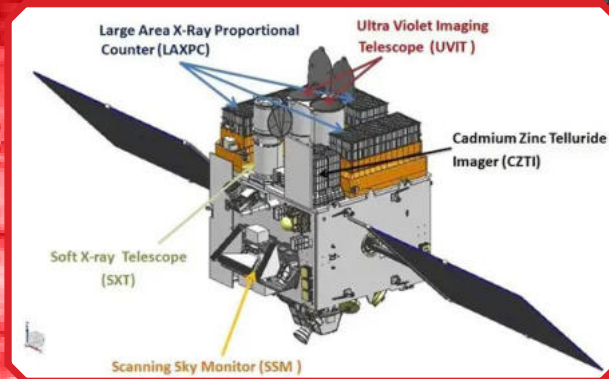


Dream

2047

JULY 2023 / Vol. 26 / No. 7 / ₹ 20

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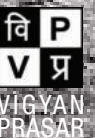
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HOLDING BREATH
LIKE A MARINE
MAMMAL



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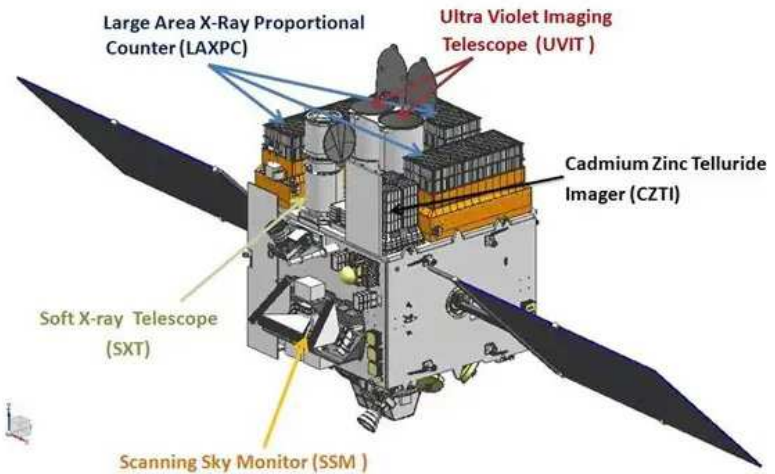
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Published by A. Dhanalakshmi on behalf of Vigyan Prasasr, A-50, Institutional Area, Sector-62, Noida-201 309, U.P. India.



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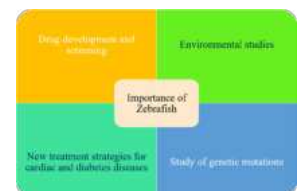
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India in Space

Indian Space Research Organisation (ISRO) is all set to launch *Chandrayaan-3*, the highly anticipated third edition of its lunar mission. The target launch window is expected to be from July 12 to 19. The unmanned lunar exploration integrated module Chandrayaan-3 follows *Chandrayaan-2*, created with a purpose to put a rover on the moon. There are three mission objectives of the Chandrayaan-3, to demonstrate a safe and soft landing on the lunar surface, land a rover that can move on the moon, and conduct scientific experiments.

Space exploration has always been fascinating and India has always been at the forefront of space research. Space agencies like ISRO (Indian Space Research Organisation), NASA (The National Aeronautics and Space Administration), ESA (the European Space Agency), RFSA (Russian Federal Space Agency) and CNSA (China National Space Administration) are some of the leading space research organisations that are engaged in space research and exploration for past several decades.

There has been a renewed interest in space exploration. The space economy is now an integral part of space science and research. All leading economies are racing to explore and exploit space. This is not just limited to government-sponsored space programs - space exploration by private players has emerged as one of the fastest-emerging industries. The space sector is not only a sun rise sector on its own, but also has a spun off effect on other sectors, including, meteorology, energy, telecommunications, transport, maritime, aviation, and urban development.

Any program related to space exploration needs to be a full fledged set of activities to create values and benefits for human beings while exploring, researching, understanding, managing, and utilising space. Similarly, the global space economy Initiatives should be healthy, responsible, and ensure sustainable growth. Space economy has been featured regularly in the work of the United Nations Office for Outer Space Affairs (UNOOSA). With its experience in supporting international cooperation in the peaceful uses of outer space, UNOOSA works to bring the international space community together in support of emerging space-faring nations to take part in the global space economy responsibly and sustainably.

Until the early 1990s, India's space industry and space economy were defined by ISRO. Private sector involvement was limited to building for ISRO designs and specifications. The Indian Space Policy 2023 unveils the government's plan to let private enterprises carry out end-to-end activities - from launching satellites and rockets into space for operating Earth stations. There is a need to promote private sector activity in all high technology areas including space, to fully unlock the potential of India's youth and entrepreneurs.

By leveraging its experience in satellite launching, India has already entered in global space economy and has expanded Its space program in the areas of cartography, telecommunication, meteorology, academic research, defence, and exploration of the Moon through two *Chandrayaan* missions and of planet Mars through its Mars Orbiter Mission, *Mangalyaan*. Launching *Chandrayan-3* is going to be another feather in the hat.



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SPACE PROGRAMMES OF INDIA - PAST, PRESENT AND FUTURE

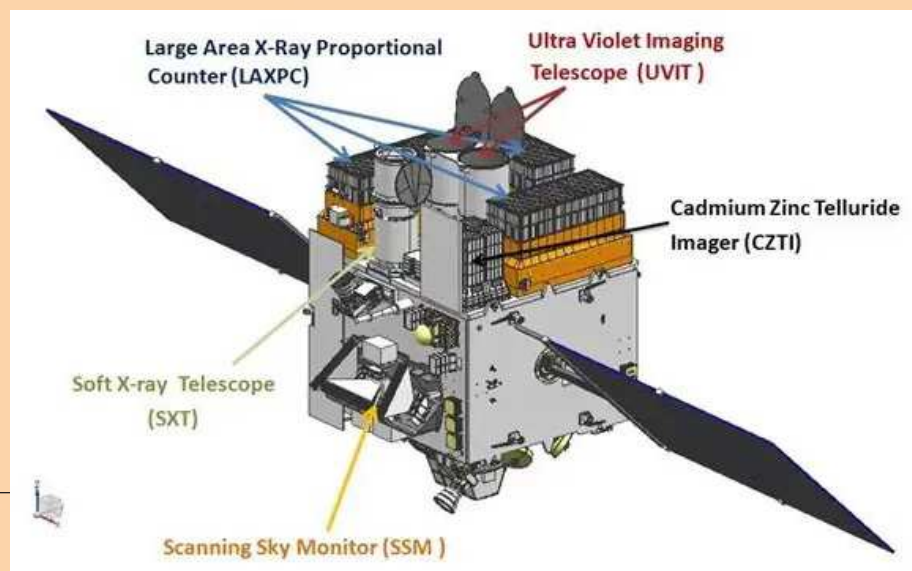
Dr Govind Bhattacharjee

On 6th September 2019, when the Vikram lander of Chandrayaan-2 lost its orientation just 500 metres away from its landing site on the lunar surface and instead crash landed on the moon, it was a moment that brought tears to the eyes of a billion plus Indians across the globe who sat glued to their TVs. A Failure Analysis Committee later pointed out the reasons including last-minute software glitches. Hopefully the soon-to-be-launched Chandrayaan-3 will take useful lessons from this failure. But that failure

does not in any way undermine the many successes of the ISRO-led space programme of India.

India's first interplanetary mission, the 2013 Mars Orbiter Mission has convincingly demonstrated India's technological capability for deep space communication, navigation, and autonomous mission planning and management, besides indigenous design and development of autonomous spacecraft. AstroSat - the first dedicated Indian astronomy mission launched in 2015 with the objective of studying simultaneously the celestial sources in X-ray, optical and UV spectral bands - carried payloads to measure the energy bands of near and far Ultraviolet, optical and X-ray bands between 0.3 keV to 100 keV with a single satellite, putting India in an exclusive club of few countries that possessed such multi-wavelength space observatories. The indigenously developed capabilities for miniaturisation and indigenisation of subsystems used in rockets and satellites led to the advanced satellite-based NavIC, or Navigation Indian Constellation of seven satellites, positioned in space with a unique configuration to provide position and navigation services with an accuracy of 5-10 metres, compared to 20 metres for the GPS.

The SATCOM satellites and navigation systems like SATNAV that uses satellites to provide autonomous geo-positioning have revolutionised satellites communication, navigation and Earth observation capabilities and vastly improved our telecommunication networks, enabling improvement of



people's lives through tele-medicine, tele-education and many specific mobile app-based applications for providing information to farmers, fishermen etc. The indigenously developed Earth-observation and geo-spatial applications have enabled Direct-To-Home (DTH) telecasting, mapping and monitoring of water-bodies spread across the country, wastelands and various crops under cultivation, besides providing advance disaster warnings like cyclones that now enables timely evacuation and saving of numerous lives. Mastering of critical technologies and establishment of infrastructure for casting large boosters, liquid propellant engines, heavy cryogenic boosters for advanced heavier launchers etc. at unbelievably low-costs have made ISRO the envy of many countries including the advanced ones. It is today a significant forex earner for the country as it launches satellites for global clients today through its commercial arm, the New Space India Limited (NSIL) which is a PSU under the Department of Space. It has earned \$279 million in foreign exchange during 2022-23 and has so far launched 345 foreign satellites from 34 countries into space on-board its Polar Satellite Launch Vehicle (PSLV).

Despite all these milestones and monumental feats achieved in the rather short span of time ever since India's first satellite Aryabhata was launched in 1975, followed by India's first indigenously-built remote-sensing satellite Bhaskara-I in 1979, India has been a laggard in space exploration. The three space powers - the USA, Russia and China - are already far ahead of India. With its space industry valued at \$9.6 billion in 2020, estimated to grow to \$13 billion by 2025, and only 0.4% contribution to the country's GDP, India currently commands only 2 percent of the Global space economy dominated by the USA with over 50 percent share. The size of India's space economy is small and mostly government funded, while the USA, Europe and Russia all have big private sector players like SpaceX, Virgin Galactic, Blue Origin, etc. There is a huge potential for India to leverage its cost-effectiveness in the

space sector and claim much larger shares of the global space economy, estimated at a staggering \$464 billion in 2022. To establish an ecosystem for harnessing this huge potential, the government adopted the Indian Space Policy in 2023, which outlines the features of India's space programme for using space as a driver of technology-development and allied benefits for socio-economic development, security, protection of environment and for the peaceful exploration of outer space. Besides encouraging advanced R&D and services using space technology, it also aims to create a stable and predictable regulatory framework to provide a level playing field to all layers. The ecosystem for space will comprise, besides ISRO and NSIL, a third entity called IN-SPACe - Indian National Space Promotion & Authorisation Centre - which will function as an autonomous Government organization for guiding and promoting all space activities in the country, to act as a single window agency for the authorisation of space activities by government as well as private sector entities.

As we know, every technology has dual use. Even though peaceful exploration of space remains the focus of India's space programmes, consideration of national security makes it imperative to see what other major space players are doing in space which are not always for peaceful purposes. In November 2021, Russia launched a Direct Ascent Anti-Satellite Missile (DR-ASAT) to destroy its own defunct satellite, Kosmos 1408, littering space with 1500 pieces of microscopic debris which posed an immediate danger to both the Chinese space station Tiangong and the International Space Station (ISS). Russia was not the first nation to conduct an ASAT, China in 2007, USA in 2008, and even India in 2019 had conducted the same.

But the increasing frequency of such tests by space-faring nations indicates the increasing militarisation and weaponisation of space. Space has long been used for communication, tracking, imagery, positioning, navigation and satellite-surveillance; many of these activities have potentials for military uses and some countries have developed comprehensive space-based architecture to facilitate military activities on the ground. While militarisation of space is pretty old - even during the World War II, Germans had used their V2 rockets for military purposes - weaponisation is a recent phenomenon; it involves putting weapons with significant destructive potentials in space or on celestial bodies. Space weapons can target enemy assets like satellites or weapons systems in space either from the Earth or from systems placed in orbits above the Earth. Space weapons generally fall in two categories: Directed-Energy Weapon (DEW) and Kinetic-Energy Weapon (KEW). A DEW seeks to destroy its target with focused energy of lasers, microwaves, particle beams, etc., while a KEW does so by firing projectiles from space towards the Earth, acquiring their destructive powers through kinetic energy simply by falling at high velocities. These projectiles can be as basic as metal rods, or as advanced as a Multiple Independently Targetable Re-Entry Vehicle (MIRV) - a missile payload that contains multiple warheads capable of striking multiple targets simultaneously.

According to a June 2021 research study by Claire Mills and others titled "Militarisation of Space" and published by the House of Commons Library, UK, there are 3,372 satellites in space, of which 2,612 (77 per cent) are in low Earth orbit (LEO, up to 2000 kms above the Earth). 562 more are in geosynchronous Earth orbit (GEO, at 35786 kms distance), also known as

ASTROSAT - THE FIRST DEDICATED INDIAN ASTRONOMY MISSION LAUNCHED IN 2015 WITH THE OBJECTIVE OF STUDYING SIMULTANEOUSLY THE CELESTIAL SOURCES IN X-RAY, OPTICAL AND UV SPECTRAL BANDS

geostationary orbit as a satellite here appears stationary to an observer on the Earth due to the same orbital period. Only 139 are in medium Earth orbit (MEO, between the LEO and the GEO). 516 of all these satellites are estimated to have military or dual-use purposes, and over half of these – 265 – are in LEO, where their low altitude coupled with short orbital periods make them ideal for Earth observation and surveillance. The USA leads the constellation of satellites with 1878 satellites, followed by China (405), Russia (174), UK (166), Japan (82) and India (60). As of February 2022, India had only 53 operational satellites in space. Space also has substantial litter, corpses of nearly 3000 satellites purposelessly roam the loneliness of space, besides 34000 pieces of junk exceeding 10 cms in size. All these orbiting bodies pose significant risk to future satellites. Some countries like Japan are trying to cleanse space of such debris by using lasers to push them back into the terrestrial atmosphere where they will automatically burn up.

International law classifies outer space as a 'Global Common', meaning outside of any country's national jurisdiction and hence to be governed only by international legislation. The high oceans, Antarctica, and even cyberspace are examples of Global Common, in respect of some of which there are international treaties. International law, including the Charter of the United Nations, applies to outer space and celestial bodies, which are free for exploration and use by all nations

in conformity with the international law. Activities in space are regulated by the United Nations Outer Space Treaty (OST) of 1967 which has been ratified by 111 nations. As per Article II of the treaty, "Outer space, including the moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means." Article IV of OST prohibits the "establishment of military bases, installations and fortifications, the testing of any type of weapons and the conduct of military manoeuvres on celestial bodies" while binding nations not to "place in orbit around the Earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction, or install such weapons on celestial bodies, or station such weapons in outer space in any other manner". The responsibility for this lies with United Nations Office for Outer Space Affairs (UNOOSA), which lacks the necessary legal authority or even the institutional capacity to enforce it. In the absence of any effective enforcement mechanism, it is left to the discretion of individual countries who would be more inclined to put their own national interests over the interests of the global common.

Another agreement in 1979, the Moon Agreement, similarly forbids the use of moon for military purposes or its weaponisation, but this treaty has been ratified by only 18 countries, which includes no spacefaring nation. The big three space powers –USA, Russia and China - have not even signed it. India

and France had signed the treaty in 1980 but haven't ratified it so far. As the space race heats up, it becomes even more necessary to bring nations together into negotiation leading to agreements about the peaceful use of space. So far there is not even an agreement on where the Earth ends and the space begins, e.g., NASA defines space to begin at 80 kms above the sea level on Earth, while some other organisation defines it at 100 kms. If countries cannot even agree on the distance at which space begins, implications may indeed be serious. As Tim Marshal says in his book, *"The Power of Geography"*, (Elliott & Thompson, 2021), if nation 'A' believes that space begins at 80 kms and nation 'B' believes it begins at 100 kms, then if 'A' flies its satellite over 'B' at 90 kms, the latter can shoot it down. The OST did not even define 'peaceful purpose'; Russia wants it to mean that all military-related activities should be illegal, while USA asserts that military purposes are lawful as long as they remain 'non-aggressive', which as per the UN Charter means activities that prohibit 'the threat or use of force', a definition that leads to multiple contradictions. This ambiguity was sought to have been removed by the Moon Treaty which remains inoperative in the absence of ratification by a majority of nations.

The rising economic activity between the Moon and the Earth, an area called Cislunar, will make it imperative for spacefaring nations to establish military presence on the lunar surface. Nations like France, USA, Russia and China have already created separate Space Divisions in their military for protection of their space assets which may trigger an arms race in space. The US Space Force created in 2019 by President Donald Trump is based on the dictum that "Space is a war-fighting domain". China, after creating a Defence Space Force in 2015 as part of the People's Liberation Army's Strategic Support Force incorporating cyber and electronic warfare, brought out a White Paper in 2016, setting out its long-term strategic goal of becoming a "space power". As an aspiring space power with demonstrated capability, India cannot afford to remain behind,

TO ESTABLISH AN ECOSYSTEM FOR HARNESSING HUGE POTENTIAL IN SPACE ECONOMY, THE GOVERNMENT ADOPTED THE INDIAN SPACE POLICY IN 2023, WHICH OUTLINES THE FEATURES OF INDIA'S SPACE PROGRAMME FOR USING SPACE AS A DRIVER OF TECHNOLOGY-DEVELOPMENT AND ALLIED BENEFITS FOR SOCIO-ECONOMIC DEVELOPMENT, SECURITY, PROTECTION OF ENVIRONMENT AND FOR THE PEACEFUL EXPLORATION OF OUTER SPACE.

INTERNATIONAL LAW CLASSIFIES OUTER SPACE AS A 'GLOBAL COMMON', MEANING OUTSIDE OF ANY COUNTRY'S NATIONAL JURISDICTION AND HENCE TO BE GOVERNED ONLY BY INTERNATIONAL LEGISLATION. THE HIGH OCEANS, ANTARCTICA, AND EVEN CYBERSPACE ARE EXAMPLES OF GLOBAL COMMON.

especially in view of the extraordinary increases in Chinese space assets and its unconcealed ambition to rule space. Russia has already tested its hypersonic missile, Kinzhal, in 2021 and even used it in its ongoing war with Ukraine; USA and China are also close in the race to develop such missiles. These missiles fly at more than 20 times the speed of sound and can change their direction and altitude making it difficult to intercept them. Since hypersonic missiles depend on satellites to operate, and since satellites are not only essential for civil and military communications but are also crucial for detecting and notifying missile attacks, each country would like to develop the capability to strike the other's satellites. China has been reported to have developed a microwave device called "Relativistic Klystron Amplifier" (RKA) that can jam or destroy satellites in space by generating 5-MW wave-bursts; RKAs can even be mounted on satellites to destroy targets in space like any other DEW. There are also reports of satellites of one nation stalking the satellites of other nations, like in 2020 when Russia's Kosmos 2542 military satellite was reported to have stalked the American satellite USA 245, besides conducting what is believed to be a 'weapon test' by firing a high-speed projectile.

In "*Astropolitik: Classical Geopolitics in the Space Age*" (Routledge, 2001), Professor Everett Carl Dolman from the US Air Force's Air Command and Staff College applied Halford Mackinder's famous Heartland Theory of 1904 to space. Space, according to him, is not featureless but has "a rich vista of gravitational mountains and valleys, oceans and rivers of resources and energy". Dolman divided space into

four territories: (1) Terra, surrounding the Earth and up to the limit where a spacecraft can orbit without being powered, (2) Earth Space, up to the GEO, (3) Lunar Space, up to the lunar orbit and (4) the unlimited Solar Space, beyond the lunar orbit. In Mackinder's Theory, Heartland was a region around the then Russian Empire. Mackinder postulated that whoever controls East Europe controls the Heartland and whoever controls the Heartland controls the world. Dolman's version was that whoever controls LEO controls the near-Earth space; whoever controls the near-Earth space controls the Terra and whoever "dominates Terra determines the destiny of mankind."

As Tim Marshal corroborates in his book, in the previous centuries, dominance on Earth was decided by controlling the sea routes. Air power was added in the last century and in this century, it would likely be space power, for which the ability to place military assets in space – especially in the LEO – will become the determining factor. LEO is also the area where any spacecraft travelling to the Moon and beyond can be refuelled and resupplied, and refuelling will be necessary if distant planets like Mars or asteroids are to be explored for energy and mineral resources. Hence whoever controls this corridor will become a gatekeeper to the outer space beyond, and can prevent a rival from refuelling within it. It is just like what is happening currently on Earth in the Ukraine War – Turkey, a NATO member which is gatekeeper to the Black Sea, has restricted Russian warships to sail from the Mediterranean to the Black Sea through the Bosphorus Strait. LEO also assumes significance, as Marshal points out, for commercial considerations. A

technology to deflect solar energy upon the Earth for power generation using a vast array of solar reflectors will likely be placed on the LEO. Given this is also where spaceships would need refuelling, a gatekeeper can easily charge a fee to allow any spaceship to travel beyond for mining or exploration purposes.

Just like on the Earth, space also can become an arena for intense competition. Five points denoted by L1, L2, L3, L4 and L5, known as the Lagrange's Points, surround the Earth where the gravitational forces of the Sun and the Earth cancel each other out, giving stability to a spacecraft placed therein while requiring minimal energy to keep it there. Two of these points allow commanding views of the belts containing satellites and one in particular, L2, where the giant James Webb Space Telescope was positioned last year, is directly behind the Earth in the line joining the Sun and the Earth. This is also where China has placed a satellite recently, allowing it to view the dark side of the moon where it is also contemplating to establish a military base. All these points will become objects of intense competition for the strategic advantages they confer.

Regarding the use of space as a military domain, the existing international treaties are clearly insufficient, and the past efforts for disarmament of space through international consensus have so far met with little success. Realising this, in November 2021, the UN General Assembly approved a resolution seeking to appoint a new open-ended working group to develop rules for military activities in space. But rules can be enforced only when several countries have developed enough capability to deter each other from using them, like nuclear weapons. This makes it imperative for India also to focus on developing space weapon systems and try catching up with China which is already far ahead of us in space technology. Only then can any UN-mediated negotiation for a weapons-free space carry some meaning.

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LIFESTYLE CHANGE FOR THE ENVIRONMENT: REVERTING TO NATURAL ADORNMENTS

Monika Koul* & Nandini Killa**

“Jewellery has the power to be the one little thing that makes you feel unique.”

— Elizabeth Taylor

Since the time immemorial, jewellery has been an indispensable part of the very existence of womanhood. It reflects a woman's embodiment of free spiritedness and her latent desire to beautify her appeal through adornments and accessories. Even the Vedas and texts of historical literature don't fail to highlight their relevance in being highly prized possessions. The strong female characters of the epics, Sita and Draupadi; Kalidasa's Shakuntala and the Panchatantra tales have mentions of

various types of ornaments worn by both the men and women.

The historical documents, paintings, and artefacts of almost all the ancient civilizations depict the usage of jewellery of various types, made from various materials that were available in the area. Women have been flaunting intricately designed garlands, bracelets and anklets that symbolized their culture, social status and enhanced their beauty. Ornaments were made and crafted from simple, yet aesthetic materials derived directly from mother nature. Flowers, the nature's most beautiful bounties,

possessing a multitude of colours, the leaves of various plants (herbs, shrubs, and trees), and the seeds with so much of diversity in colour/texture shapes and sizes were tied in threads and given various designs to cater to the status and taste of women. These ornaments were made and designed for the occasions/festivals/rituals and after they served their purpose degraded in soil. Some women used the shells, the pieces of bones, resins and gums, the stones, and many other natural things too to enhance their grace and grandeur. Though these sustainable accessories served the purpose alright, the willingness to attach an aspect of permanence to jewellery drove the civilization towards reusable jewellery. Metals, especially the precious ones such as gold and silver, were seen as the best material for making ornaments because of their shine, amenability, and easy designing. These metals were also extracted from nature, but the practices adopted for metal extraction were environmentally sound. However, the lust to extract more expensive metals



A myriad of fashion accessories like earrings and rings are an amalgam of cheap plastic and toxic chemicals that expose the environment to pollutants not only during the disposal but also the manufacturing process.

gold from nature's reservoirs has caused irreversible damage to nature. Gold and silver are recycled, and this jewellery is moderately sustainable as this could be reused. However, in the last two decades the fashion industry, especially the accessory market has seen a paradigm change. Stones another natural material have also been collected from riversides, beaches and other natural habitats all cross the world. Colourful stones in all colours of rainbow have also been the fascinating adornment for both the men and women. Some civilizations adorned feathers of various birds that they shed in the surrounding areas and hand craft them into danglers and neckpieces. Seeds dehisced from the plants show immense amount of diversity in colour, shape, size, coat morphology, shine and hardness. The plant seeds were bored to make holes and then put in a thread and turned into beautiful bracelets, neckpieces and added elegance and grace to the personality. All these things were harnessed from environment and went back to the environment, without leaving any waste that piled up. Fibres from plants such as cotton, jute, hemp, coir, kapok, and agave) were extracted using environmentally friendly processes and converted to beautiful ornaments that adorned both the rich and poor.

Women's obsession with accessories has increased a lot and since women are now going out to work, looking good and trendy has become a requisite. So, imitation and fashion jewellery markets are seen everywhere and with online shopping just a click away, the dressing tables are piled up with the stuff. This jewellery is neither very expensive nor boring and is a rage. Imitation jewellery has become a part of the fast-fashion world which fulfils a woman's desire to complement different attires with matching accessories. This low-cost and cheerful jewellery is affordable and serves their purpose. The women

of all social and economic classes buy the junk and later dispose it off in the surroundings where soil and water serve as the sink to it. Women would never have thought, this activity is quite costly when quantified in terms of environmental damage which it translates. The silver and gold-plating on the bracelets, necklaces and bangles fades out after a fleeting time persuading the consumer to throw them away just as quickly and to renew their purchases, only to generate a colossal amount of non-biodegradable waste which contaminates soil, water, and air.

Trend of fashioning oneself with imitation jewellery is taking a toll on

According to latest reports, the revenue from the jewellery segment amounts to almost \$76.77 billion in India.

Furthermore, a myriad of fast-fashion accessories like earrings and rings are an amalgam of cheap plastic and toxic chemicals like chlorine, mercury, brominated flame retardants, cyanide and sulphuric acid that expose the environment to pollutants not only during the disposal but also the manufacturing process. Plastic jewellery pieces, that are shredded by animals, have been found in the oceans and riversides and are affecting aquatic life. In this sense, the landfills are laid susceptible to hardy substances that



While sustainable practices are being continually adopted in the textile industry, the jewellery industry has largely ignored the environment.

women's preferences in the modern world, and sustainability is constantly compromised for low prices and diversity in style. So much so, that the Indian costume jewellery market was valued at \$1.78 billion in 2019. It is estimated to reach \$2.12 billion by 2027, registering a CAGR of 7% according to a study conducted by Allied Market Research.

remain retained for thousands of years in nature. The carbon-footprint of the local, unorganized sector that makes this trendy jewellery is rising. The heaps of the solid and semi-solid waste and the degraded by products are gradually polluting the soil, that is the substratum for the crops. The manufacturing units of the bangles and bracelets also pose occupational hazards to the workers who are working in these unregulated factories. Many workers, especially women, who paint and make bangles are prone to chest diseases. Besides having an adverse impact on the environment,

WOMEN'S OBSESSION WITH ACCESSORIES HAS INCREASED A LOT AND SINCE WOMEN ARE NOW GOING OUT TO WORK, LOOKING GOOD AND TRENDY HAS BECOME A REQUISITE.

imitation jewellery is endowed with the capability of inducing allergic reactions on skin owing to the cheap metals, polishes, and plastic which they are made of. Electroplating of metals for making ornaments that look good, leads to emissions of toxic fumes and gases that pollute the air. Heavy metals (lead, cadmium, mercury, chromium) are also emitted that accumulate in the environment and enter the food chain. Cleaning the grease and removing extra polish adds volatiles organic compounds to the water, that is disposed of without treatment creating harmful impact on soil. While the entire world is talking of reducing the carbon-footprint and reducing the greenhouse gas emissions, the fashion industry is growing at a fast speed. Experts say that the processing of metals, working on metals and metal alloys requires machines that run on fossil fuels. The designing of metals and carving of these metals also is done by equipment that emit lot of carbon in the environment. These emissions contribute to almost 5-10 per cent of the greenhouse gas emissions.

While sustainable practices are being continually adopted in the textile industry, the jewellery industry has largely ignored the environment, almost overlooked in the way it unearths equal perils for nature, if not more. Therefore, a dire and urgent need exists to adopt strategies that can aid in mitigating the environmental burden. An incredible amount of metamorphosis can be brought about if women are told about the environmental cost of these products, which they buy almost every week. Even the educated women are not aware of the harmful impact of the materials, polish and colours used in these fashion accessories, so the uneducated and others cannot be blamed.

Indian women have played an important role in environmental protection and conservation. They can be the change makers as they are the

LET US START SAYING NO TO IMITATION JEWELLERY FOR SUSTENANCE AND PROTECTION OF OUR ENVIRONMENT. THE MISSION LIFE IS A GLOBAL CAMPAIGN AIMED TO NUDGE ALL OF US TO ADOPT THE ENVIRONMENTALLY SUSTAINABLE LIFESTYLE AND IT CAN BEGIN IN EVERY HOUSEHOLD AND CAN BE STEERED BY WOMEN.

ones who use it the most. Campaigns such as go green and adore green, nature in fashion, fashion or pollution can be started. Students should be given projects to study the impact of materials used in making the artificial jewellery and harmful impacts these have on our environment. This year we are creating awareness on changing lifestyle practices for the environment and our Prime Minister is steering many action programmes for the same. It is time to change our behaviour and perspective. If women are made aware of the enormity of impact of these ornaments on the environment, and to their own health, and especially to the health of children, they will abandon it. A shift to environmentally sound practices can be materialised by simply switching to precious metal jewellery and has long life. Hand-made accessories of natural fibres, recycled paper, and cloth are an environmentally safer option that would also help promote small scale businesses and our indigenous culture. The making of this is carbon neutral as well. A study from 2014 unveiled that more than 80% of the consumers would like to buy ethical and environmentally friendly jewellery and are even willing to pay more for better quality. Similarly, it is of paramount

importance that manufacturers inculcate a social responsibility on their end by integrating sustainability and safety in the production practices to the farthest extent possible, which includes taking appropriate steps for treating the harmful waste before disposing it off and subsidising the application of deleterious metals like nickel, cadmium and lead in the due course of making and replacing them with more sustainable options like titanium and platinum. Additionally, use of better-quality raw materials can impart prolonged lifetime to these accessories.

Let us start saying no to imitation jewellery for sustenance and protection of our environment. Nature is beautiful and let us contribute to enhancing its grace and using its bounties as adornments. This is a wave of consciousness and enlightenment blanketed in small, subtle yet effective actions, which would direct us towards a sustainable future. The mission LIFE is a global campaign aimed to nudge all of us to adopt the environmentally sustainable Lifestyle and it can begin in every household and can be steered by women.

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AN INCREDIBLE AMOUNT OF METAMORPHOSIS CAN BE BROUGHT ABOUT IF WOMEN ARE TOLD ABOUT THE ENVIRONMENTAL COST OF THESE PRODUCTS, WHICH THEY BUY ALMOST EVERY WEEK.

TIME IN ART, MUSIC, AND FICTION

Soumya Maitra

In the inaugural issue on time last month we looked at how our concept and perception of time in common day use varies with our choice and experience of the language that is used to express it. In this issue we will take a different perspective – that of variability of time in art, music, and literature.

instance the famous surrealist painting *The Persistence of Memory*. Painted by Salvador Dali in 1931 and in the collection of the Museum of Modern Art in New York since 1934, this iconographic painting gives an impression of the incessant passing of time, transient, malleable, and merciless, leaving behind a residue of human experience we call

creamy French cheese in the Sun, was Dali's "camembert of time." The name he chose for the painting - *The Persistence of Memory* - immediately conveys to the viewer the gradual fading of a dream into oblivion after waking up and our fruitless struggle to hold on to it in our conscious memory. It is interesting to note that Dali chose to associate his painting of a malleable notion of time with memory. After all, from a human experience, what is time but our perception of the past that have gone by, felt in the infinitesimally short fleeting instance of the present, and the equally elusive anticipation of the imminent we call the future! Unlike physical instruments and equations, human beings don't experience time in seconds and minutes. All that we know of and recollect is our brain's way of encapsulating time as *memory*, and as our unique way of projecting our understanding and lessons from the past to the planning and preparation of the future.

Dali's surrealism may be fresh in our mind. After all, it has been less than a century since he painted his masterpieces including the one mentioned here; but it is not the only one when an artist experimented with man's perception and concept of time. One of Dali's later contemporaries, the Polish artist Roman Opalka, undertook a monumental and unique work of art, representing the incessant passing of time on an artist's canvas. Starting in 1965 and continuing until Opalka's death in 2011, this lifelong project titled "OPALKA 1965/1 - ∞" painted numbers in sequence on a series of canvases measuring 196x135 cm for forty-six years. He started painting the numbers in white on black canvases, and every time he completed one canvas, he added 1% white to the canvas background. This resulted in the numbers painted in white on subsequent canvases to get fainter as



Figure: Salvador Dali's iconic *The Persistence of Memory*, painted in 1931.

Art transcends language and culture. It breaks the never-ending drudgery of habit, presenting common things in an uncommon and fresh point of view. The artist uses it as a metaphor to represent reality. Human creativity through the ages has taken innumerable shapes and forms, limited only by the imagination of the artist. Be it in music, painting, sculpture, or poetry, the vivid figments of human imagination raring to take flight are not constrained by language or culture. And artists across the ages have been bold in experimenting with the intangible ideas of time. Take for

and recall as memory.

Contrary to popular belief of his time, Dali was not influenced by Einstein's theories of relativity when he painted this oil on canvas piece. He was not attempting to capture the physics behind the relativity of spacetime. When asked what his inspiration behind the painting was, Dali mentioned it was a surrealist representation of a dream he saw. In his own words, he was experimenting with a "paranoiac-critical method", a form of self-induced psychotic hallucination instigating his creative mind. The malleable watches melting like a rich soft

he continued diluting the canvases 1% whiter than the previous one. His vision was to capture the gradual fading of time as an infinite intangible concept; his goal was to slowly dissolve the numbers (representing the incessant tick of time) into the canvas' slowly whitening surface as a form of blankness, his idea of achieving *tabula rasa*. What made Opalka's art stand out from the rest is that he chose to embody the human ageing process through his work, with his final piece painted on his dying day. In his own words, "Time as we live it and as we create it embodies our progressive disappearance. We are at the same time alive and in the face of death — that is the mystery of all living beings"!

Its impossible to summarize the works of all the artists across ages and

nationalities who have used their art to reflect on the nature of time. However, one conventional renaissance artist do merit a special shout out. Italian painter Giuseppe Arcimboldo from the 16th century was known for painting imaginative colourful figure heads to symbolise various concepts. His masterpiece "The Four Seasons" is a set of four paintings, each depicting one of the four seasons – Spring, Summer, Autumn, Winter – symbolically showing the birth of life and its progression onto death as time passes. While the techniques used by Arcimboldo was more conventional, the form he chose, an imaginative figurehead showing seasonal fruits and vegetables and barks of trees ageing to depict the march of time, is what makes this art stand out.

The examples cited above are not an exhaustive survey of visual art in the domain of time. It shows how artists over the ages have tried different forms and techniques to convey the fleeting nature of life and the human experience.

Of all the art forms, the one that is most intimately related to our perception of time is music. It is our perception of time, and how the musical notes punctuate its passage, that creates melody and differentiates it from the cacophony of regular conversation. Consider any musical composition, does not matter whether it is classical or modern, western or oriental. Take the musical scores apart and play them individually, without any correlation to the other notes and the tempo that binds them together, and what you get is cacophony



Figure: OPALKA 1965/1 - ∞, a series of canvases depicting numbers in white. The first canvas was pure black, with 1% whiteness added to each subsequent canvas. The idea being the final one would be white numbers on a white canvas, completely blank to the human eye, faded to infinity.



Figure: The Four Seasons – spring, summer, autumn, winter – painted between 1563 and 1573, depicts natural order of things following the direction of time.

of instruments, but not music. Time acts as the glue in the composition which our brain interprets as music. It is akin to the canvas on which the artist paints. The brush strokes, the colour choices, the under-painting, the composition, all come together as a cohesive piece of art bound by the canvas. Poke a hole in the canvas and the painting loses its artistic essence. Play the notes out of sync or break the tempo, and the music loses its magic. Somehow the sound waves on the tympanic membrane of our ear (aka eardrum) and the resulting auditory nerve cell impulses are pieced together by the temporal lobe of the brain, superimposed on its innate perception of the flow of time.

This is not just the model for music alone. Time plays an equally crucial role in day-to-day communication. When we are excited, we tend to speak faster and louder, and the pace of our speech gives away our nervousness or tension to the audience. When we speak in a well-composed fashion, we exude confidence and control. It is the pace – the tempo of our speech more than the content – that creates the lasting impression on our audience. Great orators across all ages, regardless of their language and culture, know how to wrap their manner of speaking around the arrow of time. They know when to speed up their fiery speech, when to slow down to convey humility, and when to be silent. Think of the pregnant pause between two sentences, deliberately introduced by the speaker to command attention and emphasize

the message to the audience. Without our notion of time and how actions in it influence our world psychologically, this will be a futile exercise.

The role of time in music is not just aesthetic in nature. Our visual sense is able to comprehend a quantum of time closer to two hundredths of a second. More practically, stroboscopic motion that is usually captured and recognized by the human eye and processed by our visual cortex is usually in the order of a tenth of a second. In contrast, our auditory sense is able to distinguish quanta of time as fleeting as two thousandths of a second. Our brain is able to distinguish this temporal order based on the subtle difference between the source of the sound and the distance between the source and the two ears. Definitely our ability to perceive elapsed time therefore is heightened when we are listening to music than, say, when we are watching a play or a dance program. Visual and auditory art plays out at different pace within our mammalian brains. It seems that our mammalian brains evolved over time to be able to perceive duration and recognize patterns in visual and auditory events, which have

resulted in our capacity to build visual and performing art.

Man's attempt at representing his understanding of time through art and music is not a modern fad. The earliest known reference to man's perception of the passage of time is found in notches cared into narwhal bones dating back to prehistoric times. It is believed the notches represented days, or passing of heavenly bodies in the night skies, or something similar that our hunter gatherer ancestors were attempting to track. Flutes made of bird bones and mammoth ivory dating about 40,000 to 50,000 years ago have been found in Germany that suggests humans had musical sense and therefore an understanding of rhythm, tempo, and passing of time in prehistoric times. Closer to recorded history, similar musical instruments like harps, flutes, drums, and bullroarers have been found in ancient civilizations such as Egypt, Mesopotamia, Greece, and China that date back several millennia. The oldest surviving harp is the "Great Lyre" of Ur from 2500 BC and the oldest known drum (over 8,000 years old) is made of clay pot found in China. Whatever

THE ROLE OF TIME IN MUSIC IS NOT JUST AESTHETIC IN NATURE. OUR VISUAL SENSE IS ABLE TO COMPREHEND A QUANTUM OF TIME CLOSER TO TWO HUNDREDTHS OF A SECOND.

may have been the purpose behind the makings of these primitive musical instruments, one thing is certain: the common denominator is our perception and use of time as a musical structure, giving rise to rhythm, temp, and eventual overall meaning to life.

The post-Einsteinian world in which we live now is accustomed to the idea of spacetime so much so that it is nearly impossible for us to imagine a world where space and time were considered two different entities. A quick n-gram scan for the words “spacetime” and “space time” in Google Books Ngram Viewer shows a distinctive trend of the world adopting spacetime around the start of the twentieth century. This coincides with two key events of that time. The famous sci-fi novel *The Time Machine* was published in 1895 where the author H. G. Wells introduced the

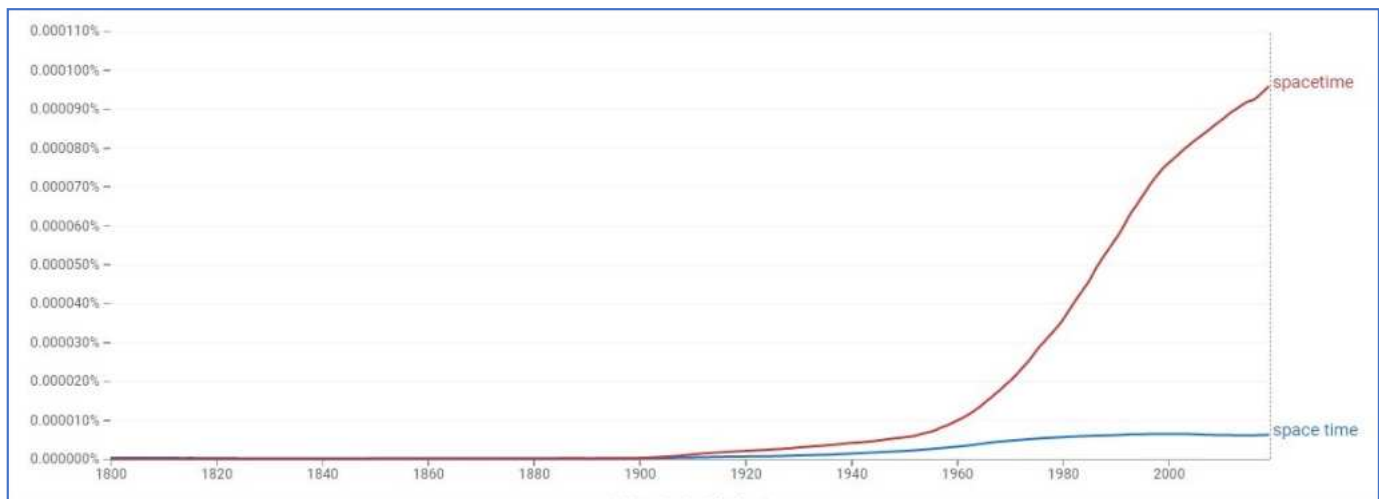
THE EARLIEST KNOWN REFERENCE TO MAN’S PERCEPTION OF THE PASSAGE OF TIME IS FOUND IN NOTCHES CARED INTO NARWHAL BONES DATING BACK TO PREHISTORIC TIMES.

has spawned since H.G. Wells’ literary and Einstein’s scientific masterpieces.

H. G. Wells’ *The Time Machine* stands out as the first true science fiction work on the idea of time and time travel as a mechanics of moving in the fourth dimension. However there have been several other notable literary works on this subject. The classic children’s tale of *Rip Van Winkle*, written by Washington Irving and published in 1819, tells the story of a villager who drinks liquor and falls into a deep sleep, only to wake up

in world literature.

Man’s fascination of space have been known for ages. Hunter gatherers lying on open fields and gazing up to the starry night skies, painting in caves their vision of the heavens, various artefacts from the stone age, bronze age, and iron age, representing man’s understanding (even if those were not always accurate) of space and building mythological stories around the heavenly bodies, are well known from documented history. In contrast, man’s rendezvous with the



idea of time being another fundamental dimension like the three dimensions of space. His novel - the first of its kind - took the reader on a journey through time to the future. Ten years later Albert Einstein would publish his seminal paper on the Special Theory of Relativity, formally joining space and time into a single cohesive property of the physical world, redefining Newtonian mechanics and much of the classical physics that was taken for granted until then. It is no surprise then that the post Einstein world no longer thinks of space and time as two different things in nature and the same outlook is evident in the fiction that

twenty years later and finds a changed world around him. Similar tales exist in Indian and Japanese literature also where the protagonist finds time in which he lived have moved on farther than his own present. For instance the tale of King Raivata Kakudmi, written around 10th century CE in the *Bhagavata Purana*, talks about the king traveling to far away godly kingdoms seeking a suitable groom for his daughter. Upon his return to Earth he finds centuries have passed and the world he knew including his loved one no longer existed. This is perhaps the earliest known reference to time travel

intangible, elusive idea of time is rare. That is not to say that prehistoric and historic *Homo sapiens* have not been pondering about it. Its just that we do not have enough evidence to build as strong a narrative around our perception of time as we have had in space. Maybe this will change as we continue to evolve as a species. It is only a matter of time.

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AQI DECODED

Dr. Nimisha Vaidya

INTRODUCTION

A decade ago, a person would check the forecast for rain in the monsoon before stepping out of the house. In other seasons, it was not essential to know weather updates, specifically in urban India. These days, it is not so. A person has to ensure that the AQI at the place is at a safe level, or he has to ensure he has safeguards like air filters or masks to counteract air pollution. The educational institutes are closed and even commercial activities are reduced to a bare minimum if AQI is too high at a place. This article aims to discuss this important weather parameter which has brought the Indian capital to a standstill very frequently in the past few years.

AQI DEFINED

AQI is an acronym for Air Quality Index. Broadly speaking, it is a measure of the air pollution at a specific location. It takes into account the various air pollutants to render a cumulative value. Greater the value, more is the pollution. It is preferable to have a value of AQI below 50, and as small as possible, to be able to breathe freely.

The Central Pollution Control Board [CPCB] categorizes AQI into six levels as shown in Table 1.

Table 1 : AQI Classification

The categories come with warnings for each class;

Good – a range of AQI between 0-50 is ideal. The air quality of the place is excellent, and people can freely enjoy all outdoor activities.

Satisfactory – a range of AQI between 51-100 tells that the air contains a high level of pollutants and is unhealthy for sensitive groups like people already having asthma, children and older people. General public is less likely to be affected.

Moderate – when the AQI is having a value between 101 – 200, not only are the sensitive people advised to stay indoors, but even healthy people may feel difficulty in breathing and throat irritation, thus, should preferably avoid outdoor activities.

Poor – AQI climbs up between 201-300, triggering a health alert. The risk of health effects is increased for everyone.

Very Poor – the air contains a large number of pollutants when the AQI is between 301-400. It is a warning for everyone to stay indoors and limit outside exposure to a minimum.

Severe – The air is not breathable at an AQI greater than 401. All outside activities should be stopped at an earliest, by everyone, irrespective of age or health criteria. Healthy people will also experience severe health issues if they disregard the warning and step outside.

they are easily portable. These gadgets sometimes are able to demonstrate other parameters of the weather like temperature (both minimum and maximum at a place), humidity, chances of rain, atmospheric pressure, wind speed and UV index of the place. Typically, they use rechargeable batteries for power, or they are plug-ins, working on low power. The display is LCD, which sometimes also displays pictograms for enhanced perception of the pollutant levels. In addition to these devices, there are certain mobile applications which give a complete description of weather at a particular place. It is also able to forecast weather for a short period, like the next five days or a week.

COMPUTATION OF AQI

To gauge the AQI of a place, the air pollutants at that location are measured. As seen from the above table, there are

AQI Category (Range)	PM ₁₀ 24-hr	PM _{2.5} 24-hr	NO ₂ 24-hr	O ₃ 8-hr	CO 8-hr (mg/m ³)	SO ₂ 24-hr	NH ₃ 24-hr	Pb 24-hr
Good (0-50)	0-50	0-30	0-40	0-50	0-1.0	0-40	0-200	0-0.5
Satisfactory (51-100)	51-100	31-60	41-80	51-100	1.1-2.0	41-80	201-400	0.6-1.0
Moderate (101-200)	101-250	61-90	81-180	101-168	2.1-10	81-380	401-800	1.1-2.0
Poor (201-300)	251-350	91-120	181-280	169-208	10.1-17	381-800	801-1200	2.1-3.0
Very poor (301-400)	351-430	121-250	281-400	209-748*	17.1-34	801-1600	1201-1800	3.1-3.5
Severe (401-500)	430+	250+	400+	748+*	34+	1600+	1800+	3.5+

*One hourly monitoring (for mathematical calculation only)

Image credit: National Air Quality Index Report by Central Pollution Control Board

INSTRUMENTS USED TO MEASURE AQI

The instruments like PCE-RCM 05, PCE-HFX 100, PCE-RCM 8 are used to compute AQI. These are generally compact, handheld or table-top monitors, with good accuracy of measurement. These are very convenient to use as

a total of eight contaminants, namely, PM₁₀, PM_{2.5}, Nitrogen Dioxide (NO₂), Ozone (O₃), Carbon Monoxide (CO), Sulphur Dioxide (SO₂), Ammonia (NH₃) and Lead (Pb), taking into consideration the atmosphere of India. Lead and ammonia contents are measured only for calculating AQI for India.

PM₁₀ refers to the concentration of microscopic particles less than 10 micrometer in diameter whereas PM_{2.5} stands for those particles which have a diameter of 2.5 micrometer or less. PM is an abbreviation for particulate matter. It is a term used to define a blend of solid grains and liquid droplets found in the air. Some particles like soot, dust, etc. can be seen with the naked eye. Dust clouds are discernible near construction sites or on dusty, unpaved roads. Most of these particles are formed due to complex reactions of chemicals such as sulfur dioxide and nitrogen oxides, which are the noxious waste emitted by the exhaust of vehicles, industries, thermal power plants etc. Forest fires and stubble burning are also significant sources of smoke and soot. These particles are classified under category PM₁₀. But PM_{2.5} particles are too minute to be visible to the unaided eye. They can only be observed by using sophisticated instruments like the

electron microscope. While the fine hair inside the nostrils is able to filter out the PM₁₀ pollutants, PM_{2.5} is too miniscule and enters the bodies unhindered. This makes them more of a health menace. Because fine particles can be transported long distances from their origin, naturally occurring events such as wildfires or volcanic eruptions can precipitate fine particle concentrations a large distance away. PM_{2.5} is also produced by indoor activities. Some common internal sources of fine particles are tobacco smoke, cooking (e.g., frying, sautéing, and broiling), burning candles, incense sticks or oil lamps, and operating fireplaces and fuel-burning room heaters.

Not only do these particles pose breathing problems or asthma, but can also lead to 70-80% of other health issues. These particles are the most lethal because they can penetrate deep into the lungs, and some may even get into the bloodstream. Also, people already

suffering from heart or lung diseases, senior citizens, and small children are considered at a greater risk from these particles than other people, especially when they are physically active. It means that an elderly person trying to keep himself fit by morning walk or jogging will harm himself more by this pollution!

As the levels of PM_{2.5} in outdoor air increases, the air appears hazy and visibility is reduced. These conditions are similar in appearance to high humidity or fog. This happens during periods when the air is stagnant due to very little wind. The wind does not have the force to carry away these harmful particles. Conversely, when high winds blowing inland bring polluted air into a place from sources outside the place, the particle concentration increases.

Ozone is the second most dangerous parameter as it aggravates lung diseases such as asthma, emphysema, and chronic bronchitis. Other gases are major causes of cardiovascular disorders such as

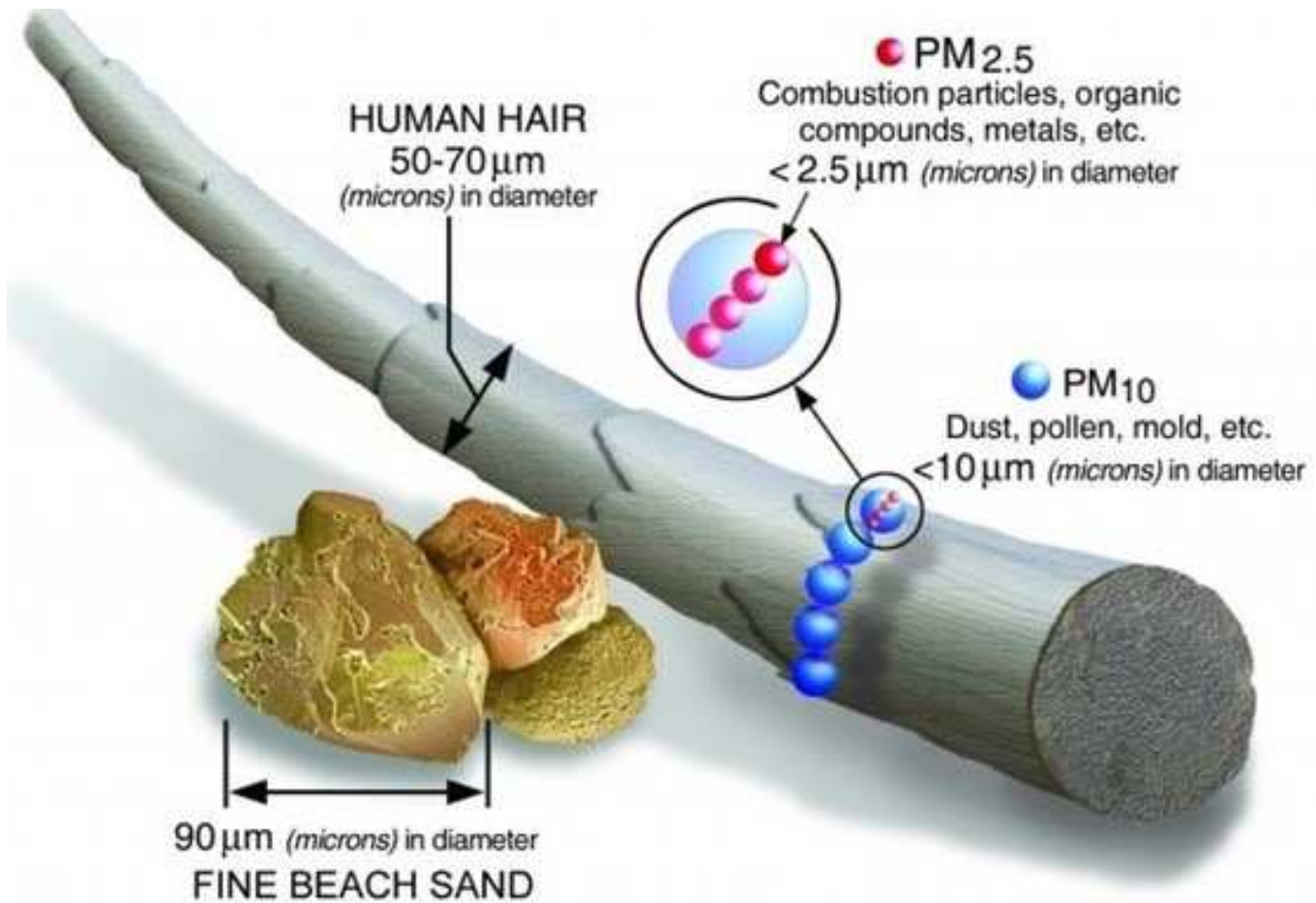


Figure 1: Particulate matter size comparison.[Source : EPA, USA]

sudden heart attacks and pulmonary diseases such as asthma.

The US Environmental Protection Agency (EPA) has published this picture which compares the size of these minute particles to everyday objects like human hair and a sand granule, as shown in Figure 1.

All the eight pollutants may not be monitored at all the locations. The overall value of AQI is calculated if data for a minimum of three of the above mentioned eight pollutants is available for a place. A further condition is that one of the three pollutants should be either PM10 or PM2.5. The concentration of these pollutants is determined. Taking into consideration the ambient concentrations, corresponding standards and possibility of effect on human health, a sub-index is calculated for each one of the contaminants. A minimum of 16 hours of data of a place is considered necessary for calculating the sub-index. Comparing the value of the sub-index for each one helps in determining the dominant pollutant for that region. The worst value of sub-index accounts for the cumulative AQI of that region.

ALARMING FACTS

The Health Effects Institute and the Institute for Health Metrics and Evaluation's Global Burden of disease project have collaborated for an initiative called SoGA (State of Global Air). This collaboration declares annually the World Air Quality report. Delhi topped the list in the fourth consecutive year, Kolkata ranked 2 and at number 14, features Mumbai, in the list of 20 most polluted cities in the world, as per the report published in August 2022.

According to the World Health Organization (WHO), around 7 million people die every year from exposure to fine particles in polluted air that penetrate deep into the lungs and cardiovascular system, causing diseases including stroke, heart disease, lung cancer, chronic obstructive pulmonary diseases and respiratory infections, including pneumonia. It is also estimated that more than 90 per cent of

air pollution-related deaths occur in low and middle-income countries, mainly in Asia and Africa, followed by low and middle-income countries of the Eastern Mediterranean region, Europe and the Americas.

A study was conducted by Sir Ganga Ram Hospital that analyzed 150 cases of lung cancer between March 2012 and June 2018. It found that 50 per cent patients were non-smokers and over 21 per cent patients were below the age of 50 years. Experts estimated that intake of every 22 micrograms per cubic metre of polluted air is equivalent to smoking a cigarette.



Figure 2: Artificial lungs

A similar study conducted by the European Lung Foundation and published in the journal 'Science Daily' in July this year validated that the pollution produced by burning fossil fuels from vehicle exhausts, power plants and industrial emissions can cause early ageing of lungs, thus decreasing its capacity.

Emphasizing the impact of air pollution on healthy lungs, doctors and environmentalists conducted an experiment in January 2019, in Lucknow, Uttar Pradesh. They installed artificial lungs in a busy street that were made from HEPA (High-Efficiency Particulate Absorber) filters and exhaust fans fitted in them which suck the air in and make the set-up function almost like real human lungs. The installed lungs started getting black within 24 hours and turned completely black in five days' time. This was done to visually portray to the common man the real meaning of poor air quality and what effects it has on living beings. This experiment was subsequently carried out at numerous places. In Delhi, last year, the lungs turned completely black in six days amid the worst days of air pollution, in Lucknow, it took five days, whereas in Bengaluru it took 25 days for the lungs to turn black.

A pair of artificial lungs put up in Mumbai's Bandra area to study the impact of air pollution started to turn black within one week, as shown in Figure 2.

The System of Air Quality Weather Forecasting and Research or SAFAR monitored the AQI at various places in Mumbai. The Bandra-Kurla Complex (BKC) recorded its worst air quality this season with the AQI crossing over 300 (very poor). Apart from Bandra-Kurla complex, Navi Mumbai recorded an AQI of 324 and Malad was at 305. While at Borivli the AQI was at 179 and at Colaba, it was at 153, which is considered as 'moderate' air quality. All other areas in the city recorded 'poor' air quality.

NOT ONLY DO THESE PARTICLES POSE BREATHING PROBLEMS OR ASTHMA, BUT CAN ALSO LEAD TO 70-80% OF OTHER HEALTH ISSUES. THESE PARTICLES ARE THE MOST LETHAL BECAUSE THEY CAN PENETRATE DEEP INTO THE LUNGS, AND SOME MAY EVEN GET INTO THE BLOODSTREAM.

GOVERNMENT INITIATIVES TO MONITOR AIR POLLUTION

The National Air Quality Index was launched in 2014 to measure the air quality in terms of six categories as described in the above table. The Central Pollution Control Board (CPCB) has developed this Air Quality Index in consultation with IIT-Kanpur and air quality-professionals and experts. The states/cities are categorized in the range of 0-500 to measure its air quality. The Ministry of Earth Sciences (MoES) has introduced a national initiative called SAFAR, which is an acronym for System of Air quality Forecasting And Research. It measures the air quality of a large city by determining the overall pollution level and also the specific air quality of different locations in a metropolis. Scientists use the pollutant data in mathematical models and evaluate the AQI in the city to design the air quality exposure guidelines.

USEFUL MEASURES TO COMBAT AIR POLLUTION

Air pollution is a silent poison. It can have both short term as well as long term detrimental effects on health. Some steps can be taken to weaken its effects.

1. Using a proper mask: This has now become the new normal, after the pandemic hit hard. Everyone knows the importance of N95 quality masks in preventing against the microscopic corona virus. While these are standard quality masks, a perfectly fitting cloth mask which completely covers the nose and mouth, or an air purifying mask will serve to diminish the entry of the particulate matter inside the nostrils.
2. Nutritious food: A proper vitamin rich diet helps in protecting the body from the adverse effects of pollution. Doctors and nutritionists prescribe Vitamin A, C, E, seeds, nuts and loads of fruits and vegetables in the diet. Fruits having high amount of Vitamin A, C, and E

AS THE LEVELS OF PM2.5 IN OUTDOOR AIR INCREASES, THE AIR APPEARS HAZY AND VISIBILITY IS REDUCED. THESE CONDITIONS ARE SIMILAR IN APPEARANCE TO HIGH HUMIDITY OR FOG.

help in repairing the body, and fighting inflammation that is caused by pollution or any kind of toxin. While fruits will help you feel energised, vegetables will act as anti-oxidants. Also, drinking plenty of water is a must. The only way to flush water-soluble toxins out of the body is to keep it hydrated.

3. Install air purifiers: The indoor air pollution in offices and homes can be controlled to a large extent by using air purifiers. Though commercial air purifiers are expensive, there are many contraptions that can be “do it yourself”, which, while being cost effective, can be made from easily available material and help in alleviating the concentration of pollutants in the home or office.

4. Air purifying plants: Indoor pollution affects one more than outdoor pollution as most of urban population spends a large percentage of the time indoors, be it home or office. Major sources of indoor pollutants are chemicals-based cleaning products, traditional cooking technique using wood and coal, deodorants and perfumes, detergents, pest repellents, air fresheners, and other sources of CFC (Chloro Fluoro Carbons) like refrigerators and coolants. To reduce the amounts of indoor pollutants, air purifying plants like Aloe Vera, spider plant, snake plant, bamboo palm, and others can be planted inside the buildings. These plants neither need regular watering nor strong sunlight and are a good source of oxygen.

5. Minimize outdoor activities: This is the last option one has to resort to in case

of extreme values of AQI. While it is not possible for everyone to remain indoors for a long time, it is advisable in case of weak and aged and children to protect them against the hazardous, poisonous atmosphere outside. Outdoor exercising should be strictly avoided as any kind of working out will induce deep breathing, which in turn will cause more toxins to enter the body. A person can refer to the Air Quality Index (AQI) any day to find out the extent of pollution in the air. The AQI rating warns of the associated health hazards that may be of concern. The AQI data is conveniently represented by numbers and colours that help people understand when to take action to protect their health. The problem is, air pollution masks and purifiers that are available at present do not protect a person from gases. They are only able to control the particulate matter to some extent. The only way of protection from these gases is to control their sources.

CONCLUSION

While the AQI monitoring of a place has become easier due to advanced techniques like mathematical modelling and data acquisition tools, the controlling of AQI to safer level is becoming harder by the day. Urban activities, the depletion of greenery, population explosion and stupendous increase in number of vehicles per capita, all serve to maintain the AQI level at a harmful notch. The world witnessed a phase of clean air during the lockdown due to the Corona outbreak. While lockdown is not a solution to the pollution problem, alternate solutions must be thought of, if we intend to stay healthy and breathe freely in the near future.

AIR POLLUTION IS A SILENT POISON. IT CAN HAVE BOTH SHORT TERM AS WELL AS LONG TERM DETRIMENTAL EFFECTS ON HEALTH.

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ZEBRAFISH: IMPORTANCE IN BIOLOGICAL SCIENCE RESEARCH

Rahul Goyal

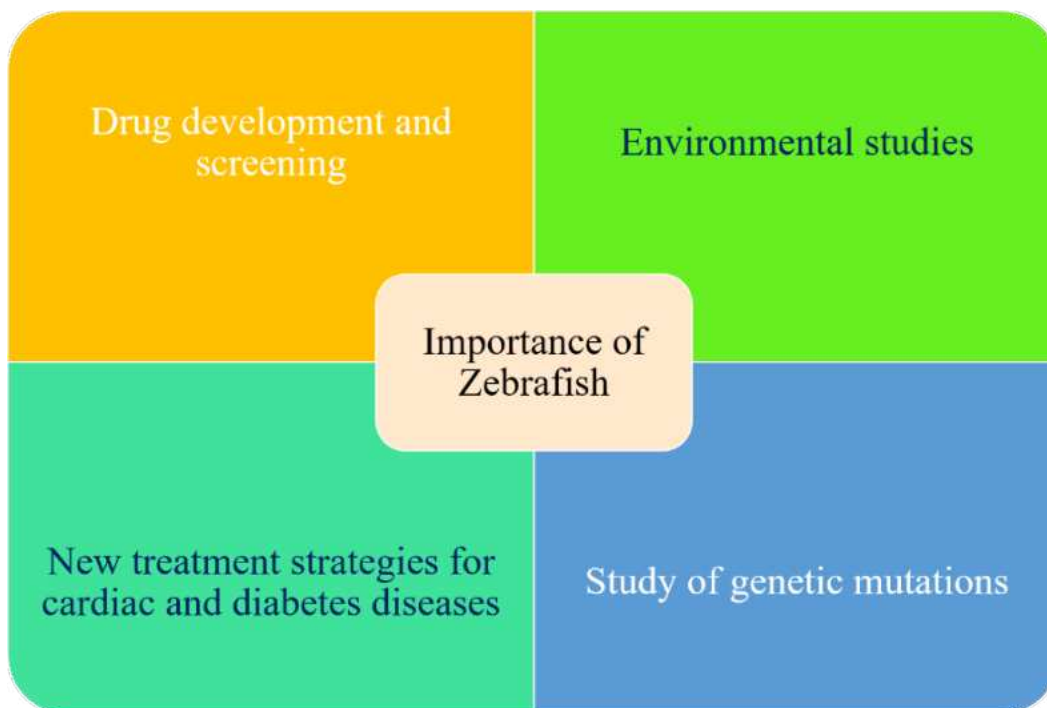
INTRODUCTION:

Zebrafish are also known as *Danio rerio*. They are tiny, lively, and colorful fish. Due to their capacity for tissue regeneration, and rapid growth, zebrafish have emerged as a crucial scientific model organism. Since their embryos are transparent and their development can be readily seen, they are essential in genetic and developmental studies. Since zebrafish and humans have

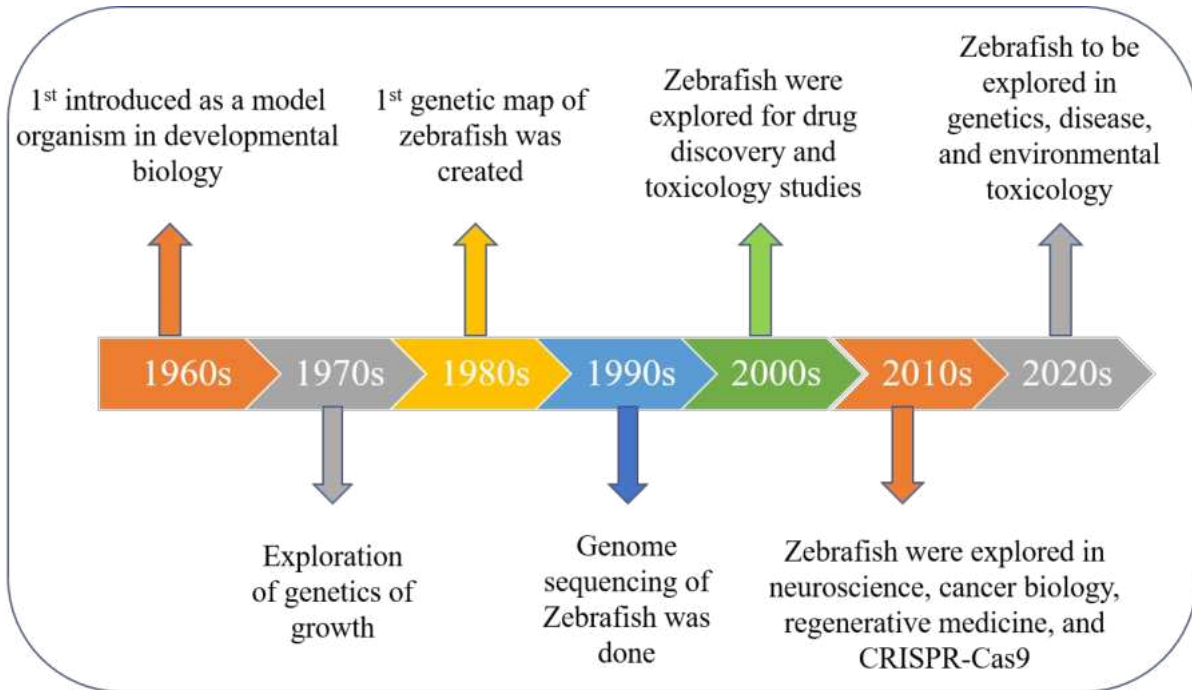
many genetic and physiological similarities, researchers use them to study diseases and try new medications. Zebrafish are significant in biological science, but they are also well-liked in the tank industry because of the simplicity of maintenance. They can survive in various tank environments and are hardy and flexible.

IMPORTANCE:

Zebrafish have grown important as a model organisms in biological science research activities due to their numerous characteristics, making them helpful for various studies. Zebrafish are essential because of many reasons, as mentioned in the schematic:

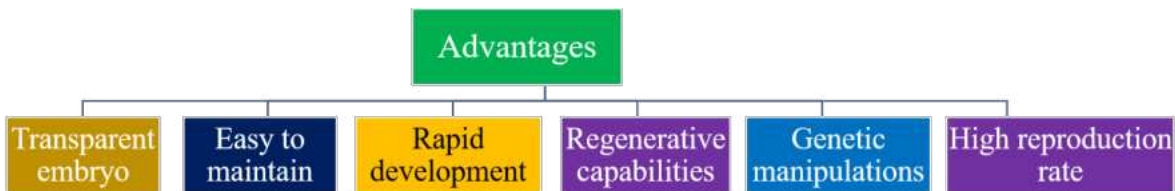


TIMELINE OF ZEBRAFISH-BASED RESEARCH:



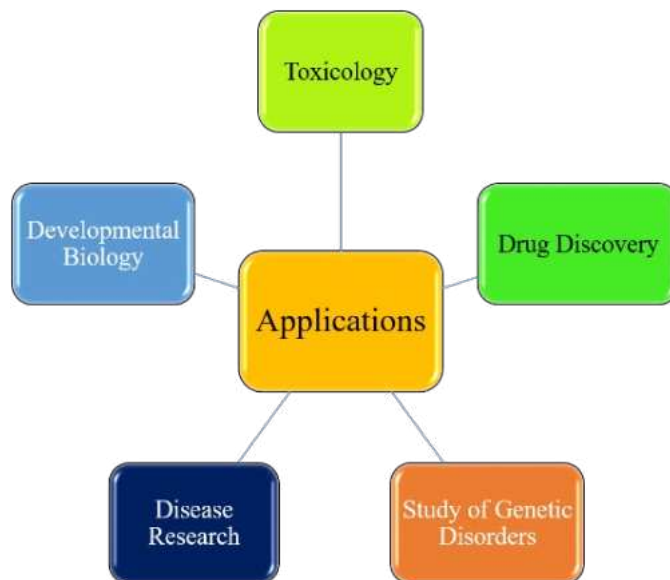
ADVANTAGES:

Zebrafish have become a well-known model organism for biological science research. Some of the main benefits are mentioned in the schematic:



APPLICATIONS:

Zebrafish are used in a variety of research studies. Here are some of the crucial applications as shown in the schematic:



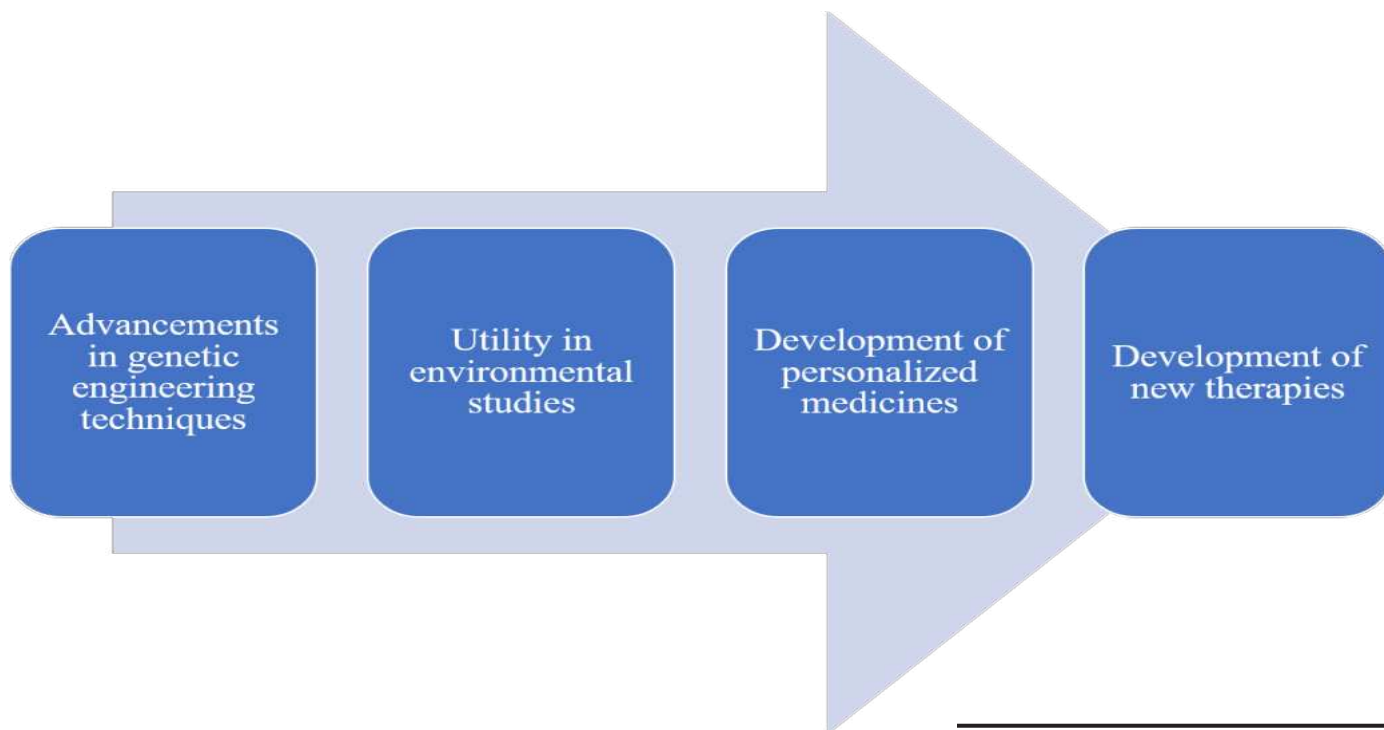
POSSIBLE CONCERNS ASSOCIATED WITH ZEBRAFISH-BASED RESEARCH:

As a model organism for biological science research activities, zebrafish has many benefits but also some potential drawbacks. The following are some drawbacks of the zebrafish-based study:

- 1. Ethical issues:** Using zebrafish for study raises ethical issues, just like using animals does. The welfare of the fish must be prioritized, and researchers must ensure that their studies are done ethically.
- 2. Lack of human translation:** Zebrafish and humans have many genetic and physiological similarities but vary significantly. Therefore, it's possible that results from zebrafish-based research only sometimes apply to humans.
- 3. Limited behavioral studies:** There are few studies on zebrafish behavior because these animals are mainly used to study disease, genetics, and development.
- 4. Limited range of study applications:** Zebrafish are adaptable model organisms, but there may be better options in some fields of study. For instance, zebrafish might not be the best choice to study conditions like Alzheimer's disease, which mainly affects humans.
- 5. Technical restrictions:** The scope of some studies may be constrained by the need for specialized tools or methods that are not currently accessible for zebrafish research.

FUTURE SCOPE:

Zebrafish-based biological research has bright future possibilities. Some of them are shown in the schematic:



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Fig. 1. A model of Scalloped Hammerhead Shark Fish at the Indian Museum, Kolkata (Photographed by: Rinki Mukherjee Saha, at the Indian Museum, Kolkata)

SCALLOPED HAMMERHEAD SHARK— A FISH HOLDING BREATH LIKE A MARINE MAMMAL

Sanjit Kumar Saha

After a long time as on 9th May, 2023 I have visited Indian Museum, Kolkata with my family members. I have found lots of specimens, stuffed animals and models as exhibits for the visitors. In Fish and Bird gallery lots of exhibits are there, having with very minimum information of habitat type and nomenclature. As per the website of the Indian museum the focus of the gallery is to inform the visitors about the habitat of those fish, birds, their behaviour and interaction with the habitat. From those model exhibits (Fig. 1) one may get the idea of habitat of the species. But behaviour of a species and their interaction with the habitat can't be depicted with those static model exhibits. But those models are exciting enough to encourage one to study further about the behaviour of an animal and interaction with their habitat.

I was interested to know more about the Scalloped Hammerhead Shark (*Sphyrna lewini*) (Fig. 2). 'Sphyrna' is a Greek word, means 'head'. 'Scallop' means series of small curves along the edges. Actually this Shark is having an unusual hammer like head, equipped with series of small curves along the edges and eyes are situated in both the faces of the hammer head. This is actually

giving them 360° full circular visions including upper and lower view in the ocean water. Scalloped Hammerhead Shark is distributed in the tropical and warm ocean waters of the Bay of Bengal, Indian Ocean, Pacific Ocean and Atlantic Ocean. From 2008 to 2018 IUCN assessed it in the Critically Endangered category from the endangered status due to its decreasing population worldwide. It is having threat from the unregulated fishing mainly for its fin, apart from the meat. China is the biggest consumer of the fins of Hammerhead shark. Recently CITES has regulated the international trade being its critically endangered status. But it will not work until unless human being will stop relishing on the fin soup of Hammerhead and other Sharks in the hotel-restaurants worldwide.

Mark Royer and his team of Shark Research Group of the Hawai'i Institute of Marine Biology (HIMB), USA recently reported cryptic breathing physiology of Scalloped Hammerhead Shark in world famous 'Science' journal. They have found that ectothermic or cold blooded Hammerhead Shark (*Sphyrna lewini*) can actively regulate their internal muscle temperature at the cold ambient water of mostly mesopelagic and initial bathypelagic zone of deep sea. It is the first report that any fish is actively regulating the internal muscle temperature without any adaptation

in the blood vessels or in muscles of the internal organs. Tuna and Sword fish can regulate their internal muscle temperature in cold water of the deep sea with specific adaptation in blood vessels and in internal muscles. To know the actual mechanism of thermo regulation being a cold blooded fish in comparison to the warm blooded animal like us, the research team tagged state of the art remote bio-loggers at the basal portion of the fins of sampled hammerhead sharks. Those tagged bio-loggers were packed with all the devices to get the temperature of the ambient water of deep sea and surface, internal body temperature and orientation of body at descent and ascent in deep sea (Fig.3).



Fig. 2. Scalloped Hammerhead Shark (*Sphyrna lewini*) (Source: Science Journal)

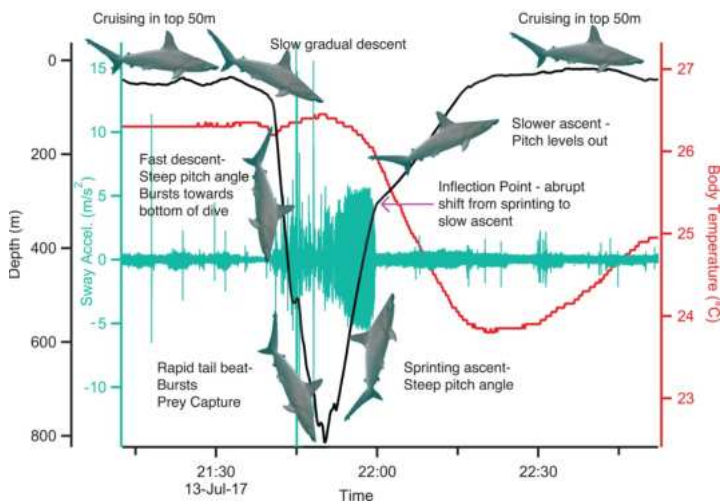


Fig.3: Orientation and internal body temperature of Scalloped Hammerhead Shark at descent and ascent in deep Sea
(Source: Science Journal, science.org)

The study results were very interesting and new to the science. Altogether the team have recorded 106 deep dives from 7 of the 10 Hammerhead sharks in the North Pacific Ocean. During their study, they have counted 6 repetitive dives mostly in the evening by a single shark with an interval of approx 40 - 45 minutes of surface side swimming. Ectothermic fish can exchange body heat with the ambient water mainly by two means viz. (1) conduction from body wall and (2) convective heat loss by blood flow through the Gills. It was found that Scalloped Hammerhead Sharks are closing their mouth and Gill slits during deep dives and open again after ascending in the surface water. At frigid water due to closing of mouth and gill slits, counter current flow of frigid water and blood both are suspended to the gills. Thus convective heat loss from blood flow across the gills was suspended. Thus they are holding the breath at frigid water like marine mammals as an active thermoregulation strategy, except being an exothermic fish. This specialized adaptation of 'active thermoregulation through breath holding' though helping Scalloped Hammerhead Shark for hunting through foraging, but also acting as a risk factor during unregulated fishing. Surface interval of 40-45 minutes during two deep dives is very crucial for the Scalloped Hammerhead Shark to perform normal aerobic respiration and metabolic activities by taking dissolved oxygen of ambient water from the normal

tropical and warm temperate waters. The appropriate authorities of each and every international Government should educate the fishermen to stop by-catch of Scalloped Hammerhead Sharks. The legal and regulatory bodies should prohibit the illegal fishing by imposition of strict law, apart from regular protection, monitoring protocol.

In recent time deep sea mining for polymetallic nodules is also imposing threat for the survival of these deep diving sharks. Mining agencies and International Sea Bed Authorities are claiming that polymetallic nodules comprises of Nickel, Copper, Manganese, Cobalt, Lithium etc. will help to manufacture different parts of the Electric vehicles, rechargeable batteries in low cost and ultimately consumers will be benefitted from that. The objective of electric vehicles is also to stop carbon emission in the atmosphere. But deep sea mining is associated with enormous load of pollution like



counter current flow of ambient water and blood to the Gills. Fishermen should avoid surface water fishing from the evening to night where schools of Hammerhead Sharks are there. Fishery department, wildlife wing of every international government with the help of marine biologists should identify and specify the extant and nursery of Scalloped Hammerhead Sharks in their territory of coastal,

water pollution, sound pollution, thermal pollution, air pollution, plastic pollution etc., which ultimately leads to habitat loss and destruction of deep sea biodiversity. Ocean is a reservoir of blue carbon also. So, destruction of deep sea biodiversity by deep sea mining may add further increase in normal oceanic temperature with the effect of climate change and global warming. Due to its specialized adapted habit the live and livelihood of Scalloped Hammerhead Sharks are totally dependent on the surface and deep sea habitat of tropical and warm ocean water. Nature through the course of evolution have specialized them to cope with the extremities of the environment. But human action leading them towards extinction by challenging their specialized adaption achieved through evolution. Now the survival and surpassing of extinction of Scalloped Hammerhead Sharks, other Shark species and other aquatic animals in large are dependent on our changing attitude and behaviour from Global Consumerists to Global Conservationists (GC2GC).

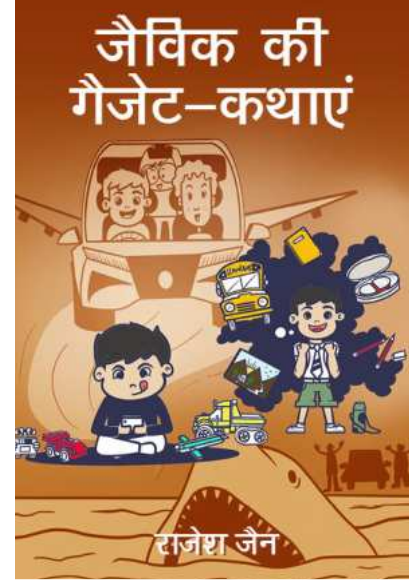
With proper research, development (R&D) and with the help of modern tools and techniques like 3D Computer graphics, Artificial Intelligence (AI) and Data Science (DS), 3D-Printing, Internet of Things (IOT) the Museums of natural history, science Museums in India and abroad has to depict such kind of specialized habit, behaviour and interaction of important faunal species to its habitat. These Museums can act as a platform of Conservation Communication (CC) based on the depiction, visualization and Communication of Science (CS) among the visitors. It will surely sensitize, inculcate compassionate conservation among the children and general masses to conserve our biodiversity, nature and environment.

Sanjit Kumar Saha is a Science Writer and Conservation Communicator and working as Deputy Conservator of Forests, Personnel at the Office of the Principal Chief Conservator of Forests (Head of Forest Force), Kolkata in West Bengal.

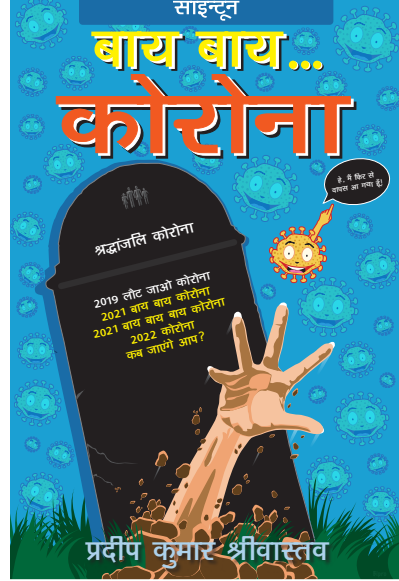
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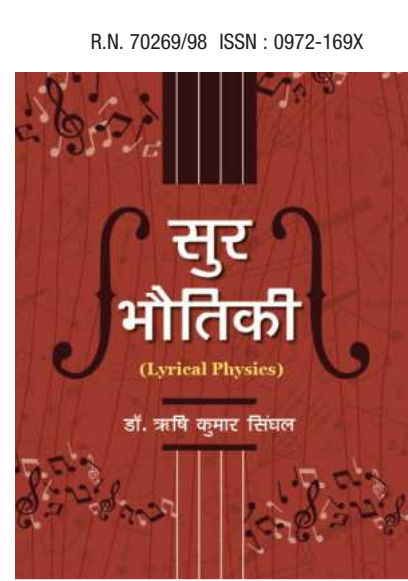
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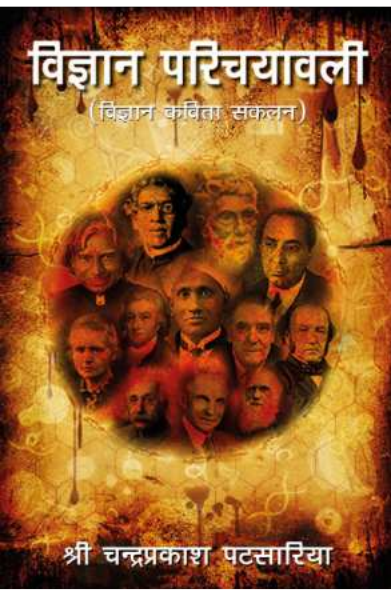
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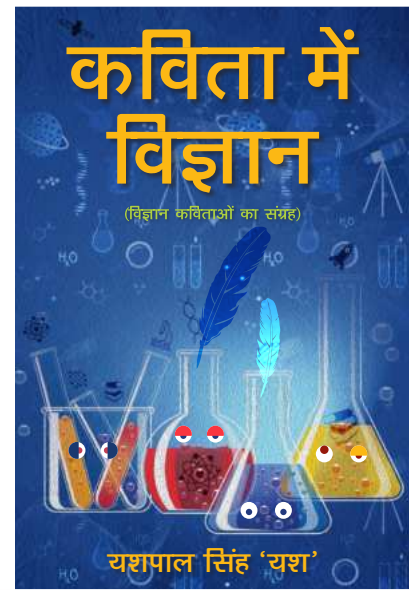
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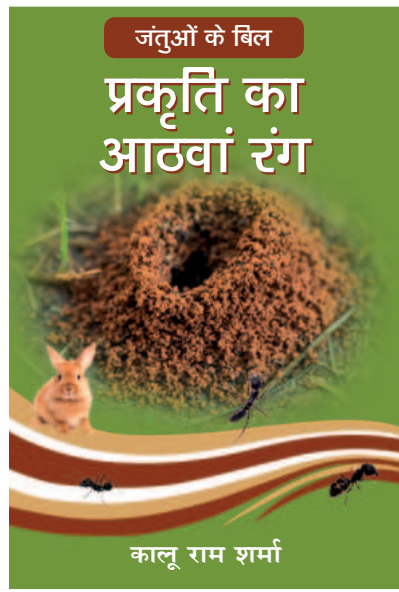
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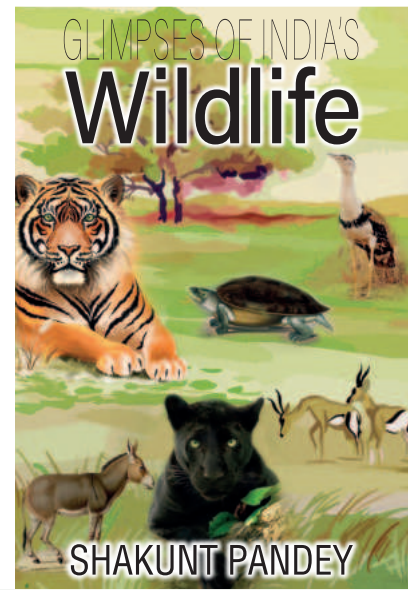
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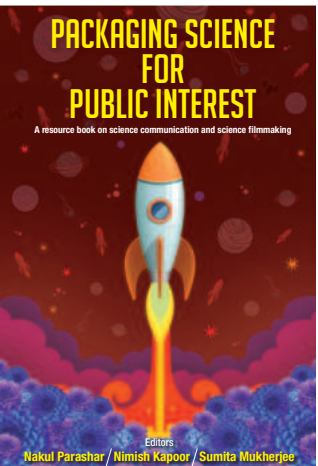
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(विज्ञान कविताओं का संग्रह)
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जंतुओं के बिल प्रकृति का आठवां रंग
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GLIMPSES OF INDIA'S Wildlife
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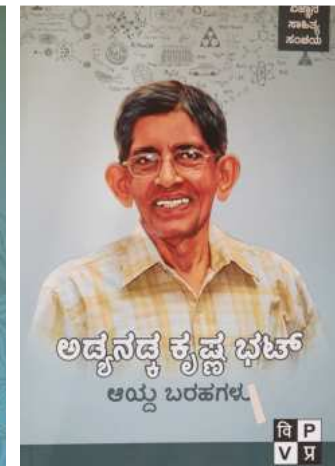
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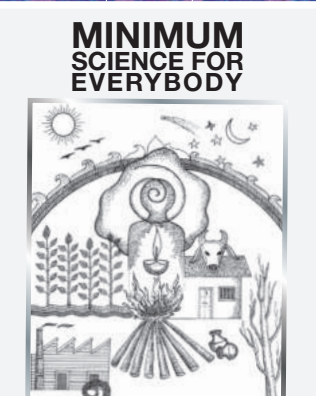
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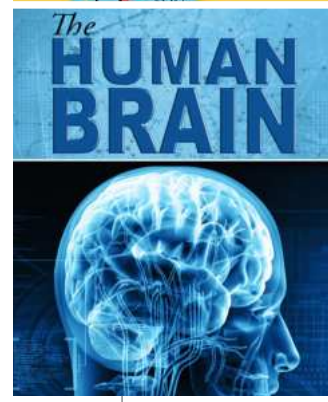
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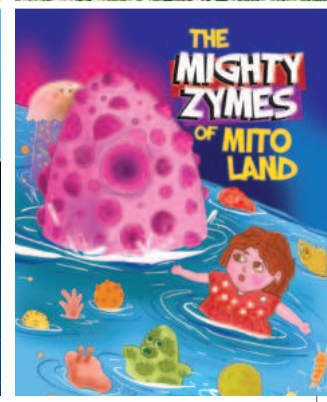
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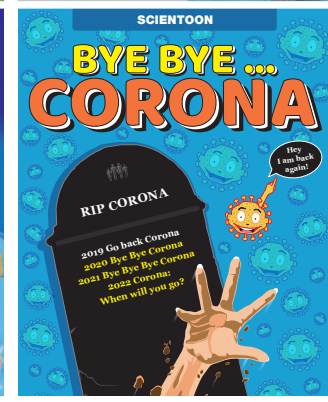
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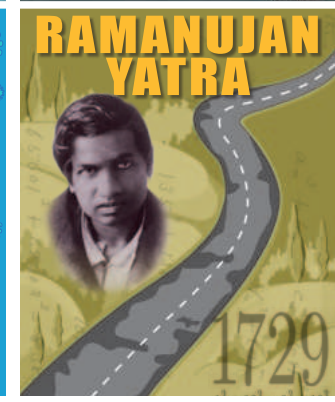
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