These allergens stimulate the expression of an adhesion molecule on the vascular endothelium that can then recruit immune cells into the inflamed tissue. “Our results show that pathological interactions between the airway endothelium and the vascular network in the airway are reproducible in our airway-on-a-chip model, and that the exacerbation of inflammatory responses by the vascular network in vivo is also reproducible in vitro.”

Mimicking complex 3D structures

The Korean team printed its structures using an in-house 3D cell printer equipped with six dispensing heads. “Two of the printing heads were connected to a pneumatic pressure-based system that dispenses a synthetic polymer to fabricate the supporting framework for the airway,” explains Park. “The other four printing heads operate on a three-axis motorized stage and we control their movement using computer programs.”

Park explains that the epithelium in the human airway mainly contains ciliated goblet and basal cells in contact with basement membrane. Lamina propria, which contain blood vessels and stromal fibroblasts, lie under this membrane. “To mimic this complex 2D/3D structure and the cellular
composition of the airway mucosa, we assembled a 2D airway epithelium on a 3D vascular platform,” she says. “We reconstructed the natural 3D vascular network by 3D cell printing the dECM bioink containing endothelial cells and fibroblasts. The dECM bioink in fact provides the cell with an in-vivo-like niche of native tissue that induces tissue-specific differentiation and function.”

According to Park, the cell-printing technique is much faster than traditional fabrication techniques, and is also better at replicating the fine cellular arrangement and complex 3D microstructure found in natural tissue. “Our 3D cell-printing system allows us to easily fabricate airway prototypes in high throughput and also allows us to directly place various types of cell at specific locations on the airway structure to mimic how cells arrange themselves in native tissue,” she explains. “The technique could be used to design many types of chip and even print organ models other than the airway.”

Towards multiple organs-on-a-chip

The interaction between the epithelium and the blood vessels in the mucous membrane is known to be important for the health of the tissue and to protect against allergens or toxins. “Our new model could be used to study these interactions and better understand the role they play in human respiratory diseases,” says Park. “The 3D cell printed airway-on-a-chip could therefore be used as a powerful complement to animal models for analysing pathophysiology and testing the efficiency of drugs in the preclinical phase.”

This technology is currently under development for commercialization by T&R Biofab, a Korean company that makes biomedical products using 3D cell printing technology.

The researchers, reporting their work in the journal *Biofabrication, 11, (1), 2018* say that they would now like to 3D cell print different organs-on-a-chip and even multiple organs-on-a-chip. These structures would integrate a number of interacting tissues and organs, and could ultimately replace animal models for studying human pathophysiology and evaluating systemic drug effects.

Source: https://physicsworld.com

**RESEARCHER UNEARHTS AN ICE AGE IN THE AFRICAN DESERT**

A field trip to Namibia to study volcanic rocks led to an unexpected discovery by West Virginia University geologists Graham Andrews and Sarah Brown.

While exploring the desert country in southern Africa, they stumbled upon a peculiar land formation — flat desert scattered with hundreds of long, steep hills. They quickly realized the bumpy landscape was shaped by drumlins, a type of hill often found in places once covered in glaciers, an abnormal characteristic for desert landscapes.

“We quickly realized what we were looking at because we both grew up in areas of the world that had been under glaciers, me in Northern Ireland and Sarah in northern Illinois,” said Andrews, an assistant professor of geology. “It’s not like anything we see in West Virginia where we’re used to flat areas and then gorges and steep-sided valleys down into hollows.”

After returning home from the trip, Andrews began researching the origins of the Namibian
drumlins, only to learn they had never been studied.

“The last rocks we were shown on the trip are from a time period when southern Africa was covered by ice,” Andrews said. “People obviously knew that part of the world had been covered in ice at one time, but no one had ever mentioned anything about how the drumlins formed or that they were even there at all.”

Andrews teamed up with WVU geology senior Andy McGrady to use morphometrics, or measurements of shapes, to determine if the drumlins showed any patterns that would reflect regular behaviors as the ice carved them.

While normal glaciers have sequential patterns of growing and melting, they do not move much, Andrews explained. However, they determined that the drumlins featured large grooves, which showed that the ice had to be moving at a fast pace to carve the grooves.

These grooves demonstrated the first evidence of an ice stream in southern Africa in the late Paleozoic Age, which occurred about 300 million years ago.

“The ice carved big, long grooves in the rock as it moved,” Andrews said. “It wasn’t just that there was ice there, but there was an ice stream. It was an area where the ice was really moving fast.”

McGrady used freely available information from Google Earth and Google Maps to measure their length, width and height.

“This work is very important because not much has been published on these glacial features in Namibia,” said McGrady, a senior geology student from Hamlin. “It’s interesting to think that this was pioneer work in a sense, that this is one of the first papers to cover the characteristics of these features and gives some insight into how they were formed.”

Their findings also confirm that southern Africa was located over the South Pole during this period.

“These features provide yet another tie between southern Africa and south America to show they were once joined,” Andrews said.

The study, “First description of subglacial megalineations from the late Paleozoic ice age in southern Africa” is published in the Public Library of Science’s *PLOS ONE*, 14 (1): 2019.

“This is a great example of a fundamental discovery and new insights into the climatic history of our world that remain to be discovered,” said Tim Carr, chair of the Department of Geology and Geography.

Source: https://www.sciencedaily.com/releases/2019/02/190204114633.htm

**ARTIFICIAL INTELLIGENCE SPOTS GRAVITATIONAL WAVES**

A deep-learning system that can sift gravitational wave signals from background noise has been created by physicists in the UK. Deep learning is a neural-inspired pattern recognition technique that has already been applied to image processing, speech recognition and medical diagnoses, among other things. Chris Messenger and colleagues at the University of Glasgow have shown that their system is as effective as conventional signal processing and has the potential to identify gravitational-wave signals much more quickly.

Gravitational waves are ripples in space-time that can be observed using the LIGO-Virgo detectors – which are laser interferometers with
pairs of arms several kilometres long positioned at right angles to each other. As a wave passes through the Earth it very slightly stretches one arm while squeezing the other, before squeezing the first and stretching the second, and so on. This generates a series of tiny but distinctive oscillations that are recorded as variations in the interference patterns measured by the instruments.

The first gravitational wave to be detected was snared by the two LIGO detectors in the US in September 2015. Unlike signals observed since then, these oscillations were visible to the naked eye within the raw data. Normally gravitational-wave signals are swamped by noise – seismic, thermal motion or photon statistics – that must be filtered out using computer algorithms if the signal is to emerge.

**Template matching**

Usually signals are picked out from the noise using a technique known as matched filtering. This involves comparing the oscillations recorded by the interferometer with a series of templates representing waveforms produced by different astrophysical event that are calculated using post-Newtonian and relativistic equations. A significant match between the observational data and any of the templates means a detection, while the type of waveform in the template reveals what caused the gravitational wave in question.

However, the need to compare large numbers of templates to ensure an accurate result means that matched filtering requires lots of processing power and is time-consuming. In the latest work, the team has shown they can potentially reduce the time needed – by using machine learning rather than conventional algorithms. Their system relies on a neural network, which, like the brain, consists of layers of processing units that fire when they receive a certain input.

The system’s input layer holds the raw data that would come from an interferometer – a series of numbers related to variations in the arms’ strain. These data are fed to the first of nine internal layers made up of neurons whose output depends on the input data and a weighting applied to each neuron. With those outputs then forming the inputs of the next layer, and so on, the system ends in a final layer consisting of just two neurons that each generate a probability value between 0 and 1. One neuron reveals how likely it is that the raw data contain a signal while the other, conversely, describes the likelihood of it containing just noise.

**Training weights**

Initially the neurons’ weights are set randomly and the system is “trained” by exposing it to a series of sample data sets, half of which consist of a gravitational-wave signal from binary black-hole mergers covered by “Gaussian” noise while the other half contain Gaussian noise only. The probability values computed by the system in each case are compared with the (known) data type – signal or noise – and the degree of error is then used to adjust the neuron weights layer by layer in a process called back propagation. The idea is that after enough iterations, the network can distinguish signal from noise reliably.

Having trained their system with half a million data sets, Messenger and co-workers then fed it 20,000 new waveforms to see how many it could correctly identify. They also analysed the
same set of waveforms using matched filtering. They found that the two techniques performed nearly equally – their ability to find the buried signals depending in a very similar way on the signal-to-noise ratio and on the probability of mistaking noise for signal. However, because the bulk of computation for deep learning occurs during training, the new technique was far quicker – taking just a few seconds to analyse all the unknown waveforms rather than several hours.

According to Glasgow group member Hunter Gabbard, this greater speed might prove handy as interferometers become more sensitive and detect gravitational waves more often. This, he says, could help alert astronomers to signals from merging neutron stars so that they can point their telescopes to the patch of sky in question and pick up the accompanying electromagnetic radiation before it disappears.

Recognizing glitches

The Glasgow group, however, is not the only one to have applied artificial intelligence to gravitational-wave detection. In particular, Daniel George and Eliu Huerta of the University of Illinois in the US have already published two papers showing that deep learning can operate orders of magnitude faster than matched filtering. They have also used their neural network to estimate properties of gravitational-wave signals, such as the masses of radiating black holes, as well as analysing real, as opposed to simulated, LIGO data. Such data, they point out, can contain what are known as glitches – noise that can mimic a signal – as well as purely Gaussian noise.

Rory Smithm of Monash University in Australia is slightly more cautious about the potential for deep learning. He says it “could one day show promise”, suggesting it might prove particularly useful for distinguishing astrophysical signals from glitches, but prefers to develop more physics-based “principled” approaches. “There’s still a lot of room to better understand the signals and data that we have without resorting to black-box techniques,” he argues.

Published in Phys. Rev. Lett. 120, 141103, 2018
Source : https://physicsworld.com

SCIENTISTS DISCOVERED MECHANISMS BEHIND NEONATAL DIABETES

Insulin is secreted from the beta cells which are located in the pancreas, and it is crucial for the maintenance of normal blood sugar levels. Deficiency of insulin leads to diabetes, characterized by elevated blood sugar. Diabetes most commonly presents in childhood as Type 1 diabetes and in adults as Type 2 diabetes. Sometimes diabetes is diagnosed already in very small babies, during the first six months of life. In these cases, mutations in the gene encoding insulin are often found.

These mutations are only found in one copy of the gene; that means that half of the produced insulin is normal, which should be enough to secure normal blood sugar. However, this is not the case: insulin secretion stops totally after a few months. It is believed that this is caused by a toxic effect of the mutant insulin inside the cell, but the exact mechanisms are poorly understood.
Mutant insulin is known to cause a chronic stress reaction in the beta cell, and it has been thought that this leads to the death of the cell. It is important to understand the detailed consequences of beta-cell stress, because this may help to develop drugs for the prevention of both rare and common forms of diabetes.

“We now had the chance to test this with real patient-derived cells,” tells Professor Timo Otonkoski from the University of Helsinki. Researchers created a human disease model using stem cells from people carrying insulin gene mutations; then they corrected cells using a gene editing technique called CRISPR. The mutant and corrected stem cells were then induced to turn into insulin-secreting beta cells and the researchers followed the function of the cells after transplanting them in mice (eLife, Nov 9, 2018).

“The main finding of the study was that these cells do not die from the chronic stress, but their growth and development is disturbed. These effects are mediated through processes that could potentially be targeted by drugs,” Dr. Diego Balboa says.

“In this study, we describe mechanisms linking chronic cellular stress to the poor development of the insulin-producing cells. A strongly reduced number of beta-cells will cause diabetes immediately, but even a milder defect will increase the risk of diabetes later in life. Understanding the molecular mechanisms of these processes may help in devising ways to preserve the mass and function of beta cells,” Otonkoski states.

Source: https://www.sciencedaily.com/releases/2018/12/181217105841.htm
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ISCA YOUNG SCIENTIST’S AWARD PROGRAMME : 2019-2020

To encourage Young Scientists, The Indian Science Congress Association has instituted a number of awards in different disciplines. These awards carry a sum of Rs.25,000/- besides a Certificate of Merit.

1. Applications are invited from members (Life & Annual) of the Association who have paid their subscription on or before July 15, 2019. The upper age limit of the candidates for the award is 32 years as reckoned on December 31, 2019 (born on and after January 01,1988).

2. Four copies of the abstract (not exceeding 100 words) along with four copies of full length paper must reach the office of the General Secretary (Membership Affairs) not later than August 16, 2019. At the top of each copy of the paper and its abstract, the name of the Section under which the paper is to be considered should be indicated. For details of Sections see http://www.sciencecongress.nic.in/html/paper/presentations.php.

3. Along with the four copies of paper, Four copies of the Application Form (to be downloaded from ISCA website (http://www.sciencecongress.nic.in/html/young_sc_programme.php)) with brief bio-data of the candidate (not exceeding 2 pages), list of publications, with copies of reprints of already published papers if any and a soft copy of the duly filled application form with scanned copies of enclosures (excluding reprints), full length paper and abstract in Microsoft Word (not PDF) along with bio-data in the form of a CD must also be sent simultaneously along with the hard copies.

4. The Paper submitted must be a single author paper and the research work should have been carried out in India and this has to be certified by the Head of the Institution from where the candidate is applying.

5. The candidate should give an undertaking that the paper being submitted has not been published in any journal or presented in any other Conference / Seminar / Symposium or submitted for consideration of any award.

6. A Young Scientist can present only one paper in any one Section (and not a second paper on the same or any other topic in any other Section).

7. A person who has already received Young Scientist Award in any section once will not be eligible to apply for the above Award in the same or any other section.

8. Incomplete Applications will not be considered.

9. The papers submitted will be subjected to verification for authenticity.

10. Full length paper will be evaluated by experts and the selected Young Scientists (maximum of six) in each section will be invited to make oral presentation of their paper during 107th Indian Science Congress. The selected candidates will be provided admissible travelling allowances by ISCA.

11. The final selection for the Awards will be made by a duly constituted committee and the awards will be given during the Valedictory Session of 107th Indian Science Congress session to be held on January 7, 2020.

12. Applications submitted for the above award will not be returned.

13. The last date for receiving papers at ISCA Headquarters is August 16, 2019. All correspondences should be made to The General Secretary (Membership Affairs) The Indian Science Congress Association, 14, Dr. Biresh Guha Street, Kolkata-700017. Tel.No.: (033) 2287-4530/2287-5323, Fax.No.: 91-33-2287-2551/2287-2551 E-mail: iscacal@vsnl.net, Website: http://www.sciencecongress.nic.in